COMPREHENSIVE PROSTHODONTICS NOTES

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Preface:

In the name of Allah, the Most Beneficent, Most Merciful

My dream after I earned my bachelor's degree with honor degree from King Saud University is how I can be a diplomate of American Board of Prosthodontics. It was my first aim since day one in my residency at University of Medicine and Dentistry of New Jersey.

I was trying to do each procedure based on a scientific evidenced. As clinician, we have many questions in our mind that require answers and unfortunately there is no one textbook or serials of articles answer all of those scientific questions. I have been through a hunderds of articles and textbooks to find a way of studying that will build my knowledge and skills based on science not on speculations. I try to cover each topic from all aspects starting from the fundamentals and going to the advance. Each point has its reference. I try to cover the controversy topics and giving reader the option to select.

After spending more than 6 years, days and nights, in the prosthodontics field, I found that it is my responsibility to chaire the knowledge that I have with all of my prosthodontics colleagues. The Prophet Muhammad peace be upon him said: "Every act of goodness is charity". Knowledge Sharing is Intellectual Charity. Please remember me in your prayer and spread the notes to all colleagues.

- First edition, 2015.
- My website will contain an important scientific materials
http://www.elitedoctorsonline.com/dr1090
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Contents

The Prosthodontics Patient

- Brewer 1964:
  - initial exam begin when you meet the patient before seating in the dental chair
  - classification of body types to:
    1- ectomorph: thin, likely to have thin inelastic mucosa
    2- endomorph: fat, easier to treat because think of eating
    3- mesomorph: normal
  - Question parafunctional habit, known pt desired, expectations, preextraction records, consultation if needed.

- Koper 1967;
  - Difficult denture birds
  - 5% of pt can't wear denture & he classify them to 5 birds species
  -

- Albrektsson 1987:
  - transfer pt from removable denture to fixed
  - 80% of pt felt quality of life improve

- Alvi: psychological study of self concept, self concept consist of
  1- perceptual: pt image of his appearance
  2- conceptual: pt conception of their own ability
  3- attitudinal: pt feeling about himself

- Koper, 1970: initial interview with complete denture (CD) pt
  - methods for interview: verbal, nonverbal & extra-verbal
  - establishment of trust:" trust talk" period-> eye to eye contact & give him all attention
  - evaluate pt problems: comfort, esthetics, function or retention
  - pt health & living patterns: medication, occupation, general health
  - oral examination & consultation if needed

- Barone, 1964: Dx & prognosis of CD prostheses
  - before denture construction -> Dx & prognosis should be made
  - Dx-> health history, clinical examination as follow:
    - evaluate existing denture: esthetics, VDO, CR, speech, retention, stability-> explain to pt short coming
  - Intra-oral exam:
    - ridge shape & form   -character of ridge & soft tissue
    - ridge relationship   - muscle & frenum attachment
    – inter arch space   - throat form
    - tongue position, size, & shape   - character of saliva – pathosis
    - asymmetry – height of lip - radiograph – mounted Dx Casts

-Koper 1964: why denture failed?

- Inadequate pt examination -> most common
- Psychological limitation-> emotional problems
- Physiological limitation-> structure abnormalities: tori or resorbed ridge
- Dentist limitations-> skill, error in denture construction
- Lack proper aftercare

-Rissin & Koper 1985: 6 years report of fixed & removable effect of abutments:

- Similar effect of fixed & removable in periodontal health
- With proper denture hygiene & good design prosthesis-> perio health can be maintain

- McCraken-> long-standing tooth has better prognosis if splinted to another tooth by fixed bridge

- Culpepper-> present a technique of refitting RPD to new abutment crown:

- Fabricate GC coping on die> add acrylic on coping and seat RPD over> contour clasp & rest will form> wax remaining contour & morphology
- Splint tooth to adjacent to improve stability, support & function of tooth with less perio support or small cone shaped root

- Landa 1985 DCNA: Dx & management of partially edentulous cases:

- 6 Mn anterior> splint & use attachment
  > circumferential clasp
  > swing look
- Mn canine only> Akers or RPI clasp
  > splint with bar or potics
  > splint with intra-coronal or extra-coronal attachments
  > OD with coping & bar
- Unilateral central, lateral& canine> simple OD> reduce stress on the root & preserve bone
- Mx 6 or 5 Anterior> splint & attachment
  > conventional RPD with palatal coverage
- 2 Mx Canine> conventional RPD (RPI or Akers clasp)
  > anterior pontics or bar for cross arch stabilization
  > it is rarely justify maintaining one or two root for Mx OD since it will make flange buldge& esthetic difficult
  > try to maintain Mx anterior teeth for OD when oppose Cl I or II RPD in Mn
- Posterior molars: Mn> single molar keep it for temporary base before CD
  Mx> remove it bc gravity , no indirect retainer, peripheral seal will be impossible
- Posterior premolars> no rest seat to avoid Cl I lever, use WW
- Canine& premolars> Mx> splint & attachments> cover palate to resist force
  > Mn> endo,coping, & OD> no attachment

Boucher's Prosthodontic Treatment for Edentulous Patients:

Chapter 2:

Forces acting on the teeth:

1- during mastication-> short periods
2- during deglutition-> long duration(500 times/day)

1+2= forces is vertical – 17.5 min/day total time of teeth contact & > ½ during swelling

3- tongue & muscles of cheek & lips
4- Parafunctional forces

- Teeth contact in natural dentition only in function(chewing and swelling) or parafunctional movement

Mucosal supports:

- Mucosal membrane provide supports as PDL in natural teeth
- Area of mucosa available to receive load in CD is limited & it is 22.96 cm^2 for Mx and 12.25 cm^2 for Mn compare to 45 cm^2 for PDL support in each arch of dentate patient
- Maximum forces in dentate is 44 Ib(20 kg) & 19 Ib(8 kg) for denture during swelling
- Maximum bite force is 5 to 6 times less for CD (forces vary with type of food)

Residual Ridge(RR):

- RR is composed of denture bearing mucosa, submucosa, and periosteum & underlying residual alveolar bone
- residual bone is bone of alveolar process after teeth lost
- all principles of CD construction is to:

1- minimize forces transmitted to supporting structure
2- decrease movement of prosthesis

- forces affect CD retention:

1- physicals: maximum extension of base, max intimate contact of denture base to the basal seat
2- muscular: buccinator, orbicularis, intrinsic & extrinsic muscle of the tongue – polished surface contour

- psychological effect retention by nervous influence by ↓ saliva
- component of occlusion: dentition, neuromuscular, craniofacial structure

Function	Vertical	Intermittent Light	Diurnal only
Parafuctional	vertical & horizontal	Prolong excessive	Diurnal & nocturnal

- Parafunction: involve repeated or sustained occlusion

⇒ Causes: emotional, nervous tension, pain or discomfort, stress & occlusal interferences ⇒↑ muscle tonus & interferences

Tissue Recovery:
- constant load for 10 minutes→ need 8 minutes for 90% recovery & 4 hours for total recovery (Kydd 1971)

Morphological changes associate with edentulous state:
1- prognathic appearance 2- Deeping nasiolabial angel 3- narrowing lip
5- ↓ horizontal labial angel

Direct sequel of removable prosthesis:
1- RR resorption 2- perio disease 3- caries
4- mucosal reaction (mucositis) 5- alter taste
6- burning mouth syndrome

Denture stomatitis: pathological reaction of denture bearing palatal mucosa
- denture induced stomatitis, inflammatory papillary hyperplasia, or chronic atrophic candidasis
- prevalence is 50 % among CD wearers
- Newton's classification:
  type I: pinpoint hyperplasia
  type II: generalized erythema of entire mucosa
  type III: agranular type- papillary hyperplasia, nodular type on hard palate and alveolar ridge
- associate with candida infection, bacterial & mechanical irritation
- type I is related to trauma, type II&III are associated with microbial infection(candida or infection)

signs associated with candida denture stomatitis:
1- erythemia of soft palate 2- angular chelitis 3- atrophic glossitis
- Etiology; 1- systemic(DM's, old, nutrition, malignancy)
2- local factors: denture hygiene, xerostomia, smoking, antibiotics
- Treatment: depends on cause →
1- Preventive: O.H, 8 hours out of mouth, brushing of denture and denture bearing mucosa
2- Antifungal therapy: after confirm Dx →Nystatin,amphotercin B ,Micronizole for 4 weeks →avoid systemic medications
2- Correction of ill fitting denture (for relining remove at least 1 mm of antaglue surface because microorganism penetrate to it
3- efficient plaque control

Flabby ridge:
- due to replacement of bone by fibrous tissue
- common in anterior maxilla due to remaining mandibular anterior teeth
- sequel of →excessive forces & unstable occlusion
- flabby ridge provides poor support but shouldn't removed surgically since it will eliminate vestibular height

Denture irritation hyperplasia:
- sequel of ill fitting denture with thin or overextended border
- Tx: adjustment or surgical correction

Traumatic ulcer:
- sore spots develop 1-2 days after denture insertion due to
1- overextension 2- occlusal interferences

Burning mouth syndromes (BMS):
- burning sensation in one or several oral structure in contact with denture
- different than burning mouth sensation in that oral mucosa is healthy
- majority affect CD wearer, woman over age of 50 y
- signs & symptoms:
  - feeling of dry mouth, alter taste sensation , headache, depression
  - aggravating factors: tension, fatigue, hot food,
  - reduce pain by sleep, eating & distraction
- etiology:
1- local factors: mechanical irritation, allergy, infection, oral habits
2- systemic: common in menopausal, DM, medications, xerostomia, vitamins deficiencies
3- psychological: depression, anxiety
- Tx: define cause

Residual ridge resorption:
- Due to bone remodeling after extraction which is loss of height about 4-5 mm in mandibular & 2-3 mm in maxillae in first year , then 0.1-0.2 mm annual loss in Mn which is 4X greater than Mx
- Pathogenesis is not well understood but it could be mechanical, anatomical, & metabolical

<u>Prosthodontics Diagnostic Index ‘PDI’</u>

(McGarry 1999 JP)

- catogrized from Cl I (uncomplicated) to IV(complicated&high risk)
- Advantages of system:

1- better pt care 2- improve professional communication 3- appropriate insurance reimbursement 4- stander criteria for outcome

- criteria for edentulous pt:

1- Residual ridge morphology of Mx:

types: A→resist V&H forces, hamular notches, no tori→Cl I
B→no Buccal vestibule or poor hamular notches→ Cl 11
C→no labial vestibule, minimum labial support, mobile ant ridge→ Cl III
D→ No labial or buccal vestibule, redundant tissue, tori→Cl IV

2- Mn bone height measure at least hieght:

Cl I → ≥21mm, 16-20, 11-15, Cl IV ≤10 mm

3- Mandibular muscle attachment:

A→adequate attach mucosa →Cl I
B→no labial attach mucosa (22-27)+ mentalis muscle→Cl II
E→no attach mucosa, cheek& lip move tongue→ Cl IV

4- Mx- Mn relationship: CL I,II, or III
5- Interarch space: limited needed surgical correction→Cl IV
6- Tongue anatomy: large→fill interarch space→ Cl III
Hyperactive→retracted→Cl IV
7- conditions required pre-prosthetics surgery:
- minor soft tissue procedure oR simple implant→Cl III
- implant+ bone graft or need for hard tissue augmentation→Cl IV

8- modifiers:
- systemic disease (mild I, moderate II, severe III)
- psychological – TMD symptoms→ Cl III

For partial edentulism :

- based on four broad diagnostic criteria :

1- location & extent of edentulous area→ single compromised →Cl I
Moderate compromised →Cl II
2- abutment condition→ severe compromised ≥4 sextant
3- occlusion: severly compromised or change VDO → Cl IV
4- Residual ridge→ Cl I-IV used same as CD

- pt with severe oral manifestation of systemic condition→ Cl IV

Diagnosis for Complete Denture

- Dx based on data collection:
1- patient evaluation: gait(patient walk to clinic), age,sex, cosmatic index (high ‘ most difficult’, moderate & low)
- Mental attitude; House classification in 1950 as;
    - Philosophical – either had no experience and not anticipating any difficulties in that regards or worn satisfactory denture
      - easy going, mentally well adjusted, cooperative, & has confident in dentist→ Excellent prognosis
    - Exacting – precise, concern on their dress & appearance, dissatisfy with previous Tx, no confidence in dentist ability to satisfy them→ very difficult to satisfy but when satisfy give support
    - Hysterical: those with bas health, long neglected pathological mouth, emotionally unstable & complain without reasons → wear denture but fail, hysterical, nervous, very exacting, want denture like natural teeth→ Difficult to Tx, poor prognosis
    - Indifferent: unconcern about their appearance, feel little or no necessary for teeth, uncooperative, non- appreciated

2- personal and medical history: taken first by pt fill questionnaires(DM, CV..)
3- Dental history:
- chief complain – expectation (realistic, attainable, unrealistic)
- period of edentulism – pre-treatment record →information about previous CD, pre-extraction records, pictures
- current denture: periods, VDO, CR, esthetic, extension, retention, stability, mold, contour, presence or absence of rugea, comfort(good, fair, poor), wear or breaking
4- Dx cast: mounted Dx cast at tentative VD to assist inter-arch space, ridge form & shape, baseline record

Clinical Examination:
- Extraoral- head & neck(look for pathology), muscle of mastication & facial expression,
- TMJ- range of movement, pain, joint sound
- Facial forms- help in teeth selection(William- square, taper, ovoid or combination looking to bi-zygomatic arch and bi-angular)
- Facial profile-Angel classification to straight, retrognathic, prognathic
- Lower facial height- with & without denture at VDO
- Lip exam- support(adequate or unadequate),mobility, thickness (thin affected by teeth position),length of lip(short difficult)
- Neuromuscular examination: speech, & coordination (Parkinson) facial movement &tongue

Intraoral exam:
- Remaining teeth- caries, perio, mobility & position

- Mucosa – color: healthy pink color or redness indicate inflammation (smoking,systemic, ill fitting) white or red patches
  - condition: healthy , irritated or pathologic
  - thickness: Cl I→ uniform density, 1mm thick, firmly attached to underlying bone
- Saliva- normal Q&Q → ideal adhesive & cohesive properties
  - excessive→ contain much mucus →thick ropy saliva →accumulate between denture & tissue→affect retention & impression
  - Xerostomia→poor retention& tissue irritation
- Residual alveolar ridge:

1- Arch size→large- good retention & stability, small- difficult
2- Arch form→ square- ideal support, ovoid- good, taper- worse
3- Ridge contour→ inspection& palpation- high ridge with flat crest (ideal), flat or knife ridge
4- Ridge relashionslip→postion relation of Mn to Mx
→Mx ridge resorpe upward& inward
→ Mn ridge resorpe downward & outward
→ normal, retrognathic or prognathic
5- Ridge parallism→ relation parallism between planes of ridge →teeth set up easy in parallel ridge
6- Interarch space : ideal- accommodate teeth, excessive or insufficient
7- Others: ridge defect, exostosis, undercut, redundant tissue

Hard Palate:
- palatal vault shape→U- shape – ideal for retention & stability
→V- shape- easy to break seal- poor retention
→ flat- less stability

Soft palate: relation with hard palate (House cl)

1- Cl I→ horizontal- little muscles movement- ↑PPS
2- CL II→soft palate make angel of 45° to hard palate
3- CL III→ angel of 70°→minimum PPS associate with v-shped palate

Palatal Throat form: house classification to

I- Larg& normal→5-12 mm of immovable band of tissue distal to the line across distal edge of tubersity→ Ideal
II- Normal size- 3-5 mm distally
III- Small maxillae- turn abruptly- 3-5 mm of immovable tissue anterior to the line→ unfavorable

-Lateral Throat Form: Niel classify of lateral throat form (retromylohyoid fossa) to CL I,II,III
- bony undercut& tori→ small-relief, large- surgery
- muscle & frenum attachment→abnormal attachment- display denture- consider surgery
- Tongue- Wright classification-→normal or retruded(33%)
- Floor of mouth- in relation to ridge crest

Radigraphic exam: pan provide entire image

- screening of TMJ, remaining teeth or roots, implaction, cyst, tumor
- amount of ridge resorption:
  - Lower edge of mental foramen divide Mn to upper 2/3 & lower 1/3
  - Alveolar ridge height= 3 X distance between lower border of Mn & mental foramen(Wical & Swoope)

  Nb: Cameo surface= polished surface of denture, intaglio & occlusal surface →By Fish

<u>Hinge Axis (HA)</u>

- Hinge axis or transverse HA or inercondylar axis or horizontal axis
  - It is hypothetical imaginary line connecting two horizontal rotational centers of the two condyle of Mn (Aull)
  - Mechanical location of axis first by Dr.Roben Harlan
  - Kinematic location of axis first by Dr. McCollum through gnathological society
  - Mn rotate around 3 axis→frontal, sagital & horizontal
  - The rotation average is 12° or 18-25 mm of incisal opening according to Rahn
  - Controversies regarding HA: single or multiple, methods to locate, validity & relation to CR
  - Mn closes in axis → Bennett & Gysi
  - Pages opinion→there is a hinge axis but two arcs of rotation
    → single point in condyle can't be located & transferred to articulator

- Aull 1963:
  - 4 theories regarding location HA:
    1. Absolute location of the axis:
       - If HA in pt not same as articulator, then reproduction of jaw motion is impossible
       - McCollum , Lucia- gnathological group
    2. Arbitrary location of axix:
       - actual location of HA is not worth effort and arbitrary HA as good as kinematic location
       - Craddock, Guichete, Weinberge
    3. Non-believer in THA location:
       - arbitrary axis is just as good since HA can't be accurate located or movement arc can't reproduce by articulator
       - Shanahan & leff, Ferarrio
    4. Split axis theory(Transograph)
       - they believe there is 2 axis of rotation in each condyle & they are parallel
       - Trapozzano & Lazzari
       - Aull (1966), Beard & Clayton (1981) found that there is one HA & they disapprove split axis theory – use paper & stylus
  - Significant of HA location:
    - HA is just step in attempt to reproduce Mn movement→it is very important bc all movement start at the axis & return there
    - then by transfer the HA to the articulator → we will have an instrument that have same relation of teeth when it come together as in the mouth
    - how does pure hinge movement affect occlusion? Through arc of occlusion
    - is it same as path of closure? No, path of closure → result from closing rotation& glinding path (Granger,1959)→is different from each position to tooth contact
    - Mn closes on axis: study of natural dentition doesn't show hinge axis → Shanahan& leff (1962) – use photograph & cameras
    →Ferrario (1996)- pure rotational didn't occur

- how accurate in location true HA:
→ Kurth & Feinsterm- within 2mm when restrict opening to 3/4" at incisal pin
→ Borgh & Posselt- within 1.5 mm when 10 ° arc was used
- within 1mm when 15° arc was used
→ Lauritzon & Wolford- within 0.2 mm when 10° arc of movement

Location of true HA→ observe motion of stylus in axis bow as created by jaw movement in relation to flag fixed over pt axis area→ when stylus no longer translate but rotate then point accepted
→ Geometric principle as described by Getz

Common Arbitrary points:

- Beyron's arbitrary axis: 13 mm anterior to posterior margin of tragus on line connect center of tragus to the outer canthus
- Gysi's arbitrary axis: 10 mm anterior to posterior margin of tragus on line connect center of tragus to the outer canthus
- Tetruk& Lundeen: 13 mm anterior to posterior margin of tragus on line connect base of tragus to the outer canthus
- Bergestrom arbitrary axis:11 mm anterior to posterior margin of tragus on line parallel & 7 mm below FHP
  - Beck, 1957, compare it with KHA → Bergestrom point is most favorable follow by Beyron point

How accurate is arbitrary selected axis:
- Schalhorn found that 95% of axis point located 13 mm anterior to posterior margin of tragus on tragus-canthus line to be within 5 mm radius from KHA
- Beyron found approximately of 87% of located point within 5 mm radius from KHA

Who found different result?
- Lauritizen & Bonder→ only 33% of true axis within 5 mm radius of arbitrary point
- Tetruck & lundeen →same result
- Walker→20%
- Palik→ 50% of the time, 92% of time is anterior to THA
→ using earpiece facebow is not repeatable
- Simpson→use point 10 mm from superior border of tragus on camper's line for arbitrary hinge axis →78% within 5 mm
- Gordon, 1988→ locate of THA effect of second molar cusp:
  - error in cusp height is 0.15 mm open space to 0.4 mm excess height
  - error in MD range from 0.51 to 0.52 mm toward distal
  - keep CR record very thin at proposed VDO

- Hall gave credit to Balkwill for recognized Mn movement
- Conzalez→ evaluate plan of reference for orienting Mx cast on articulator with FHP
  - non of three plane used parallel to FHP
  - to compensate for error – raise pointer 7mm on articulator or place pointer 7 mm below orbitale on patient

- Pitchford→ raise orbitale 18mm to compensate for error

Weinbeg, 1962→ evaluation of facebow

- 2 important steps to orient Mx cast on articulator
    1- THA must be located arbitrary or kinematic
    2- Anterior point of reference which form horizontal plane
- It has been shown mathemathically that an error of ± 5mm from KHA produce small AP Mn displacement error of 0.2 mm at second molar
- Raising or lowering facebowa doesn't affect CR but it affect
    a. Eccentric condylar reading
    b. Cusp inclines

e.g: elevate facebow of 16mm→ ↓condylar angel from 40 to 31°
→0.2mm ↓ in balancing cusp height
→ Mx cast error of 3.78 mm anterior

- AP displacement error reduced by thinning CR record(<3mm)

<u>Codylar Determinant of Occlusal Morphology</u>

(Aull, JPD, 1965)

- codylar path has a variation which can't used an average to Tx pt that is mean we should treat the patient not the average
- M&M: 50 patients, condylar graphic tracing, stuart articulator has been used
- Condylar movements:
  - protrusive: each condyle protrude & detrude, when it goes back it goes retruded & surtruded
  - lateral rotational only: rare but simple type of codylar movement is pure lateral rotational movement in which working condylar rotate without any side effect
  - Advancing condylar:
    - balancing, non working, or orbiting condyle
    - moving in 3 directions- downward, forward & midward
    - as return: it moves outward, backward & upward

- lateral rotation with side shift:
  - nine major direction of side shift on rotating condyle
  - outward, backward, or forward→all will go either straight up or down

- timing of side shift:

- all of SS or laterotrusion may occur before condylar start rotation or after slight amount of rotation or distributed through it
- if SS occur before rotation →precurrent
- if SS occur after rotation→ concurrent
- only one of fifty condyles had bilateral symmetry
- angele of eminence vary from 15 to 66 °
- mediotrusion→ translation of rotating condyle
- laterotrusion→ translation of orbiting condyle

Part II: condylar movement & occlusal pattern of teeth:

- M&M: stuart articulator, 3 scribing surface in 3 planes
- Factors affect vertical component of teeth (cusp height)

1. ↑steepness of eminence→↑steepness of cusp on balancing side, cusp on working side are not affected since movement is horizontal
2. ↑ curvature of eminence has same effect on balancing side
3. ↑ ISS (laterotrusion)→ shorter cusp on BS
4. laterotrusion on WS with upward movement →shorter cusps on WS
5. laterotrusion on WS with downward movement→longer cusp on WS

- factors affect groove direction:

- path between mediotrusion & laterotrusion path on molar of BS
- ↑ intercondylar distance →↓ angel between medio & laterotrusion path→groove moves distal on Mn teeth& mesial on Mx teeth
- ↑ ISS→ ↑angel (only factor affect V&H component)
- pure ↑ in laterotrusion→ shorter cusp on BS

Mandibular Movement & Occlusion

Bennet angel: angel form between the average path of advancing condyle & the sagittal plane as view in horizontal plane during lateral mandibular movement (lateral condylar angel= H/8+12)

Fischer angel: angel formed between protrusive & advancing (non-working) condyle path as view in sagittal plane

Pantographic: instrument used to graphically record in one or more planes paths of Mn movement & provide information to program articulator
Pantographic tracing: graphic record of Mn movement in 3 planes as register by styli in recording tables

Bonwill triangle: 4 inch triangle between Mn incisors & each condyle
Backwill angel: angel form between occlusal plane & bonwill triangle

Posselt, 1957- record Mn movement in 3 planes using gnatho-thiesometer
Boucher& Stuart- using inter-occlusal record to mount Mn cast
Lundeen & Wirth, 1973- 50 patient & engraved blastic blocks→found ISS
Morgini& Capurso, 1982→ articulator & neuromuscular factor influence tracing pattern of Mn border movement

Levinson, 1984→ No ISS if condyle fully seated in the fossa braced against bone & cant't shift without moving forward
→ same as Dawson believe

Hobo, 1984→ working condyle rotate& translate in various directions
→ same as Aull conclusions
→ point approximately of 55 mm from midpoint on the intercondyler axis is kinematic rotational center of Mn in lateral movement

1953→ Schuyler advances group function for natural teeth
- against bilateral balanced since it is not seen on nature& cause destruction on Non- workin side (NW)
- partnered with Pankey-Mann to form PMS approach for occlusal rehabilitations:
  - restore anterior teeth first
  - restore Mn posterior based on 4˝ radius
  - restore Mx posterior with FGP
- PMS philosophy:
  - wider centric to accommodate Bennett movement
  - area contact VS point contact
  - cusp to fossa tooth arrangement

Gnathology:

- 1920→ McCollum develop gnathology & gnathoscope
- gnathological theories of occlusion:

1. determine hinge axais for center of rotation
2. record 3D envelop of motion via pantographic tracing
3. maximum intercuspation in C.R position
4. cusp to embrasure
5. bilateral balance (that was in 30’s)

- gnathology / canine protected occlusion:

1940-1950→ Stallerd & Stuart:

- recommend eliminating NW contact by having canine in WS disocclude posterior teeth→ known as ‘ cuspid protected theory’
- Tripodism: cusp-fossa relation

1958→ D Amico- proposed that canine were most naturally suited for lateral excursion loads based on anthropology

1958→ technique develop to wax full mouth

- Cusp to fossa → OK Thomas → tooth to tooth, stable but not exist in nature
- Cusp to marginal ridge→ Payne→ tooth to two teeth, not stable

1961→ Lucia noted failure of bilateral balance reconstruction by McCollum

- Coined term of mutually protected occlusion:
    1. Posterior teeth contact only in CO (coincident with MIP)
    2. Anterior teeth disocclude posterior in lateral excursion
    3. Anterior teeth slight out of contact in MIP by 12 μ (Shillinburg recommend 24 μ)
    4. Posterior protected anterior at MIC & anterior protected posterior in lateral excursion

1993→ Becker & Kaiser coined ‘Biological Occlusion’

1. No interferences between CR & MIP
2. No NW contact in lateral excursion
3. Cusp to fossa occlusal contact
4. Minimum of one contact per tooth→ prevent super-eruption
5. Canine guidance or group function
6. No posterior contact in protrusive
7. No cross tooth interference on WS
8. Eliminate all interferences

Fundamental of fixed prosthodontics “Shillingburg”
Chapter 2:

- Anatomy related to CR position:
    - ➢ bone of glenoid fossa is thin in superior aspect & thick cortical in anterior aspect ‘sloope of emenince’ which is area suited for bearing stress
    - ➢ articular disc:

- bioconcave, devoid of nerve & blood vessel in central area
- superior head of lateral pterygoid is attach to anterior aspect
- attach to condyle on medial & latral aspect & interposed between condyle & eminece in function

- condyle:
  - irregular, elliptical in shape to distribute stress through TMJ rather than concentrate stress in small area if it is spherical
  - stress posteriorly by using chin point guidance to RUM position→ Lucia

Mn movement around 3 axes:

1. Horizontal axis→this movement in sagittal plane by open& close in THA
2. Vertical axis→ this movement in horizontal plane by lateral excursion, axis in working side condyle
3. Sagittal axis→ when Mn move downward at non-working side during lateral excursion

- Pure hinge movement occur of condylar rotation within 10 to 13° arc & 20 to 25 mm seperation:
  - this phenomena was base of THA theory in1920 by McCollum
  - Khono analyzes THA & termed Kinematic axis
- Mn move to one side will place it as working or laterotrusion
- Bodily shift of Mn to working side was first described by Bennett
- Bennett angle: angle formed in horizontal plane between non working condyle path & sagittal plane
- Aull→ 86% of condylar study revealed ISS
- Lundeen & Wirth→ found median dimention of ISS is 1 mm & maximum is 3 mm
- Hobo & Mochizaki→ found range between 0.4 to 2.6 mm
- Progressive SS or Bennett shift→ following ISS, there is gradualed shifting of Mn which occurs at rate of proportional to foreward movement of non working condyle
  - it is measure from sagittal plane after ISS occurred
  - if no ISS in articulator→ it measure from sagittal plane to endpoint movement of condylar center
  - Lundeen & Wirth→ mean angle of PSS or Bennett angle is 7.5°
  - Hobo & Mochizaki→ mean angle of PSS or Bennett angle is 12.8°

Determinant of Mn movement:

1. Two condyle 'fixed can't change by dentist''
2. Contacting teeth ' overall non working control'

- Posterior teeth work as vertical stop & guide Mn to MIP
- Anterior teeth guide Mn in right & lift excursion & protrusive movment
- Why anterior teeth are suitable for guidance:

1. Canine have strongest & largest root
2. Properioception threshold & reflex reduce load
3. Load bearing reduce by distance from fulcrum- Class III lever

- Closer tooth from determinant→ more influence will be
  - Anterior teeth more influence by AG & less by CG
  - Posterior teeth influenced partially by AG & partially by CG since it is middle

- Posselt→ only 10 % of population has complete harmony between teeth & joint – CO = MIP
- If no symptoms →MIP consider normal or physiologic
- Pathological occlusion→ lack patient to adapt when CO & MIP→ with parafuncional activity
  - signs→1- extraoral: muscle fatigue, headech & TMD
  2- intraoral: wear facets,fracture cusp, tooth mobility
- Ther is no effidence shows occlusal trauma will produce primary periodontal lesion but with local factor, it make periodontal breakdown faster→Clickman
- Optimim occlusion: is one require minimum adaptation by patient
  - criteria given by Okeson:
    1. In closure→ condyle in CR position& posterior teeth has solid even contact & light anterior contact
    2. Occlusal forces in long axes
    3. Working side contact 'preferablly canine' disocclude non-working teeth
    4. Anterior disocclude posterior in protrusive
    5. In upright position, posterior contact heavier than anterior

Concepts of occlusal scheme:

1. Bilateral balanced occlusion:
   - based on work of Von Spee & Monson
   - cause a lot of excessive wear & distruction, difficult to use for fixed
2. Unilateral balanced occlusion 'group function'
   - by Schyler after his observation of destructive nature of non working contact
   - distribute stress among teeth in working side & avoid contact in non working side
   - Myer used functionally generated path for unilateral balanced & Panky adapted for full mouth reconstruction
3. Mutually protected occlusion:
   - Canine guidance or organic occlusion by D Amico, Stallerd, Stuart & lucia
   - posterior protect anterior in inter cuspal position & anterior protect posterior in all Mn excursion
   - anterior teeth are in light contact or separated by 25 μ
   - Anterior teeth should be healthy & no bone loss & class I occlusion, otherwise→ group function

- Molar disocclusion→ healthy natural occlusion exhibited disocclusion at mesiobuccal cusp tip of first molar as :
  - 0.5mm in WS, 1 mm in BS, & 1.1 in protrusive→ Hobo & Takayama
  - these to make sure that is equal or surprass natural variation in resiliency of TMJ
- Condylar guidance:
  - protrusive movement in average 30.4°→steeper protrusive inclination→ higher cusp →Hobo
  - ↑ISS→ shorter cusp & oblique angle
  - ↑ distance between tooth & working side→ ↑ angle between WS & BS path in Mn teeth
- Anterior guidance:
  - protrusive incisal path: track incisal edge from MIP to edge – edge

- Gysi gave an angle of 50-70°
- AG is steeper by 5 to 10° more than CG in natural dention to be able to disocclude → Takayama
- AG has V& H component & can be control by dentist

Mechanism of mandibular movement (Ch 4, Okason)

- Types of movement occurring in TMJ:

1. Rotational movement:
   - It is process of turning around axis
   - Rotational occurs on open & close without any positional change of condyle
   - Rotational movement of condyle can be in 3 referencses plane:

   a. Horizontal axis of rotation:
      - Open & close motion which is a hinge movement
      - It is only movement associated with rotating axis

   b. Frontal 'vertical' axis of rotation:
      - One condyle move anterior out of terminal hinge axis while vertical axis of other condyle remains in terminal HA

   c. Sagittal axis of rotation:
      - One condyle move inferiorly while other still in terminal hinge position

2. Translation movement :
   - Movement of both objects with same velocity & direction
   - Occurs when Mn move foreward as in protrusive

- Single plane border movement:
  - Mn movement limited by:
    1- ligaments 2- articular surface 3- teeth
  - Boreder movement : Mn moves through outer range of motion
- Sagittal plane border & functional movements:
  - It has four distinct movement:
    - posterior
    - anterior : opening border limited by ligaments & TMJ
    - superior contact limited by teeth
    - functional: not border movement because it control by neuromuscular systems
  - Posterior opening border movement
    - it occurs in 2 stage hinging movements:
      1. condyle stabilize in superior position in articular fossa
         → rotational movement can occur until anterior teeth apart by 20-25mm

      2. condyle translate down articular eminence as mouth rotate open to maximum limit

→axis of rotation shift to bodies of rami ‘ area of attachment of sphenomandibular ligaments’

→ 40-60 mm maximum opening between incisal teeth

- Anterior opening border movement :
  - When Mn is at maxmum open → close occurs by inferior lateral pterygoid muscle
  - it is not pure hinge movement
  - It is limited by ligaments ‘stylomandibular ligaments’

- Superior contact border movement:
  - determine by occlusl & incisal morphology of teeth
  - this movement depends on:
    1. variation between CO& MIP
    2. steepness of posterior cusps
    3. OB & OJ
    4. lingual morphology of posterior teeth
    5. general interarch relationship of teeth
  - In CR → first contact occurs in posterior teeth
    → first contact between mesial incline of Mx teeth & distal incline of Mn teeth
  - if muscle apply to Mn→ superior-anterior movement or shift to MIP
  - Slide from CR to MIP occurs:
    →in 90% of population
    → average distance is 1.25 ± 1 mm

- Functional movement:
  - free movement around border movements
  - Mn in postural postion is located 2-4 mm below intercuspal position
  - in chewing stroke:
    → movement begin in ICP , drop down & foreward to desire opening

- Horizontal plane border& functional movements:
  - border movement in horizontal plane can be registered by Gothic arch tracer
  - Rhomboid shape pattern with movement & functional component
  - from CR→ contract of right inferior lateral pterygoid → right condyle move anteriorly & medially→ if left inferior lateral ptergiod still relax→condyle will be in CR

- Frontal ‘ vertical’ border & fuctional movement:
  - a shield-shaped can be seen

- Envelop of motion:
  - by combing Mn border movement in 3 planes→ 3 D envelop of motion can be produced that represent maximum range of Mn movements
  → superior border of envelop determine by tooth contact
  →other border of envelop determine by ligaments & joint anatomy

Determinants of occlusal morphology (CH 6, Okason)

-Structures control mandibular movement

1. Posterior controlling factor : TMJ
2. Anterior controlling factor : anterior teeth

- Posterior teeth

– are positioned between these two controlling factors
– can be affected by both to varying degree

- Posterior controlling factors
  -Condylar guidance – is the angle at which the condyle moves away from a horizontal reference plane from CR along the articular eminence of the mandibular fossa
  – depends on the steepness of the articular eminence
  – considered to be fixed factor, unalterable
  - CG angle when the mandible move laterally is greater than when mandibule protrudes straight forward due to medial wall of the mandibular fossa is generally greater than articular eminenece anterior to condyle
- Anterior controlling factors
  - Anterior guidance
  – the incisal edges of the mandibular teeth occlude with lingual surface of the maxillary teeth as mandible protrude or move laterally
  – The steepness of these lingual surface determines the amount of vertical movement of mandible
  – The anterior guidance consider to be a variable rather can be alterated during by dental procedure

  • The morphologic characteristics of each posterior tooth must be in harmony with those of its opposing tooth to teeth during all eccentric mandibular movements
  • Therefore the exact morphology of the tooth is influenced by the pathway it travel across its opposing tooth to teeth.
  • Nearer the tooth is to the TMJ, the more the more joint influences its movement
- Occlusal surface of posterior teeth can be effected by the significance of the anterior and condylar guidance in two manners
  – factors influences vertical components (Height)
  – factors influences horizontal components (Width)

Vertical determinants of occlusal morphology:

- Influences the heights of cusps and the depths of fossae
1. The anterior controlling factor of mandibular movement (i.e., anterior guidance)
2. The posterior controlling factor of mandibular movement (i.e., condylar guildance)
3. The nearess of the cusp to these controlling factors
- Posterior centric cusps are generally developed to contact in the intercuspal position but to disocclude during eccentric mandibular movements
- must be long enough to contact in the intercuspal position but not so long that they contact during eccentric movements

Angle of articular eminence (Effect of condylar guidance on cusp height):
• Protrusion: the condyle descends along the steepness of the articular eminence.
• more steepness :
–more the condyle is forced to move inferiorly as it shifts anteriorly
– greater vertical movement of condyle, mandible, mandibular teeth

Effect of anterior guidance on cusp height:
• Anterior guidance is a functional relationship between the maxillary and mandibular anterior teeth.
• Anterior guidance is consisted of:
– vertical overlap of anterior teeth.
– horizontal overlaps of anterior teeth.

- Increase in horizontal overlap leads to a decreased anterior guidance angle, less vertical component to mandibular movement, and flatter posterior cusps.
- Increase in vertical overlap produced an increased anterior guidance angle, more vertical component to mandibular movement, and steep posterior cusps

Effect of plan of occlusion on cusp height:
• Plane of occlusion is an imagination line touching incisal edges of maxillary anterior teeth and the cusps of the posterior teeth.
• The relationship of the plan to the angle of the articular eminence influences the steepness of the cusps

Effect of curve of Spee on cusp height:
• the curve of Spee is anteroposterior curve extending from the tip of the mandibular canine along the buccal cusp tips of mandibular posterior teeth
• Its curvature can be decribed in terms of the length of the radius of the curve
- A short radius the curve is more acute that with a longer radius

Effect of mandibular lateral translation movement on cusp height:
• Bennett movement: Mandibular lateral translation movement is a bodily sideshift of the mandible that occurs during lateral movements.
• During a lateral excursion the orbiting condyle moves downward and forward, and inward
• Opposite condyle rotate around axes in mandibular fossa (rotating condyle)

Degree of inward movement of condyle for lateral translation:
- Determined by 2 factors
– morphology of the medial wall of the mandibular fossa
– inner horizontal portion of the TM ligament, which attaches to the lateral pole of the rotating condyle.

Effect of mandibular lateral translation movement on cusp height:
1- Effect of the amount of lateral translation movement on cusp height
- The greater the lateral translation movement, the shorter is the posterior cusp
2- Effect of the direction of lateral translation movement on cusp height

3- Effect of the timing of lateral translation movement on cusp height

Effect of the direction of lateral translation movement on cusp height
• determined by the morphology and ligamentous attachments of the TMJ undergoing rotation
– Movement occurs within a 60-degree (or less) cone whose apex is located at the axis of rotation
– More superior the lateral translation movement, the shorter is the posterior cusp

Effect of the timing of lateral translation movement on cusp height:
• lateral translation movement
– occurs early, a shift is seen even before the condyle begins to translate from the fossa. This is called an immediate lateral sideshift
– it occurs in conjunction with an eccentric movement, the movement is known as a progressive lateral translation movement or progressive sideshift.
1. Immediate sideshift, shorter posterior cusp
2. progressive sideshift, longer cusp

Horizontal determinants of occlusal morphology:
• distance from rotating condyle on ridge and groove direction
• distance from midsagittal plane on ridge and groove direction
• distance from rotating condyles and from midsagittal plane on ridge and groove direction
• Effect of mandibular lateral translation movement on ridge and groove direction
• intercondylar distance on ridge and groove direction
• relationship between anterior and posterior controlling factors

Effect of distance from rotating condyle on ridge and groove direction:
• The greater the distance of the tooth from the rotating condyle, the wider is the angle formed by the laterotrusive and mediotrusive pathways.

Effect of distance from midsagittal plane on ridge and groove direction:
• The greater the distance of the tooth from the midsagittal plane, the wider the angle formed by the laterotrusive and mediotrusive pathways. (both maxillary and mandibular teeth)

Effect of distance from rotating condyles and from midsagittal plane on ridge and groove direction:
• More anterior the tooth in the dental arch, the wider is the angle formed by the laterotrusive and mediotrusive pathway

Effect of mandibular lateral translation movement on ridge and groove direction:
• As the amount of lateral translation movement increases, the angle between the mediotrusive and laterotrusive pathways generated by the centric cusp tips increases. (both maxillary and mandibular teeth)

Effect of anterolateral and posterolateral translation movement of the rotating condyle:

• The more anteriolateral the movement of the rotating condyle, the smaller is the angle formed by the mediotrusive and laterotrusive pathways.
• The more posterolateral the movement of the rotating condyle, the wider is the angle formed by the mediotrusive and laterotrusive pathways • (both maxillary and mandibular teeth)

Intercondylar distance on ridge and groove direction:
- The greater the distance → the smaller the angle formed by the laterotrusive and mediotrusive pathways. (both maxillary and mandibular teeth)→ groove move distal in Mn & mesial on Mx

Relationship between anterior and posterior controlling factors

Table 6-1

Vertical determinants of occlusal morphology (cusp height and fossa depth)

Factor	Condition	Effect
Condylar guidance	Steeper the guidance	Taller the posterior cusps
Anterior guidance	Greater the vertical overlap	Taller the posterior cusps
	Greater the horizontal overlap	Shorter the posterior cusps
Plane of occlusion	More parallel the plane to condylar guidance	Shorter the posterior cusps
Curve of Spee	More acute the curve	Shorter the most posterior cusps
Lateral translation movement	Greater the movement	Shorter the posterior cusps
	More superior the movement of rotating condyle	Shorter the posterior cusps
	Greater the immediate sideshift	Shorter the posterior cusps

Table 6-2

Horizontal determinants of occlusal morphology (ridge and groove direction)

Factor	Condition	Effect
Distance from rotating condyle	Greater the distance	Wider the angle between laterotrusive and mediotrusive pathways
Distance from midsagittal plane	Greater the distance	Wider the angle between laterotrusive and mediotrusive pathways
Lateral translation movement	Greater the movement	Wider the angle between laterotrusive and mediotrusive pathways
Intercondylar distance	Greater the distance	Smaller the angle between laterotrusive and mediotrusive pathways

Occlusion (Niel Guichet)

P24 - physiological occlusion: as one which is in sufficient harmony with anatomic & physiologic control of mandible so not introduce pathology

- occlusal disease: the sum total of pathological process precipitated by occlusal disharmony " pulpitis, prematuratey occlusion wear, periodontal disease"
- Etiology: occlusal disharmony→ mobility, migration, super-eruption
- treatment: occlusal equilibration or modification

Mandibular movement:

- McCollum credited for development of pantograph, 1930
- Pantograph graphically illustrate condyle path of movement
  - record table fix to maxillae & doesn't move (2 V & 2 H)
  - vertical styli fix to mandible
  - Intra-oral central bearing screw to prevent teeth contact
- Mandibular side shift or Bennett shift is bodily lateral side shift of Mn in lateral excursion
  - It doesn't refer to lateral movement of Mn as it rotate (ISS) but it is bodily side shift of Mn which occur as vertical axis translate
- Mandibular side shift classification:
  1. Progressive Side Shift (PSS): Mn side shift occurs at rate directly proportional to forward movement of orbiting condyle
  2. Immediate Side Shift (ISS): Mn side shift in which orbiting codyle move straight medially as it leave C.R
  3. Early Side Shift:Mn side shift in which greatest rate occur early in first 4 mm of forward movement of orbiting condyle as it leave C.R
  4. Distributed Side Shift: Mn side shift which greatest rate occurs throughout first 4 mm of orbiting condyle as it leave C.R
- ISS:
  - It is component of Mn SS measured in horizontal plane of orbiting path record
  - it is expressed on units of tenth of mm, most always <2mm
- PSS:
  - It is component Mn SS measured in sagittal plane & express in degree
  - the value is almost always < 20 degree

Clinical significant :

- ISS→ primary influence width of central groove of posterior teeth
- PSS→ primary influence on BL inclination of posterior cusp & influence direction of ridges & grooves in posterior teeth primarily in orbiting side (Mx lingual& Mn buccal cusp)

- Rotating condyle path:
  - it can move in vertical & sagital plane
  - it affect direction of ridge & groove of cusps at WS & BS

- Protrusive condyle path:

- it is usually convex in nature
- it is classify based on their convexity & measured relative to their degree of inclination from horizontal plane
- it is affect protrusive incline of posterior teeth (mesial Mn& distal Mx)

- Compensating curve:
  - Mx molar incline mesially & Mn molars incline distally
  - greater incline of teeth close to condyle

- Orbiting condyle path:
  - it is always medial to protrusive condyle path & always steeper & it could be equal but not less (damage disc)
  - it affect balancing cusp incline on orbiting side (ML aspect of Mn buccal cusp& DB aspect of Mx lingual cusp)

- Fisher angel: angel form by inclination of protrusive & orbiting condyler path

- Rotating condyle:
  - affect height of working side cusps when rotating condyle move up or down
  - Mn side shift may be as much as 3 mm & rotating condyle path may incline up to 30° up or down as measure relative to horizontal plane

- Orbiting condyler path:
  - it is movement of orbiting condyle downward & medially
  - amount & character of ISS reflect orbiting path

- Curve of Wilson:
  - mediolateral curvature of plane of occlusion to complement condylar path movement
  - Mn molar incline more lingually & Mx molar incline more buccally
  - it is made to intimate shearing when condylar move right or lift

- Hinge Axis:
  - if C.R taken at ↑ VDO → the posterior reference point must be coincide with terminal hinge axis of patient & precise HA location is necessary to avoid possible error→ in this manner arc of opening in patient & arc of closing on articulator will coincide & CO will be correct at any vertical
  - if C.R taken at correct VDO& condyle in C.R position→ the most accurate way to mount Mn cast is by occluding with Mx cast→ posterior reference point selected by average anatomical measurement are indicated because precise HA location offers no advancing

Clinical significant of mandibular movement:

- Posterior determinant in reconstruction procedure is to make a physiological occlusion available to the patient by programming the articulator of 6 geometric factors :
  1- initial reference 2- Mn SS & its timing 3- protrusive condylar path
  4- orbiting condylar path 5- sagital displacement of rotating condyle
  6- vertical axis of rotation

Initial reference:

- posterior reference point → two points at THA (pantograph or facebow)
- anterior reference point→ point located on face in which with posterior reference point, it makes horizontal reference plane
- use anatomical average if C.R taken at exact VDO

Mandibular side shift:

- if simulate actual orbiting condylar path→ balanced occlusion
- when eccentric disocclusion is desired on orbiting side→ each incline of cusp must be given attention when it is carved out OR set orbiting condylar path to line beyond its bath, then when restoration transfer to patient mouth, the condylar will follow actual path& teeth will be out of disocclusion

Protrusive path:
- can be recorded by cheekbite or pantograph record
- cheeckbite give straight path & pantograph record give a convex path
- if patient protrusive path set at 35°& articulator set at 30°→disocclusion
- if patient protrusive path set at 35°& articulator set at 35°→interferance

Orbiting condylar path:

- it should be reduced as will as protrusive to produce disocclusion in BS since if you follow path it set for balancing contact

Sagital displacement of rotating condyle:

- if articulator was set in straight outward movement & in the patient rotating condyle move upward→ interferences OR if condylar move in patient backward or foreward → interferences

Vertical axis:

- location of VA from midsagital plane with ±3mm is clinically insignificant (average 55 mm)
- it affect direction of cusp with its opposing groove to provide escaping & avoid interferences (affect both side)
- it is affect lingual groove in WS & disocclusion groove in BS
- ↑ ICD→ ↓ angel between mediotrusion & laterotrusion→angel move distal in Mn

Anterior determinant of occlusion:

- proper position of Mx anterior teeth established by esthetic & phonetic

- proper position of Mn anterior incisal edge by speech
- incisal relation (V&H) of anterior is anterior determinant of mandibular movement
- Natural Scheme:
  1- in speech→ Mn move downward from ICP to prevent contact at speech
  2- at's' sound→ it is the most forward position
     Class I- incisal edge is involuntary placed slight lingual& below incisal edge of upper with about 1mm separation (downward & foreward movement)
     Class III- No foreward movement of Mn incisor & only 1 mm downward movement
     Class II- moderate downward & foreward movement
  3- letter 'F'→ upper anterior teeth touch wet-dry line of lower lip
  4- Esthetic→ by pitch"tilt" of Mx anterior teeth provide lip support " don't change incisal edge "
     → by pitch"tilt" of Mn anterior teeth is ⊥ to lower border of Mn
     → incisal edge of Mx teeth follows curvature of lower lip
     → smile line

Pound specifications for placement of anterior teeth according to esthetics & phonetics:

1- Incisal edge of Mx→ F position "phonetics value'
2- Pitch of Mx icisors→ lip support "esthetic value'
3- M-L curvature of Mx anterior to compensate smile line " esthetic value"
4- Incisal edge of Mn anterior → S position "phonetics value'
5- Labial surface of Mn anterior→ ⊥ to lower border of Mn "esthetic value'

Vertical dimension:

- It shouldn't be greater than 1mm less than VD at 'S' position
- Freeway space→ Class I →2-5 mm
  Class II→ 4-8 mm
  Class III→ 0-3 mm
- Pantographic study of patient with esthetic & phonetics pleasing teeth shows no correlation between TMJ characteristic & vertical & horizontal overlap
- It has been suggested – steep protrusive CG→steep VO
  - ISS associate with horizontal overlap

Occlusal anatomy: (P73)

- Sagital plane record;
  - Protrusive condylar path→shallow→shallow cusp
  - Orbiting condylar path→steeper→steeper balancing cusp incline
    ' it is effect inner mesial incline of Mn buccal& Mx distal inner incline of lingual cusp

- Rotating condylar path→ occur in coronal plane
  - Upward movement →shorter working cusp incline

- Rotating condylar path→occur in horizontal plane→affect groove direction
  - if it is forward→ rotating condylar path is position more distally (lingual groove)

- Orbiting path records→ horizontal plane
    - ↑ ISS→ Mx lingual cusp escape located in Mn molar→more mesially

- Movement of articulator is not necessary same movement produce by Mn & contact of articulator should be based on our objectives unless balance occlusion is our objectives

Incisal Guidance (IG)

- IG: influence of contacting surface of Mx& Mn teeth on Mn movement
- IGA: angel formed by intersection of plane of occlusion & line through sagittal plane determinant by incisal edge of Mx&Mn central incisor
- Canine guidance (CG): form of mutually protected articulation in which the V&H overlap of canine teeth disengages posterior teeth in lateral excursion
- Mutually protected articulation: occlusal scheme in which the posterior teeth prevent excursion contact of anterior teeth in MIP & anterior disengage posterior teeth in lateral excursion movement
- Group function(GF): multiple contact relation between Mx& Mn teeth in lateral movement on working side →By Schyler

Black McAdam→ summarized difference between GF&CC:

- Similarity:
    1. Provide multiple posterior contact in CO&MIP
    2. No contact on mediotrusion
    3. No posterior contact on protrusive
    4. Anterior group function guidance in protrusive
    5. Minimize horizontal forces
- Differences:
    1. Contact in laterotrusion
    2. Minimize horizontal forces by
       - CG→ limit contact of support cusp to their opposing fossa at or near intercuspal position→ more vertical chewing
       - GF→ distributed contact as much as possible
         → ↓ angel of incline so most of forces to long axes of tooth
         → round line angel, eliminate roughness & irregularities
       - Main disadvantages of GF excessive horizontal loading due to contact at steep incline

-Tooth mobility:

- O'Leary, Shanley, Drake→ more mobility in CG group
- Siebert→ CG is necessary

- McAdam suggst both occlusion are normal & restoring portion of teeth shouldn't change occlusion

- Most common:
    - Scaife & Holt→ CG is more common in north America (1200 patient)
    - Weinberg→ GF is more common

- Jemt, Lindquist, & Hedegard→ CG with implant provide more vertical chewing
- Williamson& lundquist→ posterior disocclusion resuced temporalis & masseter muscle activity
- Schyler→ IG is equal or surpasses the TMJ in influence functional occlusion
- Kohno→ incisal path should equal condylar path but not >25°

- Schyler→ objectives of occlusal rehabilitation are:
    1. CO in harmony with CR
    2. Distribute stress in CO over many teeth
    3. Freedom in centric (lateral& anterior-posterior)
    4. Uniform contact & even distribution contact in excursion
    5. ↓ BL width of occlusal surface
    6. ↓ balancing inclines

- Dawson→ maximum comfort& stability achieved by :
    1. stable holding contact in anterior teeth
    2. no interferences in centric
    3. position & contour in harmony with envelop of function
    4. immediate disocclusion of all posterior teeth when teeth leave from centric
    5. position & contour of all anterior in harmony with neutral zone & lip closure path

    - disocclusion of posterior teeth→ shut down 2 out 3 elevator muscles
    - Dawson technique in harmonize anterior guidance:
        - reshape & restore Mn anterior→ post equilibration → CR stop in all anterior teeth → extended centric stop to include light closure from posterior rest position " short protrusive"→ establish CG in all anterior teeth → protrusive& lateral excursion "two line"

- Hobo→ has a technique in fabricate IG " twin table technique'
- Broaderson, 1978→
    - Stuart→ lingual surface of Mx anterior are entirely control by condylar border movement
    - Pankey-Mann Schyler philosophy→ lingual surface of Mx anterior are independent from condylar movement & dictated by need of long centric
- Determinant of anterior guidance:
    1. Esthetics
    2. Phonetics
    3. Condylar border movement
    4. Position relation of Mx & Mn anterior teeth
- Function of anterior guidance:
    1. incise food
    2. aids in esthetics & phonetics
    3. protect posterior teeth
- AG should be in harmony with CG(wax-up→ temp's →IG table)

-Dipietro,1976→ don't ↑ VDO in low FMA angel <20→tend to return
- Clements, 1983→ composite mock-up→ impression→ CR & facebow→ mount & wax-up→ provisional→ adjust→ provisional cast & cross mounting

Articulator

- Names & concepts:
    - Bonwill,1858→ Bonwill triangle theory
    - Balkwill, 1866→ translation condyle more medially
      → Balkwill triangle
    - Von Spee, 1890→ occlusal plane of teeth follow a curve
    - Snow,1899→ facebow
      → camper's plane
    - Bennett→ ISS
    - Monson,1916→ spherical theory for occlusion
    - Meyer→ chew in technique
    - Averybrother,1930→ antimonson reverse curve of willson
    - Pleasure,1930→ antimoson except 2nd molar in balance contact
    - PMS→ eliminate balance, IG important, long centric
    - Gnathology → pantographic important to reproduce movement
    - Page → transograph, Mucostatic impression technique
    - Alfred Gysi→ first to produce articulator with down& forward movement
    - Walker → first to record Mn movement

- Becker& Kaiser, 1993→ recommend to avoid occlusal therapy for individual who appear functionally healthy even of his occlusal scheme doesn't fit concept of optimum occlusion

- Bergestrom→ coined term arcon "articulating condyle"→ has condylar element in lower member& condylar path element in upper member
→ angle between condylar inclination & occlusal plane is fixed on arcon
→ semiadjustble articulator allow adjustment to replicate Mn movement

- Hanau model H→ non-arcon used by Weinberg in his study
→ main significant error is lack working condyle motion→-ve error produce - flatter posterior cusp
- to compensate →↓ Bennett angle "medial shift " of opposite side will lead to ↓ lateral shift of working condyle & ↑ working cusp incline –Weinberg

- Bellanti → compare semi "Whipmix" & fully adjustable "D4A" articulator
    - Fully adjustable set to simulate Mn movement
    - ISS produce large difference in cusps pathway of opposing dentition & if this in patient will need a lot of adjustment to eliminate occlusal interferences
    - 30% of 80 patient has ISS of 0.3 mm

- Guichet define ISS→ Mn side shift in which orbiting condyle move straight medially when it is leave CR
- Watchet & Curtis→ address important of ISS
- Thielmanns formula = CG X IG/CH X OP X CC
- Swenson formula for cusp height = IG+1/2(CG-IG)

-Hobo& Shillingberg, 1976→ 4 types of occlusal interferences

1. CO interference- Mn deviate forward& laterally
2. Working occlusal interference- LUBL
3. Non-working interference- BLLU most destructive
4. Protrusive interference- MUDL

- Error in occlusal restoration:
    1. +ve error→ articulator **undercompensated** for Mn movement→ cusp tip & ridge is height
    2. -ve error→ articulator **overcompensated** for Mn movement→ narrow cusp & wide groove

- facebow transfer distance between hinge axis
- using arbitrary HA location→ CR should be made at correct VDO
- small hinge articulator has shorter radius of movement → tooth will travel in shorter radius than in patient mouth→ slight +ve error
- if inter-condylar distance is greater than Mn→ path of movement will be distal to one in the mouth
- if condylar inclination in articulator is set at steeper angle than patient→ +ve error in protrusive & non-working side
- if angle is less steep than patient → -ve error & more clearance
- fully adjustable should be used when:

1. extensive treatment of occlusion
2. restore lost VDO
3. significant side shift

- Weinberg,1963→ compared arcon& non arcon articulator

- Both arcon & non arcon produce same motion since condylar guidance is result of the interaction of condylar ball on inclined plane
- Reverse relation doesn't change guidance
- Mathematical evidence showed both instrument is same

- Laucello,1978→ compare orbitale- Mx incisal edge distance to incisal notch in hana articulator

- Average distance is 53.99 mm (60 patient)
- According to Conzalez & Kingery → the porion was 7 mm above condylar axes point (54-7=47 mm)
- Incisal reference notch on hanau articulator should be calibrated to 47 mm below condylar palne
- Use orbitale as indicator & adjust pointer 7 mm above condylar plane of articulator is most accurate to orient Mx cast in articulator

- Taylor, 1985→ ISS can't be simulate in semiadjustable slot-rock articulator
- Fully adjustable articulator allows replication of 3D movement of recorded Mn motion
- Pantograph → produced by McCollum, Stuart, & Stallerd → gnathological group

→ Guichet→ simplify it & bring it to dental office

→ pantograph used for Denar is opposite to what use for Stuart

- Recording styli attach to Mx frame elements
- Recording table attach to Mn element & table moves & styli is fix

- steriograph→ instrument record Mn movement in 3 planes are obtained by engraving mil or burnish the recording media “acrylic”

-Wipf, 1979→ similarities between stereographic & pantographic

1. Central bearing screw
2. Clutches
3. Terminal hinge & orbitale reference point
4. Both system has 4 horizontal record tables

→ dissimilarities :

1. Styli are 4 in number & fixed by resin
2. Pantographic is extra-oral
3. Pantograph has 2 vertical plates & records

- Gnathology→ study & treatment of somatognathic system
→ term coined by Stallerd , 1929

- Weinberg & Guichet→ precise location of HA offers no advantages when CR recorded at VDO

- Shield & Clayton→ use RPI” pantographic reproducibility index” to detect TMJ dysfunction & muscular incordination

- Javid, 1974→ condylar guidance of Denar articulator are more stable than Hanau & Whipmix

Classification:

- Celenza classification- it is same as GPT but in GPT subclass
  - Class I→ simple holding instrument
  - Class II→ allow vertical & horizontal movement, but not related to TMJ as
    - A. Motion unrelated to the patient
    - B. Motion based on theories
    - C. Motion based on patient
- Class III→ condylar pathways using anatomical average
  - A. Accept protrusive record
  - B. accept lateral record
- Class IV→ accept 3D registration
  - A. Paths formed by engraph of patient (TMJ)
  - B. Paths formed by setting & inserts (D5A)

- Weinberg classification:
  - Arbitrary : Monson
  - Positional: stansbury tripode
  - Semiadjustable: Hanau H
  - Fully adjustable: Kinoscope

- Rihani,1980:

- Nonadjustable →accept 1 or 2 of facebow, CR, protrusive
- Semiadjustable→ all three record
- Fully adjustable → accept 5 record – facebow, CR, protrusive, lateral records, intercondylar distance

Progressive disocclusion: gnathological concept where you begin wax-up from posterior & each tooth most barely disocclude the tooth posterior to it in lateral excursion so if you losse canine guidance you still have anterior directed disocclusion pattern

- 3 control of IMLT:

1. Medial wall of non-working side
2. Superior & posterior wall of working side
   - ↑ IMLT→ short cusp
     → groove move mesially in Mn teeth

-Fisher angel: difference between NW & protrusive path in sagittal plane

- effect→ only view in pantograph→ no clinical effect

- Bennett angel: difference between NW path & sagittal palne when view in horizontal
(Bennett movement is laterotrusion side movement)

- effect→ shorter cusp & mesial position of DB groove on Mn teeth

- Lundeen & Wirth→ found ISS in their blocks engraving
-Dawson & Levenson doesn't believe in ISS since the medial pole of condyle braced by bone medially & to move , the condyle should move downward
- if articulator doesn't have ISS , what you will do?

- Switch articulator or open Bennett angel to compensate

- why is ISS important?

- Only condylar element that affect both V&H components of posterior teeth

Common articulators:
- Panadent :

- Developed by Robert Lee based on research by Lundeen & Wirth (3D measurment using engraving in plastic blocks)
- It has ¾″ curve superior wall, fixed 6° progressive SS, 0.5-2.5 mm of ISS
- Quick analyzer to set ISS& HCI "easier than pantograph)

- Whip Mix:

- Developed by Charlie Stuart
- Based on study by Lundeen & Wirth,1973
- It develop as simplifying version of stuart articulator
- It has fixed ICD of 110 mm, ¾″ superior wall, straight posterior wall, HCI of 0→ 70°, 7.5°, of progressive SS, 0-3 mm of ISS
- Quickmount facebow: use nasion as 3rd point of reference
- Reliable interchangeable cast (Cowan et al, Mansfield & Price)

- Hanau Wide View: Class III-B

- Based on research of Rudolph Hanau
- Arcon with adjustable incisal guide table, centric lock to restrict movement
- HCI is -20 to 60°, LCI (0 - 30°)= H/8+ 12
- straight condylar path has a radius of 0.5″ which might produce 0.2mm error at 2nd molar
- dual end straight incisal pin→ maintain vertical anterior stop & provide contact at excursion movement
- Pin has 2 reference groove of 37 & 54 mm below Frankfort horizontal plane (FHP)→ it is for visual alignment of incisal edge of Mx centrals for facebow transfer
  - 37mm→ based on bonwill triangle – horizontal occlusal plane
  - 54 mm→ imposes slight anterior-posterior inclination plane

- D5A

- Accept kinematic& arbitrary facebow, fully adjustable, curved pin,
- It allow to set

1. Posterior controlling facror (CG)
2. Anterior controlling factor (IG)
3. Accurate orientation of cast

- It is class IV-B
- Denar founded in1968 by Niles Guichet
- Denar pantograph introduce im 1969
- Facebow used 43 mm from incisal edge or upper lip as 3rd point of reference
- Top & rear wall can be replaced with different inserts curvatures
- Sequence of setting D5A:
  - PIPRVOT→ I used to set as VPIPRT as
    1. Protrusive (0-60˚)
    2. Immediate (0-4mm in vernier scale 0.8mm apart)
    3- progressive (0-30˚)
    4- Rear wall (WS): 0 – 30 forward or backward
    5- Vertical axis : range of 150mm
    6- Orbiting (NW) : same as protrusive
    7- Top wall (WS): 0- 30˚ upward or downward
       - The protrusive& orbiting adjustment are control by same adjustment on the articulator
       - Orbiting path should be higher than protrusive path due to medial wall of fossa is steeper than anterior sloop

D5A with Cadiax:

- Will minimize adjustment, preserve anatomical detail, minimize potential for interferences & to develop harmony disocclusion
- Purpose of articulator is to transfer the effective Mn movement of patient to laboratory bench. The accuracy of simulation jaw movement controls accuracy of fabricated prosthesis → greater accuracy of prosthesis with ↓ adjustment at insertion → lack accuracy of prosthesis in lateral excursion may result in periodontal insults & may initiate Para-functional habit

- Literature:

- Ballanti (JPD,1973)→ compare semiadjustable & fully adjustable articulator
    - Purpose: measure discrepancy that exist due to lack articulator to complete movement simulation
    - Result: the effect of intercondylar distance, mediotrusion timing, superior wall shape, laterotrusion direction,ISS were measured & it produced significant variation which will need significant amount of adjustment
- Ballanti (JPD, 1979)→ 30 % of subjects has ISS of range of 0.3 mm

- Wachtel & Curtis, 1987→
  - semiadjustable has a limitation in 3 planes because of inability to accurate duplicate posterior determinant of occlusion (ICD,ISS, rear & top wall adjustment)
  - ISS < 0.75 mm can be adjusted intraorally in horizontal plane

- Guichet, 1979→ D5A is time effective
- Beck & Knap→ D5A is adequate reproduce Mn movement
- Weinberg, 1963→ fully adjustable reproduce Mn movement & ↓ time for intraoral correction

- Indication for use of fully adjustable articulator (Dixion, 2000)
    1- When entire occlusion is reconstructed
    2- Not immediately disocclude or disocclusion angle are shallow
    3- When restore VDO
    4- When occlusal disease is present
    5- Patient with significant IMLT(ISS)

- Some of Mn movement:
    1- Horizontal condylar inclination 37° → Aull
    2- IMLT 0.75 mm→ Lundeen, Shyrock & Gibbs
    3- Progressive SS (Bennett angle):
        - Gysi →15°
        - Hobo→ 12.8°
        - Lundeen & Wirth→ 7.5 mm
    4- curve of eminance ¾° → Lundeen, Aull
    5- ICD 110 mm→ Aull, Bonwill

An evaluation of basic articulators & their concepts: part I-IV (Weinberg, JPD 1963):

- Objectives: to evalute severals articulators & their concepts
- When teeth not on contact , Mn is guided by 2 condylar path
- Biological variables for jaw relation records includes pain, head postion, musculatur, & wax temperature which should be considered as sourece of error to all techniques
- Weinberg methamathecial number based on hypothetical average patient that he used to compare one technique with other based on average skull measurement as:
    - protrusive condylar angle of 40
    - 100 mm between incisal edge of of Mn & THA & it is 32 mm below it

- 50 mm between Mn 2nd molar & & THA
- Mn 2nd molar used because it is close to condylar determinant & it height affect by those

- Basic eleminents of Mn motion:
  - protrusive excursion; condylar move in sagittal plane at pure protrusive
  - incisal guidance: movement of lower incisors against lingual incline plane of Mx anterior teeth
  - balancing condylar path: curved path slope down, foreward & medially
  - Bennett angle : the medial movement of balancing condyle is measured from sagital plane as view from horizontal plane
  - Fischer angle: it is different in angulation between balancing condylar path & protrusive condylar path
  - Working condylar movement: backword, foreword & laterally and in each direction can move upward or downward
  - Transverse hinge axis: passes throught both condyle which Mn rotate around it in vertical
  - Vertical axis: rotation on hrizontal plane
  - Sagital axis: rotation on frontal plane

- Kinematic facebow:
  - it is used to locate the true HA which then orient Mx cast with true relation
  - true HA is determined at point on the skin, that mean the bow of facebow shouldn't change to meet pin on articulator, the pin on articulator should meet facebow(it is only true at that point if you move it you are off axis)

- Arbitrary facebow:
  - using anatomical average to locate HA
  - Snow used 11 to13 mm anterior to tragus at tragus-outer canthus
  - Hanau used 13 mm anterior to auditary opening
  - Anterior point of reference:
    - The THA formed horizontal plane of reference
    - orbitale pointer, 43 mm from incisor
    - ala-tragus line used to make it parallel with occlusal plane

Part II:

- Monson felt the condylar path & occlusal plane form a curve
- Spherical theory (By Monson): the condylar path & occlusal plane form a curve which is a part of an 8″ sphere with a glabella as center
- Bonwill triangle: two condyles & incisors formed 4 ″ equilateral triangle
- Balkwill angle: angle between occlusal plane & Bonwill triangle (average :20°)
-

- Monson articulator : based on his believed that all jaw move around two axes, one axis run throught common center & other throught condylar axis
- Hagman balancers: differ from monson articulator on that it has universal joint mechanism that allows movement from monson common axis
- Hanau model H:
  - Semiadjustable, non- arcon articulator

- Used on his study to make all calculation
- Protrusive angle taking from protrusive record
- Bennett angle taking from hanau formula
- By ↑ protrusive angle to 50 → it is only ↑ BA from 12 to 18 which make this angle on this articulator not significant
- Arbitrary HA:
  - To try to locate HA with 5mm produce an error of 0.2mm at 2nd molar (anterior-posterior error)
- Anterior point of reference:
  - by ↑ anterior point of refernce to maximum achievable error of 16 mm will ↓ protrusive condylar angle by 9° which will ↓ cusp height by 4.5° at 2nd molar which is equal to 0.2mm error of 0.3mm cusp height → CG x occlusal plane
- This error is true only for non arcon because it is closed track but for arcon it doesn't affect since relation between Mx cast & condylar angle is the same
- Straight condylar path:
  - average condylar path ¾ ˝ radius & smallest curvature is 0.5 ˝
  - differnce betweem straight & curved condylar path is 0.4mm at condylar & 0.2mm at 2nd molar

- Clinical evaluation:

- Due to relation mobility of denture base & re-aleff (resiliency & like effect) → Hanau H model is adequate but for fixed → it needs more precise articulator for lateral excursion
- Due to lake indivisual working condylar guidance→ articulator will produce –ve error & flatter cusp posterior than are necassery on patient mouth& to componsate for that:
  1- ↑ IG for lateral excursion will ↑ working cusp incline
  2- ↓ Bennett angle for opposite balancing condylar guidance ➤ this produce more rotation & less lateral shift➤ ↑ cusp icline

<u>Summary of error at 2nd molar</u>

	Balancing cusp	Working cusp
Average HA	0.2 mm	0.2 mm
Arbitrary of anterior point of refernce	0.2 mm	non
Straight condylar path	0.2 mm	0.2 mm
No fischer angle	0.1 mm	non
No condylar working movement	non	0.8 mm
Total	0.7 mm	1.2 mm

Articulator in completet denture constructions (Forrest R Scandrett)

- Articulator: mechanical device that represents the TMJ& jaw members to which Mx & Mn casts may be attached to stimulate jaw mavement

  - Primary function of articulator is to represent absent patient

- Articulator can simulate but the can't duplicate all possible Mn movements
- Other purpose of articulator:
    1. Mounting of dental cast for diagnosis, treatment plan, & patient presentation
    2. Fabrication of occlusal surface for dental restoration
    3. Arrangement of artificial teeth for complete or partial denture

- Advantages of articulator over patient mouth 'patient mouth is best articulator':
  1. Properly visualize patient occlusion
  2. Lingual view for articulating teeth in complete denture
  3. Patient cooperation is not a factor
  4. For refinement of CD occlusion in mouth is difficult
  5. More chairtime & patient appointment when used mouth as articulator
  6. Patient's cheek,saliva & tongue is not a factor for articulator

- Classification of articulator:
  - Based on international prosthodontics workshop in Michigan,1972
  - Based on instrument function, instrument capability, registration procedures & registration acceptance as:
    1. Class I→ simple holding instruments, accept single registration, allow vertical motion
    2. Class II→ horizontal& vertical motion, dosen't orient motion of TMJ via facebow transfer record :
        A. Eccentric motion permitted based on average or arbitrary motion
        B. Eccentric motion permitted based on theories of arbitrary motion
        C. Eccentric motion permitted based on engraving methods
    3. Class III→ instrument stimulate condyle pathways & allow joint orientation of casts via facebow transfer
        A. Accept static protrusive registration & used equivalents for rest of motion
        B. Accept static lateral protrusive registration & used equivalents for rest of motion
    4. Class IV→ accept 3D dynamic registration & allow joint orientation of casts via facebow transfer:
        A. Represent condylar path by registration engraved by patient
        B. Condylar path can be angled & customized either by selection from variety of curvatures, by modifications or both

- Class I:
  - Accept single inter-occlusal record & may or may not allow vertical motion
  - Examples: - Slab articulator, Hinge joint articulator(Gariot,1805), Barn-door Hinge articulator

- Class II-A:
  - Allow eccentric motion based on average & not accepting facebow
  - Examples:
    - Grittman articulator (1899) → condylar inclination at 15°

- Gysi simplex articulator→condyle in Mn, CG=30°, IG=60°

- Class II-B:
  - Allow eccentric motion based on arbitrary theories of motion & not accepting facebow
  - Examples:
    - Monson maxillomandibular articulator→ based on his spherical theory of occlusion, 1918→ each cusp & incisal edge conforms to a segment on the surface of sphere 8˝ in diameter & its center at glabella

Class II-C:
- Allow eccentric motion based on engraved from patient & not accept facebow
- Examples: House articulator by M.M House, 1927

Class III:
- Hanau-Mate articulator:
  - it is arcon instrument & accept facebow
  - it is not III-A or B because it is not accept protrusive or lateral interocclusal record
  - HCG= 30°, LCG'Bennett angle'= 15°, IG= 10°

Class III-A:
- Accept facebow & protrusive interocclusal record
- Hanau model H " Rudolph Hanau,1923"
  - Non arcon, HCG set by protrusive record
  - LCG set by Hanau formula
- Dentatus ' Suealer 1944':
  - relation between upper & lower member can be standerized by engrave block
  - cast can be transfer from one articulator to another
- Bergstrom arcon articulator "Texas":
  - similar to Hanau-H except it is arcon
  - first to coined term arcon "<u>ar</u>ticulator-<u>con</u>dyle"
  - Arcon→ instrument has condyle in lower member & condylar guidance in upper member
  - Beck→ no superiority of arcon over non-arcon

Class III-B:
- Accept facebow, protrusive interocclusal record & some lateral interocclusal record
- Trubyte articulator by Gysi,1926:
  - non arcon, fixed interocclusal distance, HCG- indivisual adjustment
  - LCG indivisual near center of intercondyalr axis
  - IG is adjusted to patient gothic arch angle
  - accept some lateral interocclusal records but not all
- Kinoscope articulator by Hanaue, 1927:
  - intercondylar distance is adjustable
- Stansberry tripod articulator
- Ney articulator by Depietro, 1960
  - true arcon instruments
  - first articulator has rear,medial,top wall adjustment in condylar housing
  - intercondylar distance is adjustable
- Hanau 130-21 by Richard Beu & James Janik in 1964

- most adjustsble hanau articulator
- allow adjusting of HCG & ICG

- Telodyne articulator – intercondylar distance is fixed
- Panadent PCL by Robert Lee
  - Arcon with fixed intercondylar distance
  - Fossa analog available with average lateral pathway & ISS range of 0.5 to 2.5 mm

Class IV-A:

- Accept facebow & 3D dynamic registration
- Condylar pathway formed by registration engraved by patient
- TMJ instruments designed by Kenneth Swanson in 1965
- Intraoral registration is generated in autopolymerizing resin→ stereographic record is then place on articualtor & used to mold fossa → it is claimed that these fossa produce an accurate analog of patient TMJ function

Class IV-B:

- Accept facebow, 3D registration, condylar pathways can be selectively angled & customized
- Utilized pantographic tracing procedure
- Tracing produced by pantograph are called pantograms
- Six styli & tracing tables are attached to Mx & Mn
  A. 2 tracing tables in each condyle in horizontal & vertical plane
  B. 2 tracing tables in anterior horizontal plane
- Mn movement produced pantograms on tracing table
- Mn positions in table is most posterior position, left& right lateral excursions with protrusive make arrow
- All are repeatable except for protrusive pathway
- Those tracing transffered to articulator as same as in patient
- Articulator can adjusted according to tracing or it can be selectively adjusted
- The philosophy of selective adjustment is to allow certain occlusal tolerance to be programmed in articulator prior to develop patient occlusion
- Denar develop ‘pantronic’,1982, to eliminate time cosuming procedures
- Pantronic is electrical pantograph provide computer print out of condyalr reading
- All articulator in this class are arcon & allow adjustability of intercondyalr distance , accept facebow
- Condylar hosuing can be adjusted in horizontal, sagittal & frontal plane
- They are referred to gnathological instrument because of fully adjustability
- Gnathology is sience deals with masticatory apparatus,anatomy, physiology, pathology, & therapeutics
- Gnathologist is study of occlusion & occlusal rehabilitation based on pantograph
- Gnathoscope is old instrument in this class design by Charles Stauart,1955
- In 1968, Niel Guichet design Denar (D4A) fully adjustable
- D5A similar to D4A except refinement of machining
- Plastic condyle insert are availabele for custome made setting
- Stimulator by Ernest Grayer→ Bennett angle adjusted not customized

Requirments of an articulator:

- For CD, requirment for articulator not suphosticated as fixed because:
    1. Relationship between two opposing surface is not fixed
    2. Dentures bases are moving due to lack stability
    3. Occlusal relationship is changing due to resorption
- Minimum requirment of articulator:
    1. Maintain accurate V&H relation of casts
    2. Casts must be easily removed & attached
    3. Should have incisal guide pin & position stop
    4. Open & close in hinge fashion
    5. Accept facebow
    6. The construction should be accurate, rigid, & of non corrosive materials
    7. Adequate distance between upper & lower member, not bulky or heavy
    8. Condylar guidance allow right & left lateral & protrusive
    9. Condylar guidance should be adjusted horizontally
    10. Articulator should have provision of Bennett movement
    11. Incisal guide table should be adjustable
- For removable prosthesis, intercondylar distance & ISS are less important than in fixed
- Intercondylar distance affect character & inclination of grooves & cusps
- ISS affect width of grooves of posterior teeth
- Average intercondylar distance is 110 mm
- Lack ISS can be compensated by providing lateral freedom
- Denar Mark II & Whipmix maintain V&H between casts

Hanau articulator:
- Hanau H2:

- It is condylar or non-arcon articulator
- Fixed intercondylar distance of 110 mm (intercondylar distance is distance between 2 vertical axis)
- Incisal guide table adjustable in sagittal & frontal axis
- Bennett movement calculated from protrusive relation
- 4 facebow can be used with Hanau H2;
    1. facia facebow 2. Earpiece facebow
    3. Twirt- Bow 4. Adjustable axis or Kinematic facebow
- earpiece facebow should be seated in external auditory meatus when it transfer to articulator, it should be in auditory point of ccentric lock which gives horizontal axis relation
- the facia & earpiece facebow may used 1 or 2 as anterior reference point:

1. orbitale
2. incisal plane ‘ incisal motch in fork’

- These refernce point used to be serve the occlusal plane has same relation in articulator as in patient mouth

- Twirl-Bow is new earpiece facebow that allows Mx arch relation to be transferred to articulator without physically attaching to articulator, horizontal orbitale pointer is attached to right temple arm
- Relation of Mn cast to Mx cast by CR record
- HCG set by taking protrusive record ‘ask patient to move 6 mm anteriorly’ which it might be as accurate as patient. LCG which may give aresult of heavy contact in working side & light contact in balancing side
- LCG fom Hanau equasion
- The validity of equasion is questionable as large changing in HCG produced minor change in Bennett angle as calculated “the Bennett scale in articulator is calibrated in 5 degree
- Using IG table before setting posterior teeth protects anterior teeth from dislogment when arranging posterior teeth
    a. Sagittal inclination of IG table: by bringing central incisor into edge to edge
    b. Frontal inclination of IG table: cuspid into edge to edge
- IG pin with adjustable angled ‘foot’ allow in change VD of 5mm & not changing in IG table position

Hanau arcon H2:

- Introduced by Hanau in 1972, arcon articulator
- Same as Hanau H
- Incisal plane is adjusted to notch of incisal pin which is 47mm below Horizontal condylar plane

Hanau radial shift:

- It is arcon with fixed intercondylar distance at 110 mm
- It has right & lift centrics latches & easily removed upper member
- The CG design to allow a curved ISS “radial shift’ with adjustable Bennett angle
- It is allow up to 3mm radial shift
- 3 incisal guide table (mechanical, flat, pantacrylic table)

Hanau Wide view:

- arcon with fixed intercondylar distance
- any closed condylar track doesn’t allow upper member to be removed
- similar to H- model

Whip-Mix articualtor:

- it is arcon by Charles Stauart
- intercondylar distance is adjustable to 3 positions:
    a. small 96 mm
    b. medium 110 mm
    c. large 124 mm

- 2 facebow used with Whipmix:

1. Quick mount or earpiece facebow
2. Kinematic facebow

- Bridge of nose used as anterior reference point with earpiece facebow
- HCG obtain with lateral, interocclusal record will be slightly steeper than that obtained from protrusive record
- Bennett angle adjusted so medial wall contact condyle with lateral record
- It has accumount mounting systems for interchanging casts between articulator

Denar articulator:
Mark II:

- It is arcon, was designed by Denar, Hobo, & Celenza in 1975
- It design for mounting diagnostic cast because it is simpler than Denar D5
- Intercondylar distance is fixed

Denar Omni:

- ➢ It is arcon with interchangeablity open& closed track fossa

Fundamental of fixed prosthodontics "Shillingburg"
Ch3:

- ➢ Articulator: mechanical device simulate Mn movement

- Non adjustable:

- ➢ Shorter distance between teeth & axis of rotation→ less accuracy since it is shorter than skull
- ➢ Thick IO record→ teeth occlude in different intercuspal position than mouth
- ➢ Arc of closure is different→ interfernce 'MUDL' mainly in NW side

- Semiadjustble**:**

- ➢ larger instrument has closer proximity distance between teeth & axis of rotation
- ➢ reproduce direction & endpoint but not intermediate track of some condylar movement
- ➢ ICD is not totally adjustable→ use for single or FPD

- fully adjustable:

- ➢ Reproduce entire border movement
- ➢ Expensive, need high skill, use for extensive treatment

- Arcon:

  - Condylar eleminent in lower member & mechanical fossa in upper member
  - Angle between condylar inclination & occlusal plane of Mx teeth remain constant between open & close position

- Non-arcon:

  - Opposite to arcon , non anatomic
  - 8° difference between condylar inclination at open & close position

-THA:

  - using facebow to transfer relation of Mx teeth, THA & 3rd reference point from patient skull
  - accurate way to detemine is ' trial & error' described by McCollum & Stuart

- kinematic HA location→ a device with horizontal arm extend to region of ear & fix to Mn

  → stylus attach to Mx→adjust in open & close of 10 mm until it rotate without translation → tattoo & transfer

- Arbitrary HA→ provide enough accuracy of VDO will not be alter
  - types:
    1. Quick mount- Whip Mix
    2. Denar slidematic
    3. Hanau spring bow facebow
- Register condylar movement:
  - ➢ Pantograph use for fully adjustable – 2 V& 4 H recording table
  - ➢ Wax wafers- lateral cheeks for semiadjustable

- when mount Mn cast raise pin 2mm to accommodate IO record thickness
- when making IG table raise pin 1mm

Cadiax

- Salvicek→ originally used for electronic pantograph for ortho & TMD group of patient
- Chang & Driscoll,2004→ 10 mm condylar track distance is recommended to program the articulator since it is most reliable compare with 3&5 mm
- Anderson,1987→ electronic pantograph are reliable & valid in recording Mn movement angle
- Payne→ condylar determinant & reading are various in large range when using electronic pantograph
- Bernhardt,2003→ measurement of cadiax compact based on arbitrary axis is reliable to program the articulator
- PRI:
  -pantographic reproducibility index by Denar pantronic
  - Clayton, Myers, & Crispin→ took 3 tracing & if it is good →line will be the same
  - used to detect TMD & muscle dysfunction
- Electronic pantograph compared with mechanical pantograph doesn't required transfer of facebow & tracing to the articulator

Centric Relation (CR)

- CR→Mx-Mn relationship in which the condyle articulate with the thinnest avascular prtion of disc with complex in anterior superior relationship against articular eminence
- 4 methods of obtaining CR:
  1. Static recording→ direct IO record
  2. Graphic recording → Gysi-extraoral, Hardy & pleasure- coble balancer
  3. Functional recording→ Myomonter-Jankleson, swallwing- Shanahan, Chew in-Myer, Steriograph- Stuart
  4. Cephalometric→ Atwood, Pyott & Schnaffer

- Kantor & Silverman, 1973→ compare 5 ways of guide patient to CR:
  1. Swallowing 'unguided'→ produce 0.4mm error
  2. Chin point guidance→ 0.14mm error- gnathology by McCollum
  3. Chin point guidance with anterior jig→ 0.07mm error
  4. Bimanula manipulation→ 0.05mm error
  5. Myomonter→ electrodes provide impulse to 5th cranial nerve→ 0.38mm error

- Hobo, 1985→ compare unguided, chin point, & bilateral manipulation
  - Bilateral manipulation produced the most consistence & reproducible position

- Simon→ no differnce between between chinpoint & bilateral manipulation

- Methods to verify CR:
  1. Split cast technique by Needles
  2. Verticheck→ mesure AP & lateral error
  3. Intraoral record
  4. Buhnegraph (modifying Whip Mix)→ doesn't show lateral discrepancies
- Deprogrammer: various types of devices or material used to alter properioception mechanism during Mn closure
  - Use CR minimize clinical adjustment in patient

- Deprogrammer:
  1. Eliminate muscle engrams→ deprogramming talking around 30 minutes
  2. Prevent activation of neuromuscular avoidance mechanism
  3. Allow Mn to move easily to achieve CR
  - Techniques for deprogramming:
  1. Bite on cotton roll
  2. Lucia jig→ make it indirect & use articulating paper to get gothic
  3. Leafe gauge→ close in thick gauge & reduce it until teeth minimally separated & then use it with posterior recording material
     - Disadvantage: incline of leafe gauge may force condyle posteriorly
  4- Anterior flat plane→ like Lucis Jig but no incline

- Lucia Jig, 1964→ function
    - Eliminate patient engram→ properioception determine path of closure
    - Don't let teeth touch but as close as possible
    - Scribe Gothic arch in jig
    - Incline plane attach to Mx incisor will hep to fully seat condyle in fossa
- Atwood→ 2 basic concepts of CR:
    1. Anatomical concepts- most posterior border established by ligaments
    2. Pathophysiological concept- most posterior border established by muscles
- Dawson→bilateral manipulation
    - CR is a functional position & relates to muscle harmony of patient
    - Lateral pterygoid muscle resist elevator muscle (master, temporalis, M pteygiod) when there is interfernces to provide full closure
- Why CR→ only clinical repeatable & verifiable jaw relation
    - It is bone to bone, & MIP is tooth to tooth
    - CR & MIP are coincident only in 10 % of population- Posslet

- Recording technique:
    1. Chin point guidance: not recommended due to posterior displacement & stress on bilaminar zone
    2. Biamanual manipulation technique:
       - deprogram patient→ finger at angle of mandible & thumbs at chin with downward pressure→ manipulate into pure hinge movement
       - technique is very sensitive not to over manipulate patient & place condyle posteriorly
    3. Singel handed technique: same as bimanual but with one hand
    4. Myotronic or Myocentric by Jennglson:electrodes to measure muscle activity
       - records are difficult to verify & tend to be anterior to CR position
    5. Unassisted free closure:
        - swallow & pull tongue back
        - record tend to be anterior to CR position
    6. Unassisted free closure with anterior programming
    7. Power centric by Roth:
        - Flat plane anterior deprogrammer with patient free closure to eliminate operator induced error
        - During deprogramming patient taught to move to CR without assistant
        - Recording material introduce posterior & patient bite against anterior jig

- Recording material:
    1. Waxes→ baseplate or reinforce aluwax
    2. Compound→ accurate but technique sensitive- need uniform softening
    3. Plaster or ZOE→ accurate & stable difficult & messy to use
    4. Elastomeric→ stable, easy, acceptable accuracy
- Factors affect CR record:
    1. Resiliency of supprting tissue
    2. TMJ & neuromuscular
    3. Stablility of record base
    4. Pressure applied at recording

5. Technique used to record & recording device

- Atwood, 1968→ posterior limit of Mn at VDO is established by structure anterior & lateral to condyle (TM ligaments & lateral pterygiod)
- Kingery, 1952→ reviews problem associated with CR :
  1. Positional error→ caused by operator,excessive force , change supporting area
  2. Techanical error→ ill fitting rim & slight shift at closure
  - Error manifist as loss of retention, irritation at crest of ridge due to premature contact

- Celenza→ CR various overtime within patient

- Shafagh, 1975→ Diurnal variance in CR position
  - Most of the patient has variation in CR position during day time
  - In the morning condyle in most anterior-inferior positon
  - In the evening condyle in most superior-posterior position due to joint fluid

- Williamson, 1977→
  - Biting hard in leafe gauge cause condyle to placed posteriorly
  - Temporalis muscle has more influence in CR than masseter muscle

- Serano, 1984→evalute change in CR position up to 3 months of treatment
  - CR is not one position, it is range of position

- Guichct, 1977→ 4 articles talks about biological laws of muscle in mandibular movement
  - Use deprogrammer in anterior teeth→ relax elevator & deprosser muscle of mandible & gave more accurate CR record

- Kngery & Brewer→ suggested two step in mounting cast
  - First mix stone & keep space between cast & mouting material, then fill space by 2nd mix after 1st mix set

- Lucia, 1964→ use three record & use split cast technique to verify it

- Mullick, 1981→ Alue wax most variable & least reliable
  - 5 elastomers result in least amount of error

- Graphic recording:
  - Bakwill→ gothic arch tracing
  - Hesse→ needle point tracing
  - Gysi→ Extraoral tracer
  - Hardy & Pleasure→ coble balancer
  - Philip→ central bearing point

- Functional recording:
  - Greene→ use wax occlusal rim& plaster index

- Boose→ use biometer to get V& H relation & then plaster in between
- Shanahan→ use cone of soft wax on Mn rim & ask patient to swallow

- Cepahlometric recording:

- Pyott & Schaeffer→ use cephalomeric to record CR & VDO

- Direct cheekbite recording:

- Philip Pfaff,1756→ use wax, call it mush or biscuit bite
- Chrestensen→ use impression wax
- Schuyler→ use modeling compound because:
    1. Soften more even & cool slower
    2. Doesn’t distort like wax
    3. Lighter pressure
- Payne, Hickey, Boose→ plaster is more accurate, less material use& less pressure
- Gysi→ plaster is only accurate matrial

- PVS ‘Blue mouse’→base- dimethyl siloxane polymer
→ catalyst- divinyl polysimethyl siloxane

- Initially dead soft,fast set, when it set it rigid & can be trimmed
- Dimentional stable & unaffected by desinfection

- Mullick, JPD 1981→

- Compare different material, thickness & operator variability
- Five elastomers produce least error
- Alu-wax was most variable & least reliable material

- Breeding& Dixon, 1992→

- PVS material provide a good resistance to compressive when it set

- Millstein & Hsu, 1992→

- Examin 5 brands of PVS according to dimentional stability& weight loss
- All brand shows accurate & dimentional stable record for 48 hours

- Chai et al, 1995→

- Examin hardness & dimentional stability of different IO record
- PVS has high dimentional stability

Functional Occlusion: From TMJ to Smile Design: Peter E. Dawson
Chapter 7:

- CR is only condylar position that permtid an interfences free closure
- If MIP not coincident with completed seated position of both condyles, condyle must displace to achieve complete jaw closure into MIP which is related to disrupt the coordination of masticatory muscle function
- Two most important factor for CR:

1. Complete relase of inferior lateral pterygiod muscle

2. Proper alignment of disc on condyle

- condyle can freely rotate in CR up to about 20 mm without moving out from fossa
- Mn can be in CR even if teeth is separated or no teeth on the jaw
- CR refer to condyle positon regardless of teeth contact
- Why CR psition?
    1. Repeatable
    2. Interferences free occlusion
- Mounted Dx cast should determine correct Mx-Mn relation to bring teeth in harmony with joint position
- Condylar disc assembly should be in superior position which facilitated by muscle pulling action of Masseter, temporalis & internal pterygiod
- Inferior lateral pterygiod muscle is responsible for forward position of Mn from CR to MIP when ever not coincidence
- Glenoid fossa is triangular in shape
- Mn are in CR if 5 criteria present
    1. Disk properly align in both condyle
    2. Condyle-disk assembly (CDA) in hige position against posterior slope of eminence
    3. Medial pole of CDA is braced by bone
    4. Inferior lateral ptergoid (ILP) muscle relase contraction & passive
    5. TMJ can accept laoding without tension
- The goal of CR is completely relase ILP muscle on both side
- If CR is not coincident with MIP, you put ILP muscle in tension each time when you close

Chapter 9- Determine CR

- Unguided closure of Mn has tendensey to close in MIP
- Bilateral manipulation can be repeated more precisely
- Technique→ patient recline→ stablize head→ left patient chin→ four finger at Mn angel → bring thums to form C with each other
- No matter how solidly condyle seat & how freely Mn hinge, you can't tell by touch alone that condyle in CR→ CR must be verified by laod testing
- Testing by applying firm pressure as:
    1. Up with fingers in back hafe of Mn
    2. Down with thumb pressure on symphysis
    3. Start in increment, thumb should keep teeth apart
    4. Ask patient if he feel any signs of tenderness or tension
- To record CR, condyle kept under pressure to first point of teeth contact
- CR is repeatable position withon needlepoint accuracy because:
    1. Condyle stopped by bone in CR position
    2. Only when it reach bone stop at CR, ILT muscle relase their contraction
- Gilboe found that bilateral manipulation has benefit effect on slight displacement of disc while chin point displce disc more anteriorly

- Anterior bite stop
    - Allow separartion of posterior teeth & condyle free moving V&H

- Materials used:
    1. Direct fabrication of anterior deprogramming device
        - In dough stage→ manipulate Mn to CR & then jaw close, anterior teeth will make indentation
        - It should be flat to allow horizontal movement of Mn
    2. Pankey J.B by Kieth Thonton
    3. Best bite appliance
    4. Lucia jig
    5. Nociceptive trigeminal inhibitor (NTI)
    6. Leaf gauge by Hart Lang

- Primary purpose of study cast:

- To observe tooth to tooth relationship in CR at correct VDO
- If goal of treatment to make CR coincident with MIP→ the condylar axis must be located & transferred to articulator →facebow relate Mx cast to the horizontal condylar axis
- Mount cast without facebow hasn't any value because it record it only in open position but when you want to close the cast to closest VD→ the arc of closure will be different on the articulator than in patient

Vertical Relation

Vertical relation 'Swenson CD by Boucher'

- Muscle will not tolerate an increase in interarch space
- There is aproof of exact VD at which occlusion should be established
- ↓ interarch space result in a crease at corner of mouth which result in disease known as perleche
- What is the result of reduced interarch space:
    1. ↓ biting force & ↓ sorness
    2. Not desirable facial expression
    3. ↓lower 1/3 of face
    4. Lip lose the fullness
    5. ↓ action of muscle→ less muscle tone→ face flabby 'not fulness'
    6. Push tongue toward throat
    7. Ear discomfort
    8. TMJ trauma

- Records, methods & theories to obtain correct VDO:
    1. Ridge relationship
        A. Distance of incisive papilla from Mn incisors
        - explained by Mckevitt, which is an average of 2mm & distance from Mx incisor edge is 6mm that mean the vertical overlap is 4mm
        B. Incisive papillae from crest of lower ridge
        - it is equal to 12 mm
        C. Distance of hamular notch from retromolar pad ' they claim it is remain constant through life & it give VDO
        D. Paralllism of posterior ridge 'open 5 °)
        E. Esthetic values
    2. Measurement of former denture:
    - measurement between Mx & Mn denture border is made by boley gauge & then evaluate patient if need for changing
    3. Interarch distance & physiological rest position
    - phonatics (s,m,j,ch) has been used in determine correct VD in assumption of direct relation between interdental space, occlusal plane & tongue position
    - physiological rest position technique:
        - Depressor & elevator muscles are theoretically in balance
        - Trunk upright & head unsupported
        - Used mmm letter to insure patient is relaxed
        - Put occlusal rim & ask patient to relaxed
        →>4mm freeway space- VDO is too small
        →<2mm freeway space- VDO is too large
        - Keep adjust until satisfy
    4. Pre-extraction record
        - profile radiograph provie some accuracy
        - Radiograph of position of condyles; not reliable
        - Profile photograph

- cast of teeth in occlusion
- facial measurments
- paralleling of posterior ridge: parallism of Mx & Mn ridges + 5 degree opening in posterior region as suggested by Sears give clue of correct aamount of jaw separation

5. Vertical determinants by means of power point:
    - VR determine by use of a device register the biting force at varying degree of jaw separartion
    - The theory is by Boos is that patient register maximum biting force when teeth contact in CO & measurment done by Bimeter
    - It is also give CR position
    - It is usless of ridge not parallel
6. Interpupillary distance in old photograph in relation to interpupillary distance on face as aid in determining VD
   - Wright made suggesting in using old photograph to determine VD
   - this methods used the formula of :
   interpupillary distance of photograph/interpupillary distance of patient
   =
   brow to chin distance of photograph/brow to chin distance of patient
   e.g: 6/60=12/X→X=12X60/6=120
   - After that made occlusal record in patient mouth & make measurment, try until you have same measurment at VDO

Methods of determining VD:

1. Mechanical:pre-extraction record, parralism of ridge
2. Physiological: rest position, swallowing, phonatics
3. Esthetics

- All determine of VD should be used as tentative until teeth is set then used esthetic & phonatic
- Phoantics & esthetics as guide:
  - use sibiliant sounds which bring lower incisor very close to upper incisors, almost touch, without clicking or to far from each other
  - lip contour & skin must be generated to old nature before extraction, if lip is too straight that mean it should get more support
  - Esthetics guide of VD is by:
    - Select same size of teeth as natural teeth
    - Accurate estimation of tissue lost from alveolar ridge

- Swallowing: by Shanahan

- When patient swallow→ teeth come in contact at beginning of swallowing cycle → in this basis the records will be at VDO at that swallowing cycle
- Cone of soft wax in lower record base & contact Mx occlusal rim when patient open , give patient candy to stimulate flow of saliva, cone wax will be shaped util reach exact VDO

Vertical dimention ‘summarry’

- Rest position is constant→ Niswonger& Thompson
- Rest position is not constasnt→ Atwood& Tallegren
- Goodfriends→ pupil to lip = subnasion to gnathion→ Willis has credited for publication

Methods to get VDO:

1. Rest position:
    - Niswonger→ pleasure point
    - Atwood→ ceph for 4 years→ VDR is not constant
    - Sheppard→ same result
2. Physiologic: swallowing
    - Shanahan→ natural dentition
      - soft wax over Mn posterior teeth→swallow→teeth kis, no perforation
      - if no touch in wax→ there is loss of VDO
      → Complete denture
      - get VDO usin freeway space, then verify it→set Mx posterior teeth & put soft wax in Mn
    - Veirhiller→ use bees wax in Mx & notch in Mn rim→water & swallow
    - Laird→ 75% of patient teeth contact in swallowing
3. Electromyograph→ Jenkelson & Hoffman
   →Shipmtoff→use it to get CR& VDO
4. Neuromuscular perception→ Lytle,1964→use central bearing device
   →Timmer→ similar technique but more accurate
5. Cephalometric → Douglas& Maritato,1962→vertiocclusogram- tin foil at crest of ridge of first premolar & lip corner
6. Open rest position→ Douglas& Maritato
   - upper occlusal rim→ 3mm above lip corner at first premolar
   - lower occlusal rim→ 2mm below lip corner at first premolar

7. Facial meeasurment:
    - Willis→ distance between pupil& lip= subnasion to gnation
    - Boyanov→ distance between corner of mouth= mid philtrum to gnathion
    - McGee→ 1- from center of pupil to junction of lip (stomia)
      2- glabella to subnasion
      3- chelion to chelion (corner of mouth)

   1=2 is VDO , 1=2=3 is edge to edge relation

8. Speech→ Silverman→closest speaking space measure VDO
    - Ch,s,j→sibiliant sound→minimum space separate teeth
      → contact mean excessive VDO
    - Murrell→ set nterior teeth based on S sound
    - Earl Pound→ verticentric

9. Power point→ Boose bimeter → measure maximum biting force

10. Anatomical average→ McGrane:
    - Distance between incisal edge & depth of vestibule in Mx= 22mm
    - Distance between incisal edge & depth of vestibule in Mn= 18mm
      → Fayz- support McGrane result

- Wagner→ rest methods is the most accurate in determine VDR compare with other 3 methods
- Facial measurment mask position of Mn:
  - Sheppard . Carossa
- Is clinical measurment more accurate than cephalometric?
  - Toolson & Smith → more reliable to get VDO with clinical measurment
  - Smith profile scale→ use millimeter ruler & blade at chin
  - Sorenson profile scale→ metal scale at nose & indicator at nose & pad at chin
- VD= distance between two selected anatomical point
- VDO= the VD when Mx teeth occlude with Mn teeth

- Main cause of loss VDO is lack posterior support
- Why do wwe need to ↑ VDO?
  - Room for restoration
  - To improve esthetics
- Who said VDO is constant through life?
  - Schyler & Tench→ any ↑ in VDO will
    1. interfere with physiology of masticatory system& patient ability to adapt
- What is consequnces of ↑ VDO?
  1. hyperactivity of masticatory system
  2. elavation of occlusal force
  3. Bruxism
  4. TMD
- Is symptoms transitory? Yes by Gross & Ormianer
→ up to 5 mm ↑ in VD doesn't cause maladaptive or pathological changes by Gross, Carlsson, Dahl, Hellsing
- Do we always ↑VDO? No, increase it with caution, it required at least one arch to reconstruct
- How to assist loss of VDO& is there any ideal way to assist?
  - More than one method should be used since noone of the techniques abrove scientifically better than other
  - Assisment by:
    1. rest position & freeway space – average of 2mm , >2mm indicate safety
    2. speaking space
    3. esthetic→ at lateral profile, lip morphology & teeth display
       - Mn psudognathic apperance give sign of loss VDO
       - Verrela & Grothers
- Grothers→ signs of loss VDO:
  - Sagittal→ Mn psudoprognathic apperance
  - Frontal→ 1- alter facial contour
    2- narrow vermillon border
    3- overclosure commissre
- Gross et al→ ↑ VD upto 6 mm in dentate patient :
  - Insignificant extra-oral improvement in patient apperance
  - Facial profile doesn't always reflect loss of VDO
- Relation between upper lip & incisal edges of Mx teeth when smile& rest

- Insiginificant display of Mx anterior teeth can be improved by lowering occlusal plane
- Excessive display of gingival tissue→ need crown lenghenning, will not improve by ↑VDO

So→ No evident that in dentate patient that ↑ in VD will improve esthetic
→ even, teeth display may improve by lowering occlusal plane

-TMD & VD:

- Prevelance of 7-10 %
- Primary affect young & middle age adult
- Attrition is not associate with TMD
- Use appliance to ↑VDO with TMD patients to
    a. Stabilize TMD→ as treatment of TMD
    b. Test ↑ of VDO

- Intraoral considerations for VD:

1- Remaining tooth structure
   - Hight for retention& resistance form
     → minimum of 3mm with 10 to 20° by Parker
     → minimum of 4mm with 10 to 20° by Goodacre
     →>3mm use axillary features
   - If no ↑ in VDO
     → crown lengthening : improve esthetic for high smile line
     Disadvantages:
     1- loss of soft & hard tissue
     2- black triangle
     3- exposure of root
     4- diffictive emergence profile
     5- ↑ C/R ratio

2- Occlusion: by ↑ VDO
   - eliminate interfernces
   - restore anterior guidance
   - protect posterior teeth

- How patient adapt to increase in VDO?
1- Muscle lengthening→ primary adapatation by Orminar & Gross – follow patients for two years & patient stays at increase VD
2- Dentoalveolar maturation→ by Dahl

- How did you decide to ↑ VDO?
1- remaining tooth structure
2- space available for restoration
3- occlusal variables
4- esthetics- smile line & occlusal plane

- Physiologic VD& CR by Shanahan, JPD 1956:

- during function of swallowing saliva→Mn leaves its rest position & rises to natural VDO, then as saliva is forced backward into pharynx by tongue→ the Mn is retruded along with tongue to its natural CR

- A study of physiological rest position & centric position by electromyography, Shpuntoff, JPD, 1956:

- article described use of electromyographic method to determine rest position & centric position
- Jankelson & Hoffman introduce technique

- A cephalometric study of clinical rest position of mandible, Atwood, JPD, 1956:

- 42 patient followed for 4 years, caphalometric (nasion to gnathion measurment)
- rest position vary from one patient to another & for same patient at different time
- VDR is different if denture is in or out
- Many factors influence posture which could be:
  - physioloigic: fatique, sleep, function, heat,cold,pain, posture reflux
  - pathologic: muscle, nerve, bone, joint disease, mental disorder

Part II; clinical factors related to variablility of clinical rest position follow removal of occlusal contact:

- More than 30 factors could affect rest position
- 6 groups of factors has been discussed:
  tooth-bone factor, tongue,lip,health-age,neuromuscular, previous closure

- Rest position: An electorgraphic & clinical investigation, Garnick & Ramford, JPD, 1962:

- EMG→ VDO-VDO range from 1-9mm
- Clinical→ VDO-VDO range from 1-8mm
- All techniques measuring rest position varies widely in & between them

- Vertical relation of occlusion by the patient neuromuscular perception, Lytle, JPD, 1964:

- Describe technique using patient perception to determine VDO
- Central bearing device used (you go too close& too open until the patient feel happy)

- “Open Rest”, a new concept in the selection of VDO, Douglas& Maritato, 1965, JPD:

- Upper occlusal plane 3 mm above commisure of lip & lower occlusal plane 2mm below at 1st premolar area used to get VDO
- Open-rest position is unstrain position with minimum lip separation

- Aroentgenographic method to determine VDO of complete denture, Douglas & Maritato, JPD, 1967:

- Descibe using ceph at open rest technique ‘ tin foil at area of 1st premolar at ridge crest& commisure of lip’ to get VDO by allying occlusal plane→ Vertiocclusogram

- A functional method of establishing vertical & tentative centric Mx-Mn relation, Vierheller, JPD, 1968:

- Descibe tecnique of using swallowing to get VDO & CR

- fabricate Mn occlusal rim (posterior at ½ of retromolar pad, anterior at lower lip height
- notch in area of 1st premolar & 1st molar→ bees wax on Mx record base→ inject water & ask patient to swallow→ record is form for VDO& CR

- A reproducible method for determine VDO, Timmer,JPD, 1969:
  - Similar to lytle technique by using patient perception
  - Range for repeatability was within 0.5 mm for screw aompare with 2mm for phonetic & rest position

- Determining VDO& CR, Boyanov, JPD, 1970:
  - Using anthropometric ' facial measurment' to get VDO
  - Distance between corner of mouth equal to distance between mid philtrium & ganthion d

- Comparison of four methods determining rest position of Mn, Wagner, JPD, 1972:
  - Compare four technique: rest 'swallow,moist lip& clear throat' , m.m.m then relax, swallow then relax, open-close then relax,
  - The rest method appear to be most acceptable since it has less high & low reading, m-method gave large VDR & swallow method gave smaller

- Clinical assessment of VD, Turrell, JPD, 1972:
  - Niswonger& Thompson→ rest position is constant through life
  - Atwood & Tallegren→ VDO & rest position are not constant
  - Goodfriend→ distance from pupil→ junction of lip is equal to VDO→ Willis has been given the credit for popularizing these measurment

- Intermaxillary relationship during deglutition, Laird, 1974:
  - Swallowing is accurate to use in VDO since 75% of 10 dentate patient has the teeth contact in swallowing

- Phonetics, function & anterior occlusion, Murrell,1974:
  - Describe technique to set lower incisor according to normal, abnormal & atypical s sound

- Vertical dimention measurment, Sheppard, 1975:
  - Facial structure mask position change of Mn
  - Rest position vary with time frame
  - Rest position of Mn more constant of denture in patient mouth

- Let/s/ be your guide, Eral Pound,1977:
  - Verticentric→ use s sound to get position of Mn anterior teeth then guide patient to CR by retruding Mn& have contact between Mn & Mx anterior at that point→ you get CR& VDO →then build posterior wax rim & evaluate posterior speaking space

- Restoration of extremely worn dentition, Turner& Missirilian,JPD,1984:

Class	VDO	Space	Tx
I	L	S	Removable appliance for 6-8 weeks
II	N	S	Return patient to CR - enameloplasty
III	N	N	Ortho, surgery, or ↑ VDO

- The effect of body position on preferred VDO, Wright,1984:
    - Upright or supine doesn't affect VDO measurment on preferance

- Functional adaptation to change in vertical dimention, Hellsing, 1884:
    - Rapid adaptation of postural position to any increase in VDO ' interocclusal space is independent to ↑ VDO

- Increase OVD, Abdio, Aust D J, 2012:
    - Clinical study found patient adaptation to increase VDO within 2 weeks ' Carlsson, Helssing, Gross& Orminar, Dahl'
    - ↑ VDO by fixed appliance has less symptoms than removable

- Use of anterior teeth measurment in determine VDO, Fayz, 1987:
    - it is support McGrane of 22 for Mx & 18 mm for Mn

- The unreliability of facial measurment in determine VDO in edentulous patient, Carossa, JPD, 1990:
    - extra-oral measurment point don't reflect correct intra-oral measurment regarding VDO

- Clinical measurment & evaluation of VD, Toolson& Smith:
    - Smith (chin-nose use blade at chin) method & Sorenson profile scale were reliable compare to ceph in determine VDO

Functionally Generated Path

- FGP register paths of movement of occlusal surface of teeth or occlusal rim of one dental arch in plastic or other material attach to teeth or occlusal rim
- Meyer,1959→ describe technique for CD to get balanced occlusion
    - Part I: occlusal rim of compound → soft carding wax on the rim→ remove wax from lower rim & pour stone→ set upper teeth according to path in stone→ soft lower compound & ask patient to move→ get VDO on compound & replaced it by soft wax → pour stone & set teeth
    - Part II: for fixed prosthesis

- McCraken, 1958→ describe technique for RPD → make no interfernces & ease of occlusion
- PM-Schyler→ Broadrick plane analyzar
- Mann& Panky, 1960→ lower occlusal surface rebuilt based on Bonwill triangle & Monson curve→ IG rebuilt by restoring or grinding → Mx posterior reconstruct using FGP
- Schyler, 1959→ IG is most influential factor compared with CG due to:

1- proximity to occlusion 2- Non resiliency

- Posterior teeth incline control by IG, & degree of Bennett movement
- Technique: mount cast with retruded position → place tin foil of thickness 0.5 to 0.75mm between condylar ball & condylar guidance→ restoration is finishe in this position → then, retrude articulator to CR→ milled again restoration → this produce AP freedom

- Dawson, 1974→
    - IG influence disocclusion at 2nd molar twice as that of CG during protrusive movement
    - IG influence disocclusion at 2nd molar three times as that of CG during non working movement
    - IG influence disocclusion at 2nd molar four times as that of CG during working movement

Geriatrics

- Venton, 1964→ examine nature changes & effect on denture
    1. Physiologic
        - Loss of muscle & tissue tone
        - ↓in taste & saliva
        - drop in brain metabolism

→ leads to possible generalized sorness & difficulties to adapt

→ consider to reduce flanges, VDO and increase horizontal overjet to reduced cheek bitining

    2. Psychological→ hypochondrosis, loss self steam may lead to depression & loss ability to adapt
    3. Nutrition→ carolic required decline, need protien for nitrogen balance

- Storer→ effect of aging in diagnosis and treatment plan:
    - Assesr biological & chronological age
    - Loss of teeth with aging
    - Mucosa→atrophy, ↓in thickness & resiliency
    - Musculature→ loss of muscle tone & ↓motor control& slow in learning
      → affect adapt to new denture
    - Bone→ loss of teeth→ loss of alveolar bone, osteoporosis
    - Saliva→ xerostomia→ difficulties in relining denture
    - Climactric patient→ 45-60 years old with endocrine changes & oral symptoms ‘ glossitis, discomfort, & burning tongue & mucosa’

- Wiscott, 1983→
    - chronological age→ number of years one has lived
    - Biological/Physiological age→ based on degree of loss physiological capability & function of organs
    - Sociological age→ retiering from active work
    - Behavioral age→ falling in stereotypical image attribute to elderly ‘ conversation& senility’

- Massler, 1980→three classes of caries lesion
    1. Pit & fissure caries→ cariogenic ‘ Lactobacillus acidophilius’
    2. Smooth surface caries→ cariogenic ‘ Streptococcus mutans’
    3. Cemental caries→>50 years. Odontomyces viscosus→ adhere to dorsum of tongue → brush tongue 2x/day & apply stannos fluoride

- Thomas- Weintraub→ masticating difficulties was most complaint for elderly patient

- Krechener, 1987→ drug induce hyposalivatory side effect have deleterious influence in denture bearing tissue

- Winkler, 1977→ Geriatric complete denture signs & treatment

Nutrition

- As patient get older, he needs more protein to resist infection, resist anemia & loss of muscle volume

- Vitamin A→ important for integrity of mucus memebrane
  → egg & liver
  → deficiency leads to xerphtalmia , Keratosis
- Vitamin B1→ Thiamine for carbohydrate metabolism
  → meat & egg
  → deficiency leads to Beriberi
- Vitamin B2→ Riboflavin for ectodermal tissue & need for metaboloic oxidation
  → Milk & egg
  → deficiency leads to Cheilosis & angulr stomatitis
- Vitamin B12→ liver, kidney
  → deficiency leads to anemia & sore tongue
- Vitamin C→ effect in wound healing & maturation of RBC
  → deficiency leads to scurvey & ecchymosis
- Vitamin D→ enhance absorption of Ca & necassery for Ca-ph metablism
  → Fish , Liver, Ca high in milk
  → deficiency leads to Rickets
- Endocrine organ→ parathyroid glands:
  1- ↑absorption of Ca from GI tract & reabsorption from kidney
  2- it stimulate bone resorption
- Osteoporosis→ little bone, radiograph can't be diagnosed until 30% of mineral loss from bone
  → serum Ca level is controlling factor of bone metabolism
- Calcitonin →↓ Ca level by inhibit bone resorption & parathyroid hormones reverse action

- Nizel→ oral problems for vitamin deficiency :

- Effects→lips, taste ' salt disappear first & better last'
  → Xerostomia 'salivary gland', tongue ' Fungiform papilla in anterior 2/3 of tongue and response for salt, sweat & sore, Circumvallate papilla at posterior 1/3 for sore & better
  →gingiva, TMJ, head & neck cancer

- Wical & Swoope, 1974→ when Ca deficient, the primary source of Ca is trabicular bone 'resorption'

- Water soluble vitamin→ B&C, deficiency develop rapidly and should be taken in daily basis
- Fat soluble vitamin→ A, D, E, F, K, deficiency develop slowly, body storage & no supplement need

- Drummand→ Dietry deficiency diagnose by history or serum level- refer patient to lab

- Osteoporosis→ type 1 postmenopausal , type 2 affect bone orgin
    - High Ca & vit D intake difficult to achieve by diet alone
    - Supplement is needed to ensure enough mineral & vitamin

Pre-prosthetic Surgery

- Try to avoid it, if other non surgical treatment is possible
- Objectives:
    1- Comfortable denture foundation to support denture
    2- Enlargement of denture bearing area to provide stability
- Paterson, Chase & Laskin→ Types
    1- Soft tissue related surgery
        A- Resective surgery:
            1- Hypermobile tissue→ resection of alveolar height is adequate
            → ridge augmuntation & vestibuloplasty if no adequate ridge height
            2- Papillary hyperplasia
                - Hyperplastic tissue in palate due to mechanical irritation, ill fitting denture, poor OH, fungal infection ‘candida albicans’
                - Treatment- soft liner, electrosurgery of small or conventional surgery if it large
            3- Inflammitaory fibrous hyperplasia ‘ epulis fissuratum’
                - Continous fold of hyperplasia tissue fill space between ill fitting denture & alveolus
                - Treatment- correct denture extention, relining or surgery
            4- Frenectomy:
                - Labial or lingual→localized vestibuloplasty or simple excision
            5- Tubersity reduction of soft tissue→ excsess soft tissue by x ray & bone sounding
        B- Ridge extention surgery:
                - Vestibuloplasty→ use remaining bone for denture by extended vestibule & eliminate high muscle interfere with denture border
                - Heals by 2nd intention or skin graft
    2- Bone related surgery
        A- Resective surgery
            1- Alveoplasty→for sharp & thin ridge
            2- Tori removal→ Mx tori 20% - large tori removal to eliminate mucosal damage
            3- Mx tubersity reduction→ when interfere with interarch space
            4- Ridge undercut, irregularities or exostosis
            5- Genial tubercle reduction due to excessive resorption
            6- Mylohyoid ridge reduction→ shelf like projection at insertion of mylohyoid muscle → immediate deliver denture to relocate of mylohyoid muscle
        B- Augmentation surgery:
            a. Synthetic graft
            b. Onlay bone graft
            c. Interpositional bone graft
            d. Osteotomies due to supereryption of segments

e. Nerve relocation due to mental nerve exposure at severe ridge resorption

TMJ-TMD

- TMJ: is articulation between temporal & Mn bone
  - Diarthroidal, bilateral ginglymus joint
- TMD: abnormal, incomplete or impaired function of TMJ

- Sears→ tooth occlusion out of harmony with joint relation may cause mechanical stress in TMJ

- Morgini→ direct relation between joint remodeling & two main cause of changes in occlusion scheme 'attrition & partial edentulism' , occlusal alteration are one of factor eliciating bruxism & other parafunction which increase loads to TMJ

- Lundeen→ denture wearers had higher level of TMD symptoms but fewer complaints

- Kroon& Naeve→ myalgia occurs without any signs of attrition

- Pullinger& Seligman→ attrition is isolated variables & shouldn't be considered as predisposing factor to TMD

- MnNamara→ low association between occlusal function, anatomy, & TMD
  → no ideal occlusion doesn't cause TMD
  → Diagnosis- evaluate condylar motion, CAT scan, EMG, ultrasound, & psychological test

- Sears, 1995:
  - occlusal pivots use to ↓ stress & not force condyle into rear position by adding acrylic in posterior to ↑ VDO or if VDO is ok by grinding anterior teeth
  - stress in TMJ:
  1. Vertical→ when occlusal load carried more anteriorly
  2. Horizontal→from occlusal action of cusp incline when CR is incorrect

- George Dimitroulis, 1998→ TMD update
  - 3 cardinal signs of TMD:
  1. orofacial pain
  2. joint noise
  3. restrict jaw function
  - 70% of population will have at least one sign but only about 5% will seaks treatment
  - clinical cause of TMD doesn't reflect progress of disease but rather a complex disorders that is molded by interacting factors such as stress, anxiety & depression
  - Non surgical treatment such as counseling, pharmacotherapy & occlusal splint therapy is most effective treatment in managing >80% of patient
  - Drugs use to relief syptoms: NSAID, Opoids, & antidepressent

Bone Physiology

- Mx& Mn is intramembranous or membrane bone, humerous & femur are endochondral or cartilage bone
- Bone formation started by organic matrix 'osteod' formation follows by mineralization phase
- Two types of bone:
    1. Compact→ dense,corticated,& made outer surface of most bone
    2. Trabecular→ spongy, cancellous, & made up inner surface of most bone
- Two types of bone histological:
    1. Woven ' immature'
    2. Lamellar ' mature'
- Alveolar bone is first source for Ca follows by ribs, vertebrae & long bone
- Role of Ca in body→ main of skeleton, transmit of nerve impulse, regulate cardiac function & blood clotting metabolism
- Role of phosphorus→ mineralization of bone, energy production & maintain body PH

- Atwood, 1971→ reduction of residual ridge 'RRR':
    - When tooth loss →external resorption & endosteal deposition
    - RRR is chronic, progressive, irreversible & commulative
    - Rate of reduction is high in first 6 months after extraction
    - Mx has negligible reduction after 6 months but Mn resorption in advance rate of 0.4 mm/year
    - Factors contribute to etiology of bone loss:
        1. Anatomical→ size,shape of ridge, type of bone
        2. Metabolic→ age,sex, hormonal balance, & osteoporosis
        3. Function→ frequency, direction & amount of force applied to ridge
        4. Prosthetics→ type of denture base, form, type of teeth, IO distance

- Wical, 1974→
    - positive correlation between alveolar ridge resorption & combination of low Ca intake & low dietry ratio of vitamin D
    - Ca supplement of 750 mg & 375 unit of vit D daily will retard progress of osteoporosis disease
    - 34% less resorption in Mx & 39% less resorption in Mn
- PTH hormones→primary hyperparathyroidism→gland produce high amount
→ 2nd hyperparathyroidism→low Ca intake, poor absorption of Ca , renal disease & pregnant

- Glucocorticoid:
    - inhibit bone formation & cause severe osteoporosis
    - excess secration of cortisol by adrenal gland→ Cushing's syndrom
    - use for treatment of rhematoid arthritis
- Estrogen→ antagonist effect of PTH on bone resorption

- Atwood, Carlsson→ resorption of residual bone is inevitable & irreversible regardless denture use

- Atwood& Loy, 1972→ Mx resorp of 0.1 mm/year & Mn resorp 0.4 mm / year

- Mercier & La Fantal, 1979→ classify residual ridge atrophy to 5 classes: no, minimal, moderate, severe, extra-severe atrophy
→ close VD→more compressive force→ greater chance to reach extreme severe atrophy

- Isreal, 1979→ Mn expand of 2% per deacade through life

NB- Wolff's law= change in form & function of bone follow by change in internal structure

Eating Disorders & Tooth Wear

- Hazelton, 1996→
    - Anorexia & bulimia nervosa are psychological condition that start in adolescent & continue into 4th or 5th deacde
    - Women affected more due to fair of weight gain
    - Anorexia is restrict their food intake
    - Bulimia is binging & purging upon food cosumption, have history of self induced vomiting
    - Early detection & intervention by team approach ‘dental.psychologist & nutritionist’
    - Chalange of treatment based on:
        1- Nature of disorders
        2- Excessive loss of tooth structure
        3- Patient compliance
        4- Prevention of caries
        5- Oral hygien
    - Full mouth rehab is necassery based on damage & esthetics demands of patient after control habit

- Barlett, 1996→ relation between gastroesophageal refelex disorder ‘GORD’ & dental erosion
    - Regurgitation is reflex of gastric juice through upper esophageal sphinctor

- House, 1981→
    - Perimolysis is decalcification of tooth due to gastric acid in patient with chronic vomiting as may occur in anorexia or bulimia
    - Lab test take urinary chloride level to diagnose chronic vomitor
    - Sign in teeth of acid erosion :
        1- Erosion in lingual & occlusal
        2- Round contour
        3- Amalgam island
        4- Absence of staining

- Barry, 1990→ Anorexia nervosa in male
    - It is a syndrom characterized by extensive weight loss, disturbance of body image, & intense fearing of becoming obese, mainly female
    - Classified as:
        1- Primary → involve preoccupation wit body size & feeling of inadequancy
        2- Atypical→ weight loss secondary to another psychiatric disorder

- Winstead, 1983→
    - Bulimia is an eating disorder characterized by ingestion of large food usually follow by self induce vomiting or laxative abuse
    - Oral signs: sore throat, bleeding gum, burning tongue & enamel erosion

- Verretts, JP 2001→ Analysis of an extremely worn dentition

- Tooth wear → physiological process with age
  → pathological process: normal rate accelerated by endo or exogenous factors
- Assessment by:
  1- History 'of wear, occupation,habit & diet'
  2- Examination ' compare previous cast, x ray , observation, rate, facial apperance , VDO
- Four types of structure loss:

1- Attrition→ mechanical wear result from mastication or parafunctional habit & limit to contact surface
2- Abrasion→ mechanical tooth wear result from abnormal process rather than tooth contact eg; brush
3- Erosion→ progressive loss of tooth structure through chemical process, no bacterial involvement
4- Abfraction→ pathological loss of tooth structure through mechanical load result in cervical wedge shape defect – theory of flexture is controversy

- Determine etiology
  - Mechanical wear:
    1- Wear facet of sharp define line angle
    2- Restoration wear in same rate of adjacent rate
    3- Asymptomatic with history of parafunctional habit
    4- Surface match on articulator
  - Chemical wear:
    1- Occlusal cupping or creatining with round margin
    2- Erosion doesn't articulate with opposing
    3- Elevate island of restoration
    4- Unstain & hypersensitive teeth

- Hereditary dysplasia accelerate chemical or mechanical wear
- Determine cause of mechanical wear: 4 patterns

1- Anterior teeth wear greater than posterior teeth
- Posterior teeth loss ' inadequate posterior support'
- Malposition or posterior interfernces- ↑in function of anterior teeth

2- Progressive greater wear in anterior teeth
- Bruxism give more wear to anterior teeth except on open bite patient

3- Wear on facial surface of cuspid & premolars→ excessive tooth brushing
4- Wear in variable location: primary occlusal & incisal surfaces
- Parafunctional habit – needle biting or hair pin

- Determine cause of chemical wear:

1- Anterior greater than posterior
- Lingual surface of Mx anterior teeth→ chronic regurgitation 'eating disorder, gastric reflux, chronic alcoholism'
- Facial surface of Mx anterior teeth→ fruit sucking

2- Posterior greater tham anterior
- Occlusl surface of Mx first molar→ soda swishing
- Occlusal surface of all posterior teeth→ fruit milling

3- Variables location→ enviromental,medication & drug

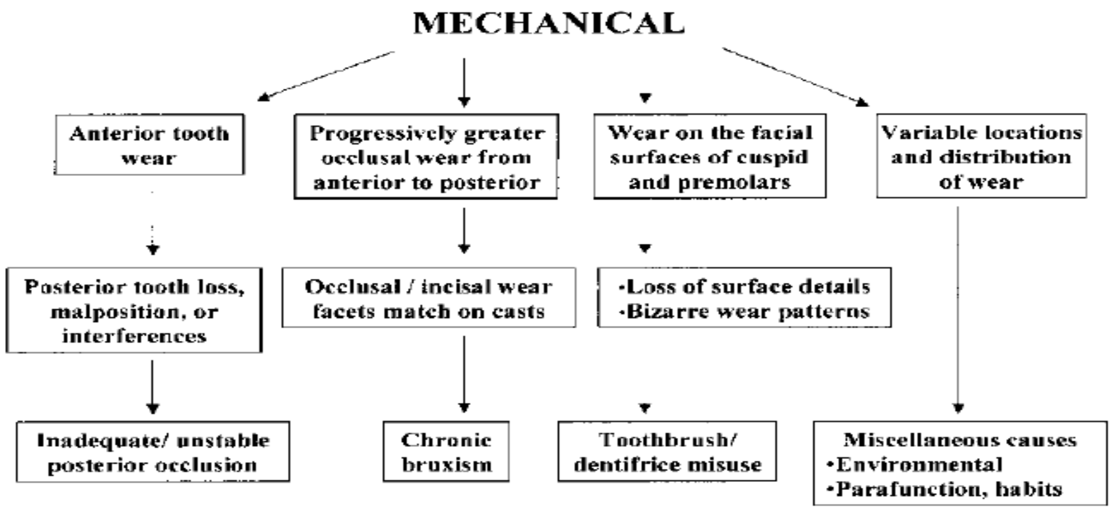

Figure 8. The etiology of pathologic wear resulting from mechanical causes can be determined by correlating the location of wear, other signs and symptoms, and information obtained during the patient interview.

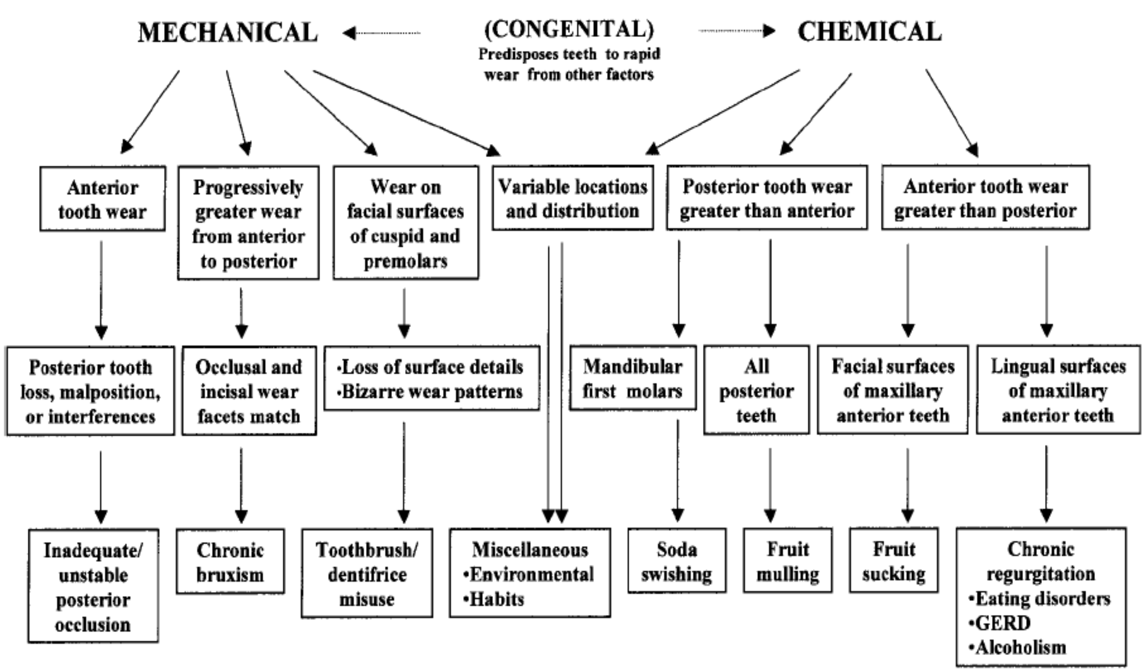

Figure 15. The chemical and mechanical branches of the diagnostic decision tree can be combined to provide a methodical framework for analyzing an extremely worn dentition.

<u>Masticatory Efficiency</u>

- The masticatory efficiency is the effort required achieving a standered degree of communiution
- Gunne→ masticatort efficiency is capacity to grind food or alter material & it is one component of mastication
- Muscle of mastication:

1. Masseter→ raise Mn to occlude teet, protrude Mn with superfacial section & retrude Mn with deep section
   → nerve: massetric nurve of Mn division of trigeminal nerve
2. Temporalis→ anterior fiber elevate Mn, posterior fiber retrude Mn
   → nerve: temporalis branch of Mn dividion
3. Lateral pterygoid→ contribute in jaw opening with hyoid muscles & bilateral contraction leads to jaw protrusion
   → nerve: anterior branch of Mn dividon
4. Medial ptergoid→ elevate Mn
   → nerve: main trunk of Mn division

- Kapur 1965→ study effect of denture factor on masticatory performance 'peanut& carrot'
- Part I: influence of denture base extension;12 patient, 16 changes in denture 'short,PPS, thin…'
  - Reduction in extention of Mx& Mn CD bases in different areas fail to affect chewing ability
  - Significant reduction of lower denture base affect chewing ability
  - Patient with previous denture experience possessed significant better chewing ability
- Part II: influence of polyshed surface contour of denture base: 10 patients with a buccal changes in contour & smoothness
  - No significant variation in chewing ability of different denture form 'B-L,S-I,A-P'
  - Polysh surface denture contour affect masticatory function through food transportation mechanism
  - Subject with good ridges perform better than subject with poor ridges
- Part III→ the location of food plate form: 12 patients with 9 positions of foodplate form
  - Most chewing efficiency found with teeth at crest of the lower ridge, at hight of lower canine & parallel to flat portion of lower ridge
  - Significant reduction in chewing efficency of teeth set buccal to crest of ridge onpatient with a good ridges
- Part IV: influence of occlusal patterns; 16 patients & 15 different occlusal patterns:
  - Presence of groove in occlusal surface ↑ chewing efficiency ' transverse in lower & oblique in upper'
- Part V: Food platform area & metal inserts; 16 patients
  - Presence of groove or inserts improve masticatory efficiency
  - A-P dimention of food platform has no influence in masticatory performance

- Yurkstats 1965→ review article shows that occlusal contact area is most important factor controlling masticatory efficency

- Thompson, 1937→ natural teeth have 5 times the crossing power of artificial teeth but artificial teeth provide 75% of efficiency of efficiency of natural teeth

- Trapozzano, 1959→ compare 20° teeth with Hall's posterior teeth 'non anatomic'
  - Greater chewing efficency & patient preferance of 20° teeth

- Wayler, 1983→ reduce of masticatory performance of CD subjects compared with intact or partial dentate subjects

- Rissin & Kapur, 1978→ masticatory performance of natural teeth is '90%'> OD ' Mn two canine' is 79%> CD is 59%

- Kapur, 1985→
  - Denture wearer applied 22-39% of muscle forces apply by dentate to chew peanut or carrot
  - Saliva rate is a little high in CD subject due to mucosal stimulation componsate for reduce of muscles activity & perioreceprors

- Gunne, 1990→ patient with CD or RPD componsate for impaired efficency by chewing longer up to 3 strokes before swallowing

- Micheal & Gibbs, 1990→
  - Biting strength of natural dentition is 162 pounds & denture wearer is 29.3%
  - Maximum biting strength of CD wearers is 35 pounds '16 kg'
  - Force at closing is 4.6 pounds & 9.8 pounds at occlusion during chewing
  - No statistical differnce in chewing force between 0 & 30° teeth

- Gunne→ CD with good retention, stability & balanced occlusion has increase in masticatory efficency

Esthetics

- Esthetics is theory & philosophy deal with beauty

- Sears,1930→ art in denture
- Frush & Fisher,1950→ dentogenic denture
- Lombardi→ visual perception in dentures
- Levin→ Golden proportion→first to apply proportion of smile to face

- Tjan & Miller→

- Smile type- high '10.77%', low '20%', average '69%'
- Mx teeth parallel inner curvature of lower lip – 84%
- Incisal curve touch lower lip '46%',not touch '34%', covered by lip '13%'
- Number of teeth display- up to 1st premolar '48%', up to 2nd premolar '40%', up to 1st molar '3%'

- Scandrett→ evalute different variables to get width of Mx incisor

- Intercommisures width has high correlation & inter-zygomatic is lowest compare to teeth width

-Vig & Brundo→ teeth display

- Sex→ male 1.9mm & female 3.4mm
- Race→ caucasion 2.4mm, asian 1.8mm, black 1.5 mm
- Lip length→ more length- less exposure
- Age→ ↑age=↓exposure, >60 years – no exposure

- Frush & Fisher→ Dentogenic factors 'SPA'

- Sex→ muscline- strong, large, square
  →Feminen- delicate,round & smaller
- Age→ translucency, shade, wear
- Personality→ Vigorus, medium to delicate

- Mavroskoufls, Ritchic→ 2/3 of indivisual shows no correlation between face form & incisor form

- Cade,1974→ Mn anterior teeth should be consider in older patient for esthetics & facial expression

NB: Pound→ first to mention posterior speaking space

Fundamental of esthetic by Claude Rufenachi
Bioesthetics by Robert Lee

- Bioesthetics is study or theory of beauty of living thing in their natural form & function
- Primary function of teeth:

- Mastication – swallowing – speech – expression ‘smile’ – psychologic – esthetics – craniomandibular stabilization

- The bioesthetic relationship of natural teeth to :

- Rest position- CR-VDO- VO&HO- condyle position at rest & function – plane of occlusion – mastication

Natural unwarn permanent cown morphology:

- Mandibular incisor:
  - Physiological cornerstone for good occlusion
  - Length 9-12 mm ‘average 10mm’ from CEJ to incisal edge
  - Central narrower than lateral
  - Thick incisal edge of 0.5 to 0.75 mm
  - It has labial angulation in dental arch
- Maxillary incisors :
  - Mesial & distal incisal edge are rounded
  - Incisal edge width of 0.7mm
  - Lateral incisor are shorter & has more round incisal edge
  - Crown length of central is 11-13mm with average of 12 mm
  - Lateral incisor is 1-2 mm shorter & around 10 mm in length
  - Gingival height of lateral incisor is 1mm below central
- Maxillary canines area:
  - Canine length is like central
  - Buccal cusp of 2nd canine ‘1st premolar’ is shorter than canine& 2nd premolar ‘3rd canine’ is shorter than 1st premolar
  - Straight line connect canine to MB cusp of 1st molar
  - 3 lines ‘connect cusp tip,contact area, CEJ’ are straight but slightly distally converging line ‘graduation effect’
  - Mesial & distal embrasure to canine is 90°
  - BL cusp angle of 1st premolar= 65°, 2nd premolar=65°
  - MD cusp angle of 1st premolar= 90°, 2nd premolar=110° ‘less height’
  - Grooves is deep for function to disspate food
- Mandibular canine area:
  - Longest clinical crown in the mouth of 11-15 mm with 12 mm average
  - Cusp is sharp & pointed
  - BL cusp angle of 1st premolar =65°, 2nd premolar = 75°
- Molars:
  - Molar cusp angle is not steep like canine & premolar
  - Cusp height to fossa depth range 3-4 mm
  - Buccal cusp of Mx molar to protect cheek & to hold food in occlusal table
  - Lingual cusp of Mn molar to protect tongue & to hold food in occlusal table
  - Lingual cusp of Mx & buccal cusp of Mn molar are for piercing & cutting food
  - Steep triangular ridge for escape & extrusion of food to reduce masticatory load
  - Cusp of carabelli protect tongue & produce more acute palatal cusp profile

- Tooth genetics:
- Teeth morphology is totally genetics & not specific to race or gender
- After occlusal morphology completed, gnathostomatic system change significantly ‘Mx,Mn,TMJ,muscle, ligaments’
- Skeletal component are genetically programmed but also it affected by enviromental modifications ‘poor occlusion, thumb sucking, sleep apnea’

- Physiology of occlusion:
- CR is used more than 5,000 time a day during mastication & swallowing
- CR is the most stable, comfortable, repeatable position for patient
- In good occlusion, all teeth must contact similtanous at CR ‘ anterior teeth has contact but less than posterior, 2 contact in each anterior tooth ‘protrusive & lateral excursive’ and one for canine ‘lateral excursive’
- Posterior contact at cusp ridge & mesial & distal marginal ridge
- Total tooth contact at CR = 4 mm^2 of all posterior & anterior teeth ‘ by Show’
- Posterior teeth occlude evenly in CR with small contact point ’16 to 32 per side’, Mx lingual cusp & Mn buccal cusp occlude in opposing fossa or mesial & distal marginal ridge or cusp ridge
- Cusp to fossa relation produced flat cusp due to poor tooth position & lack space

- Anterior overlape:
- Overbite= 4-5 mm in incisor & canine
- Overjet= 2-3 mm in incisor & 1 mm at canine
- Lip-tooth-tongue relation provide seat during mastication ,swallowing & maintain teeth position

- Rest position & free way space:
- 22 hours per say, the mandible is not in CR but in semirest position range from 1 to 10 mm
- During speaking ‘S sound’ condyle are usually 2-3 mm foreward from CR position & there is close position between incisal edge & larger space between posterior teeth
- Increased H.O leads to unbalance between lip & teeth cause teeth migration & poor esthetics

- Vertical dimension of occlusion:
- It was believed of VDO need to be increased, the teeth will worn & return back to original VDO. Also, they believed is passive eryption of teeth to maintain VDO
- By Lee et al→ cephalometric radiograph of 5 & 10 years post treatment showes maintain of VDO between nasion & menton
- The improved anterior & posterior guidance help patient from learned ingrams in cerebral cortex for new chewing pattern at restored VDO
- No need to ↑ VDO ‘upto 10 mm’ more than the amount necassery to obtain good morphology of teeth

- Development of occlusion:
- With eryption of teeth the process of mastication is learned & learning depends on cerebral cortex

- Afferent ‘properioceptive stumili from PDL, mucosa, lip, tongue , cheeks, muscle, TMJ→ cerebral cortex ‘learned center’ → Efferent ‘ stumuli to muscle ingram’
- 6 year molars are first guide teeth to establish lateral chewing pattern before that it is only vertical chewing pattern
- When teeth morphology change, new ingram for occlusion must be developed
- There are five factors involved in occluding of teeth:anterior teeth – posterior teeth- right condyle path – left condyle path – neuromuscular mechanism ‘cerebral cortex’
- Teeth are primary factor in jaw closing pattern
- If teeth relationship doesn’t allow proper condylar position with disc or if teeth inhibit condylar movement, they can cause traumatic occlusion
- Traumatic occlusion: is nay closure of teeth that produce unphysiological stress, damage, or overload to teeth , muscle , bone, periodontium, joint or nervous system
- Signs for traumatic occlusion:
    1- Abrasion & fracturing of teeth
    2- Tooth migration
    3- Overload in periodontium
    4- Tooth mobility
    5- Crainofacial pain ‘myalgia’
    6- Crainomandibular dysfunction ‘TMD’
    7- Exostosis

- Basic identifiable interfernce that cause traumatic occlusion:

    1- CR 2- protrusive 3- lateral ‘W& NW’

- In CR → the interfernce is more traumatic because condyle is distracted from disc & lead to disc derangement
- Non-working side are most disturbing to neuromuscular system & lead to excessive wear in anterior teeth due to avoidance pattern
- Horizontal envelop of functional motion; it is 3 X 3 mm horizontal ‘ 3 mm to right, left & protrusive’ from intercuspal position ‘ diamond shape’

- Anterior tooth guidance:

- It is two type:
    1- Incisal guidance in protrusive & rretrosive movement
    2- Canine guidance in mediotrusive movement
- Posterior tooth guidance:

- 2-3 mm separates posterior teeth in protrusive ‘ Mx centrals contact Mn central & lateral’

- 1,5 – 2 mm separates teeth in working & 2-3mm in non working

Color

- Color is substance that absorb different wavelength to varying degree
- Metamerism is paired of color objects doesn't match under different light source
- Clark→ color matching in dentistry
    - Primary colors are red,yellow, green & blue
    - Color dimensions:
    1. Hue→ quality of color as related to the spectrum= reddest yellow, yellow '80%', greenest '1%'
    2. Brilliance→ lightness or darkness- black at zero & white at max
    3. Saturation→ strength of hue- strongest yellow to neutral gray
    - Color selesction→
        1. Illumination= white light is suitable light, mid day is best time
        2. Characterization= solid color make teeth look false
        3. Cementation= translucent vs grey cements
    - Saturation increase when you move from incisal to gingival 1/3
    - Incisal is darker than gingival 1/3 since it allow transmission of light

- Preston→ color science & dental art
    1. Additive color
        - Mixing of colored light to yield white light
        - Mix begin with black & end with white
        - This phenomena applied only to light not to pigments
        - More color add→ more white e.g computer color
        - 3 primary hue of additive color is red, green & blue 'RGB'
        - Mix of 3 color = white ' light color absorb
    2. Subtractive color
        - White light pass through filter, some wavelength are absorbed & therefore subtract from spectral content of light that enter the filter
        - Subtractive system is converse to additive color system
        - Begin with white & end with black eg; paint
        - Cyan, Magenta & yellow are additive color for the secondary hue
        - Mix of 3 color= black

- Sproul, 1974→
    - 3 articles talk about color matching, invent spectrophotometer
    - Shade guide should be based on Haysh '125 shade' or Clark '60 shade'

- Presswood, 1977→ shade should be select by elemination, not electively
- Barghi, 1977→ no detectable color change upto 5 firing, vacuum- fired more color stable

Color science 'Rosensteal , Ch 23'

- Light is visible electromagnetic energy whose wavelength is measured in nanometer or billionths of meter
- The eye is sensitive to visible part of electromagnetics spectrum with a narrow range of 380 to 750 nm
    - Shorter wavelength <380nm = ultraviolet , x ray, & gamma ray
    - Longer wavelength >750 nm= infrared, microwaves, TV, radio waves
    - Prisms bends shorter waves of light more than longer waves
- Quality of light:
    - Most common light source in dental office is fluroscent or incandescent, neither of is pure white light
    - Incandescent light bulb: emit high concentration of yellow light than blue & blue-green
    - Flurescent light bulb; emit high concentration of blue waves
    - Northen day light has close to fill spectrum white light
    - Never select shade in direct sun light since distribution of light waves from sun depends on time of day, humidity & pollution
    - At morning & evening, shorter waves 'blue & green' are scattered & only longer waves 'red & orange' penetrate atmosphere
- Light source refernce stander:

1- Color rendering index 'CRI'
- Indicate how well a particular light source render color as compared to specific stander source
- Scale of 1 to 100%: 100 mean full spectrum white color 'ideal'
- Color- corrected flurescent light is recommended ' CRI>90'

3- Color temperature:
- Color of standered black body when heated
- Measure by Kelvin or absolute '0° k= -273° c'
- Northern day light 'ideal'has CT of 6500° k

- Description of color:

1- Munsell color order system:
- Most common used with 3 attribute of color hue, value & chroma

a- Hue:
- Particular variety of color 'red,yellow, green…'
- Shorter waves in visible range of spectrum close to violet
- Longer waves in visble range of spectrum close to red
- Munsell color system divided into 10 gradation 'yellow,yellow-red,red..' on wheel
- Most natural teeth fall into range between yellow& yellow-red
- O'Brien found average hue of teeth ' G1/3= 1.2 Y, M1/3=1.3Y, I1/3=1.4 Y'

b- Chroma ' saturation'
- It is intensity of hue or strength of given hue ' like ink in water tank, ↑ink= ↑chroma
- Maximum chroma depends on hue but can range from 10-14

- Achromatic shade ‘no hue’ have chroma near 0
- Natural teeth found with chroma of 0.5 to 4

c- Value

- It is lightness or darkness of color or brightness of object
- It is amount of light energy the object reflects or transmits
- Light energy measure in photons, different hue can transmit same number of photons, same value
- In Munsell color system, value has 10 gradation ‘0-black& 10-white’
- Natural teeth value range from 5.5 to 8.5
- Restoration has high value→ easier to detect → esthetic failure

2- CIE LAB color system ‘commission international de I E clairage, 1978’

- It is getting common in dental research
- It has three coordinates like munsell which is L,a,b
- L & value are proportion to each other, high L→white color
- a&b represent chromatic ‘non black or white color’ which is hue & chroma
- Unlike Munsell, CIE lab define color in uniform step of human color perception

- Color measuring instrument:

- Colorimeter to measure tooth color

- Perception of color:

- Light from object enters eye & acts on photoreceptors ‘rods&cones’
- Most of cone is in center of eye & more color perceptive than rods in periphery
- Scotopic vision→ rods used under low light condition
- Photopic vision→ cones used under high light condition
- Dark adaptation→ change from photopic to scotopic vision & take 40 minutes
- There are three types of cones sensitive to red,green & blue

- Color adaptation:

- Color vision decreased rapidly as object observed
- Clinic walls should be painted pale blue & look at it during shade selection
- Color influences by surrounding color ‘clothes & lip stick’

- Metamerism is tow color appear to match under given light source but have different spectral reflection ‘ metamers’

- To avoid such problem, select shade & confirm it under different light condition e.g; natural day light & fluroscent light’

- Flair or color constancy is color change by single color when light source change
- Isomeric pair has same spectral reflectant of two objects
- Fluorescent→ like tooth enamel, doesn’t apply significant role in color matching
-Opalescence→ light scattering effect that creates apperance of bluish-white color as teeth seen at different angle e.g; insical edge
- Color blindness→ defects in color vision affect 8 % of male & less in female

Esthetics: study of beauty

- Completet outline of Mx anterior teeth & teeth posterior to first molar are more attractive
- Aging, ↑showes of Mn incisor & less of Mx incisors

- Mx teeth parallel to lower lip are more attractive
- Average smile line is more attractive ‘Dong, IJP 1999’

- Proportion:
- It is based on what found in nature
- The grouth is closely related to mathemathic progression (called the Fibonacci series by Leonardo Fibonacci, Italy) which each number is sum of two number immedaitly preceeding to it ‘0,1,1,2,3,5,8…’
- The ratio between two succeeding term converge in approximately 1.618 to 1 known as the Golden proportion, apply in dentistry to width of incisors & canines

- Balance:
- Balanced arrangement implies stability & permanence
- Facial & incisal midline should be coincide
- Mean threshold for accepted midline deviation is 2.2 /1.5 mm

- Shade selection:
- Select shade at eye level so use color sensitive ‘cones’ part of retina
- Select shade in different light source ‘close to window & fuorescent light’
- Prophy & clean teeth before shade selection
- Select teeth at beginning of visit, teeth increases in value when it is dry or in rubber dam
- No lip stick, no bright clothing or paint
- Eye rest by focusing in gray –blue surface before comparing to balance color in retina

- Commercial shade guide:

A- Vita shade guide

- Select hue ‘ A4,B4,C4,D4’, then chroma ‘B1,B2,B3,B4’, last verify value by shade order ‘ B1,A1…’ & compare both
- Squinting of eye during shade selection which will ↓ light transmit to retina & grater sensitivity of rods will be helful in value or achromatic selection

B- 3 D master shade guide ‘Vita pan’

- It is based on CIE lab system
- Select value first – available in 6 lightness level
- Then, chroma ‘ Max 3 color saturation’ →start from M-group
- Last, Hue ‘Max 3 color hue’→R-reddish, L- yellowish

RPD Treatment Planning

- Applegate, 1960→ treatment for RPD choices:
  - Factors to be considered→ Abutment- caries, perio, bone, shape of root, distribution
    →Residual bone- size & shape
    1- Bone maintance potential & previous cervical bone loss around teeth
    2- Abutment root form,length, & stability- length of root determine intra-alveolar support
    3- Extent of periodontal involvement:
       - degree of lateral mobility of lesser significant
       - remaining predisposing factor which produce mobility
    4- Caries susceptibility- to determine to go for CD or RPD
    5- Size & form of residual ridge- determine support
    6- Location of remaining teeth – more important than number of teeth remaining
  - Clinical classification of partial edentulous situations:
    I- All remaining teeth anterior to bilateral edentulous ridge
    II- All remaining teeth in right or lift anterior to unilateral edentulous ridge
    III- Edentulous space is bounded by teeth anterior & posterior but one or more boundey teeth unable to use for support
    IV- Edentulous space is anterior to remaining teeth & cross midline
    V- Edentulous space is bounded by remaining teeth anterior & posterior – one abutment can't provide support e.g. space extend from week lateral to 2nd molar
    VI- Edentulous space is bounded by remaining teeth anterior & posterior but teeth can barry all the load ' fixed or RPD'

- McCracken, 1961→ Fixed or removable partial deture:
  - Indications for fixed are:
  1- Tooth bounded edentulous space- large span, weak abutment & perio involved teeth→ removable
  2- Modification spaces; mainly pier abutment too
  3- Anterior modification space except for excessive ridge resorption
  4- Non replacement of missing molar- premolar canilever
  - Indications for removable:
  1- Kennedy class I&II
  2- After recent extraction until it heals
  3- Long span
  4- Need for bilateral bracing in RPD may act as perio splinting by cross arch stabilization
  5- Esthetic in anterior region for severly resorp ridge
  6- Weak abutment for fixed
  7- Cost
  - Fixed should be the prefernce unless specific reason for removable

- Beumont, 1990→ factors to consider for using Mn premolars for RPD design:
  - Evalute C/R ratio, support, & survey it

- Avoid placing rest seat part on enamel & part on restoration→ weak cusp protected by gold onlay for contact and support cast assembly
- Amalgam is good for rest seat but not for guide plane or clasp contact due to poor abrasion resistance
- Rest seat & guide plane should be in metal & avoid porcelain contact
- Esthetic by lowering survey line in buccal or used I bar

- Rissin→ cross section evaluation of effect of age, RPD on periodontal health:

- ↑ pocket depth & bone loss & mobility of patient wear RPD compare to dentate patient

- Bergman & Olsson, 1982→ 10 years evaluation of caries, perio, & prosthesis for RPD patients:

- RPD doesn't cause caries, perio disease of proper design & with a good oral hygiene

- Chandler, 1984→ Up to 9 years follow up of RPD:

- RPD provide a reasonable survice with no change in mobility or bone loss

- Franzetti, 1985→ Periodontal cosideration & guidline

- Pretreatment records
- Abutments selection
- Trauma from occlusion ' wider PDL space'
- Mobility & splinting
  - Non progress mobility or stabilized mobility doesn't affect prognosis or not indicated for splinting

  - splint for:
    1- RPD with intracoronal attachment
    2- Need for bilateral splint to resist stress in all direction for mobile abutment more than I degree
    3- Spint to preserve & protect periodontium & patient comfort

- Hebel, 1984→ Clasp abrade natural & demineralized enamel of 20 ųm & composite of 50 ųm

- Akery, 1977→ Traumatic vertical overlap

I- Mn incisors extrude & impinge on palate
II- Mn incisors extrude & impinge on gingival sulcus of Mx incisor
III- Mx & Mn incisors incline lingually & impinge in gingival sulcus of each other
IV- Mn incisor move to abraded palatal surfaces

RPD Design

- Cummer, 1921→ 1st classification based on remaining teeth or teeth lost, 131 & 72 cominations
- Skinner→ based on relationship between abutment teeth & supporting alveolar ridge
- Bailyn→ anterior or posterior suddle, designated as anterior or posterior, class I to III based on number of missing teeth

- Purpose for Kennedy classification is:
  1- Immediate visualization of teeth loss
  2- Immediate differentiation between tooth & tissue born
  3- Communication with dentist & lab
  4- Univeral understood
- Principles of design by Henderson & Boero:
  - Support→ Rest- Mearther & Berg
    → surveyed crown→ Yalisove
  - Stability→ major & minor connector
  - Fulcrum line→ theoretical line around which RPD tends to rotate
    →length of fulcrum ‘ lever arm’ determine amount of force trasfered to abutment
    → through most distal abutment ‘rests’ → multiple line exist
  - Roach→gave clasp its name I-bar, bar went to DF undercut
  - Nispon→ circumferential clasp
  - Kratochvil→ locate I bar to mid facial undercut
  - Krol→ modify distal proximal plate
  - Demar→ Review & analyze system

- Thompson, Kratochvil & Caputo, 1977→ photoelastic study compare 7 RPD design:
  - Retainer with M rest , buccal I bar or WW with cast lingual arm exhibit most favorable vertical stress distribution
  - Distal rest tend to move crown distally & root mesially at apex result in horizontal stess on bone
  - Place rest more anterior in tooth →force more in vertical direction

- Wagner, 1982 → compare 3 Mx & 2 Mn major connectors
  - Most preferable is Mx single palatal strap & Mn lingual bar
- Schutle & Smith, 1980→
  - Swing lock RPD should be considered as treatment alternative for patient with unfavorable periodontal support & missing key abutments
  - Proper design swing lock & good oral hygiene with follow up shows favorable RPD

- Yalisove, 1966→ telescopic crown developed by Pesso
  → Miller & Yalisove brought concept to the light

RPD Clasp

- Kratochvil, 1963→ discuss design for distal extension RPD
  - Transition region from tooth to mucosa support requires carful consideration
  - Mesial rest on most distal abutment provide more perpendicular support to residual ridge
  - Mesial rest is less likely to pinch on ginigival margin
  - Mesial rest tend to tip tooth mesially & reinforce by other tooth
  - I-bar cause less contour change & allow more gingival stimulation
  - I-bar casue less torquing in tooth when placed at M-D area of greatest circumference
  - Proximal plate contact tooth & allow space at tooth-mucosa junction
  - Proximal plate is physiological adjusted to prevent tooth & tissue impingement

- Krol, 1973→ clasp design for extention base RPD;
  - Requirment for proper design clasp:
    1- Support- against vertical forces
    2- Bracing- against horizontal forces
    3- Retention- resist force in occlusal direction
    4- Encircelment- of >1/2 of its circumfernce
    5- Reciprocating- equal & opposite forces by clasp arm
    6- Passivity- at rest when it seated
  - RPI concept :
    1- Mesial rest→ point of rotation which exert mesial force on tooth
    2- Distal proximal plate→ 2 to 3 mm length & space at gingival junction
       → it should disengage at loading & slight lingual for reciprocation
    3- I-bar- 2.5 mm from gingival margin cross at ⊥, 0.01˝ undercut at greatest M-D prominence to allow disengagment at function
  - Advantages of RPI:
    1- Proximal plate & I-bar move away from tooth during function to ↓ torque
    2- MMC & DPP provide receprocation & eliminate need for lingual arm
    3- Mesial rest eliminate class I lever
    4- I-bar more esthetic & minimal contact for hygiene

- Clayton, 1971→ Cast I-bar are more flexible than 18 gauge WW
  - Cast I bar are less force than 18 gauge WW

- Celloni, 1971→ compare clasp design on abutment when loaded
  - RPI cause significant amount of tooth movement
  - Direction of movement wasn’t alter by clasp assembly
  - When abutment loaded, direction was MB not D as expected

- Eliason, 1983→ RPA clasp design
  - Differ than RPI in retention arm ‘Aker or circumferential clasp’

- Retention arm come from proximal plate above survey line & cross survey line in middle to engage undercut
- Simple, easier to grasp for patient & use when can't use RPI

- Taylor, 1982→ effect of 2 clasp assembly & base adaptation
  - RPI clasp cause less distal displacement on abutment than circumferntial clasp
  - Effect of clasp design minimized by well adapted basal seat & fully seated
  - Force in distal extension base have greater effect on same side abutment
- Design variation of RPI by Krol:
  - Stress control with minimum tooth & gingival coverage
  - Rest- mesial rest extend only in triangular fossa- in Kratochvil design upto central fossa
    - canine rest circular concave depression in mesial- in Kratochvil design hodded rest
  - Proximal plate→ making greater departure from Kratochvil design
    → 2-3mm occlusogingival height & contact only 1 mm of ginigival portion of gingival plate
    → relief at tooth-tissue interface to allow proximal plate to disengage
  - I-bar→ at mesial to M-D hight of contour to disengage

- Stone, 1936→ Tripping action of bar clasp
  - Tripping action of bar clasp move favorable design than horizontal clap
- Aviv, 1990→ RLS- lingual retainer clasp
  - R- MO rest
  - L- DL- L-bar direst retainer
  - S- distobucccal stabilizer

- Browning, 1986→ movement of 3 RPD clasp design under occlusal loading
  - I bar & ww clasp cause least amount of abutment movement

- Cherkas & Jaslow, 1991→ Saddle back hidden clasp
  - Clasp design use only proximal wall of abutment for retention with no facial clasp
  - Retainer→ emerge from denture base to engage proximal undercut
  - Lingual bracing arm
  - Proximal minor connector with relief to allow flexture of retainer
  - Disadvantage- no guide plane

- Retention of clasp based on:
  - Type of clasp
  - Undercut
  - Flexibility- taper, cross section, length, material, clasp curvature

- Support for distal extension:
  - Maximum border extension
  - Accurate border

- Primary supporting area
- Form of ridge under function

Partial Denture Impression

- Applegate, 1955→ the partial denture base

- Success of RPD is mainly based on well adapted base to resist lateral & vertical movement
- Support of distal saddle come from two dissimilar structure 'teeth & residual ridge tissue'
- Describe technique of register saddle area using wax in tray made over metal to properly register periphery of saddle area

- Hindles.1952→ laod distribution of extension saddle partial denture

- Mclean as first to discuss problem of equalize resilient & non resilient support & suggested taking functional impression to equalize support
- Requirments for proper load distribution:

1. Tissue surface of saddle should be a negative reproduction of undisplaced surface of alveolar mucosa
2. Masticatory load should be distributed between ridge & abutment
3. Denture saddle should be related to metal framework in similar relation as it is loaded

- Anatomical impressison→ denture at rest – no load in alveolar mucosa , contact only in rest seat area
  → denture at function- contact only at rest seat & bone near most distal part, occlusal rest prevent saddle area from laod transmission to alveolar bone
- Occlusal rest should be in its position when saddle at masticatory load & it is seated in fully displaced mucosa→ alveolar bone wil carry load through full extent & will be aided by abutments→ upon release masticatory stress→ saddle move occlusaly with rebounding tissue & rest lift off→ when force applied again, saddle be able to move tissueword without interferance of rest until mucosa is fully displaced & alveolar bone carry entire load & the rest contact & share load
- Describe technique of dual impression→ make custom tray with window over teeth→ border mold & ZOE impression→ pick-up alginate impression with holes made at saddle area to allow pressure in acrylic tray while alginate set

- Steffel, 1954→ Types of Mn dentures needing relining

- Those occlusion has been lost but base still fit→ bone resorp but still contact
- Those basal seat has been lost but occlusion still perfect→ tooth borne, fill gap is no problem
- No occlusal contact & no basal fit→ mainly distal saddle area & treatment objectives:
  - reposition metal framework – re-establish occlusion
  - make impression to ensure intimate tissue adaptation of basal seat
- Diagnosis by indirect retainer raise when loads posteriorly & distal end raise when indirect retainer seated
- Methods of relining- static or functional
  - before relining tripoding contact is essential anterior & posterior- well distributed is better

- indirect retainer prevent anterior tilting of partial denture at relining time

- Leupold & Kratochvil, 1965→ describe alter cast technique:
    - Makes relashionship between teeth & edentulous tissue as compatible as possible→ alginate impression→ meatal framework→ tray, border mold & ZOE impression, pressure at metal contact teeth to insure seating→lab, section & pouring
    - Aim of alter cast is to equal distribution of occlusal force between resilient & non resilient tissue

- Leupold & Flinton, 1992→ compare vertical movement of 3 impression technique 'alter cast, alginate, border molded tray':
    - Alter cast provide least amount of vertical denture base movement
    - 0.19 mm is main difference between border molded tray& alter cast which might be clinically insignificant

- Holmes, 1965→ determine amount of movement result from occlusal load on Mn distal extension made by different impression technique
    - Alter cast provide least movement & with Korecta wax IV impression had least movement
- Leupold, 1966→ compare tissue displacement & adaptation between one piece & alter cast:
    - Least horizontal & vertical displacement of soft tissue with alter cast than one piece cast

- Three most common trechnique used:
    - Double impression 'dual technique'
        1. Functional impression technique 'tissue displace under function'
           - Mclean- custom tray like record block→ take impression under load→ pick-up alginate impression
           - Hindle's
           - Fluid wax technique
        2. Selected pressure technique- alter cast

-Stuart→ Class I & II RPD
- Important factor for Class I & II RPD:
1. Adequate support for distal extension base-alter cast
2. Flexible direct retainer
3. Indirect retainer
- Latticework or mesh extension:
  - Mn→ 2/3 distance between distal of the abutment & pear shaped pad
  - Mx→ cover tubersity
- 8 mm for lingual bar
- Tissue stop prevent framework distortion at backing
- External finish line is <90° to mechanically lock resin
- 3 types of rest seat→ occlusal, incisal& cingulum '1/2 B-L cusp &1/3-1/2 MD space'
- No rest over amalgam except if tooth has guarded prognosis

- Handreson→ major connector
- Clasp flexibility→ undercut for cast 0.01˝, gold 0.015˝, WW 0.02˝
- Types of anterior teeth replacement:
  - Porcelain→ shade, resist abrasion, fracture easily by impact stress→need interarch space
  - Acrylic resin ‘plastic’→ high impact strength, rarely fracture, lack wear resistance
  - Facing→ anterior-thin veneer of resin backed by metals, use in limited interocclusal space
  - Tube teeth→ cemented on bridge, shade match since it is preformed tooth
  - Reinforce acrylic teeth→ projection of metal around artificial teeth process
- Types of posterior replacement: plastic, porcelain, metal pontic, tube
- Quadrilateral ‘Cl III,mod 1’, triangular ‘ Cl II,mod 2’, bilateral ‘Cl I’
- Cast has 10 mm at thinnest area
- Importants of mounted diagnostic cast:

1. Permanent dental record
2. Educate patient
3. Supplement intra-oral exam ‘ extruded& malposed teeth, interarch space, tubersity growth’
4. Visual occlusal examination

- NB; Ala-tragus line proposed by Gysi first

Rotational Path RPD

- Differences between rotational path & conventional RPD:
   1. In conventional RPD all rest seat seated at same time
   2. No straight path of placement
   3. Eliminate of unesthetic clasps
   4. Clasps replaced by rigid retainer
   5. Rigid retainer engage undercut
   6. Needs high skill of dentist & technician

- Direction of rotational path of placement:

1- Anterior-posterior→ anterior seated first

2- Posterior-anterior→ posterior seated first

3- Lateral→ one side seated first

- Categeries of rotational path designs

A- Category 1

- Rotational centers at distal rest seat
- Rotational determine placement
- Rotational centers seated first
- Utilized proximolingual undercut

B- Category 2

- Rotational center at gingival extension
- Rotational center determine final placement
- Rigid retainer seated first
- Utilized proximofacial undercut

- Occlusal rest for rigid retainer:
  - Depth- 1.5 to 2mm
  - Floor- perpendicular to long axis
  - M-D: extend more than ½ of tooth
  - F-L: walls should be parallel
  - Asymmetrical outline of rests ‘dovetail’
  - Bilateral parapllel wall
  - Intimate contact ‘of MC& rest’

- Cingulum rest for rigid retainer:
  - Depth- 1.5 to 2mm
  - Rest seat may needs restoration ‘crown or composite’
  - Permit an intial straight path

- Advantages of rotational path:

1- less number of clasps- reduced tooth coverage & plaque accumulation

2- improve esthetics

3- minimum tooth preparation

4- be used even in absence of F or L undercut

5- less distortion of rigid component

6- prevent abutment tipping

- Disadvantages:
    1- Adjustment of rigid component is difficult
    2- Difficult lab technique –
        - Survey at 0° tilt, used divider to determine undercut, design, tripodized on each other

Acrylic Resin

Brauer, 1966 – review dental application of polymer

- Methacrylate are most extensive use dental resin b/c:
  1. High strength
  2. Optical properties
  3. Low water sorption and solubility
  4. Dimential stability

Peyton, 1963 – denture base when subjected to heat, stress release and produce warpage

- So: repair denture based should be done by using cold cure resin to avoid warpage

Goodkind, 1970 –

1. Both pour and cold curing flasking technique produce shrinkage in denture base,
2. Shrinkage of pour > cold curing technique
3. No sign changes in dimensional stability after 6 minutes water

Lorton & Philip, 1974 – when denture base subjected to heat even by using bur or lathe discs – produce high heat and cause localized distortion and dimensional changes

Winkler, 1978 – Titanium oxide is most frequent used coloring agent

- Pigment should be use in small amount b/c it doesn't enter reaction

Pagniano, 1982 – ideally wait at least 9 hours before using custom tray to make sure it is stable

- If you used sooner after fabrication – put in boiling water for 5 minutes, cool to room temp
- With any method, impression should be poured as soon as possible to minimize distortion by tray

Beyli, 1980 – repair of Fractural resin

1. Gap should be ≤3mm to minimize bulk of repair material – decrease shrinkage and dimensional changes, decrease color changes
2. Butt joint is inferior to knife edge or reverse knife edge, round, lap, reverse rabbits
3. It is beneficial if delay denture repair of period of 4 hours or ½ a day for elapse
4. Use bumice or monomer has no benefit in fractural resistance

Weaver, 1980 = acrylic resin allergy is possible but rare and pt. shouldn't be tagged under this diagnosis unless all possible reasons of symptoms have been evaluated

Fisher, 1956 – MMA is sensitize agent cause allergy & complete polymerization of MMA is not cause any reaction

Lechner, 1985 – both shrinkage and distortion occurs after first curing cycle

- Thickness, undercut and two curing cycles doesn't affect shrinkage

Dukes, 1985 - ↑ in VD was 6.5 times greater for pour resin technique than compression method

Polyzois, 1987 = linear shrinkage of heat curing resin is <1%

Peyton, 1975 = 1937, Wright introduce MMA and in 1946 was used in 95% of denture

Takamata, 1989 = review of resin denture base: 4 technique:

1. Heat activated – most common, shrinkage, internal stress due to different in CTE of resin & gypsum
2. Self-activated resin – time saving, poor mechanical properties, teeth dislodge, more fracture and ↑ wear
3. Microwave – similar to heat cure but not strong and have less free monomer
4. Visible light cure – low mechanical properties and ↑ tendency to stain

Jerolimov, 1989 – rapid cure produce high residual monomer and more porosity

Baemmert & Lang, 1990 – simple process with denture teeth produce most accurate point than without it

- Use conventional compression, Luciton is most accurate than Ivocap injection mold
- Material for relining of denture:
  - 1. Heat cure resin
  - 2. Autopolymizing
  - 3.Light activation, has low bending strength, fit is good, strong adhesion (Hayakawa)

4 Stages in Polymerization of Polymer (IPCT): Philip (p:119)

1. *Induction*: two process control induction
   a. Activation: by heat or chemical (tertiary amine) of benzoyl peroxide to produce free radical
   b. Initiation: start reaction
      -benzoyl peroxide activated b/w 50 - 100°C to release two free radical

   Three types of activation:
   1. Heat and benzoyl peroxide = 2 free radicals
   2. Chemical " tertiary amine" + benzoyl peroxide = self cure at room temp
   3. Light activated: comphorquinone or organic amine (dimethyaminethyl MA, DMAEMA)

2. Propagation: continue in reaction and form longer free radical
3. Chain Transfer: active free radical of growing chain is transfer to activate unreact molecule (Craig didn't include this & he mention 3 only)
4. Termination: deactivation by formation of a covalent (=) bond

Inhibition of addition polymerization: (Philip)

- Add small amount (<0.006 %) of hydroquinone will inhibit and retard polymerization
- O_2 reacts with free radical and retard reaction and produce air thinning of bondig resin
- Use matrix to prevent direct contact with air

Craig: 3 stages = initiation, propagation, termination

Polymerization setting reaction:

1. Free radical = acrylic
2. Condensation = polysulfide rubber base + condensation PVS
3. Hydrosilytion = “ionic” – adiditional PVS
4. Ring opening = polyethyl and epoxy resin

<u>Denture Processing</u>

Processing: conversion of wax pattern of denture into resin

First porcelain denture by Alexis Duchateau, 1774

1. Heat activation process:
   Powder: PMMA + BP “initiation” + Dibetyl Phthalate, plasticize and pigment
   Liquid: MMA + hydroquinone + glycol dimethacrylate “cross linking” + plasticize
2. Chemically activated: tertiary amine ‘ less shrinkage, poor strength’
3. Light activated: campherqunion, depth of cure, less shrinkage

Technique of Processing:
1. Compression moulding
2. Injection moulding: success and ivocap
3. Microwave processing
4. Digital scanning denture

Compression Moulding:
- Cast separation (facebow presentation, separate cast, seal denture, anchorage holes) – flasking (3pour- easier for deflasking) – dewaxing (5 minutes, separating medium, diatorics) – packing – curing
- *Gayle, 2001,JP*: use holes in posterior land area improve palatal adaptation (0.1 vs 0.3mm)
- 3 layer to ↓distortion and facilitate deflasking
- *Dukes*: compare 5 different material for deflasking, artificial stone produce less incisor opening (.025″) and plaster highest opening of .04″
    - 2-Step using stone and silicon rubber has least opening of .016”

Dewaxing: 2 layers of Na alginate “all coat”

A. First Layer – apply when flask warm – close micropores in cast
B. Second Layer – apply after complete dryness – all area except teeth

Function of separating medium:
1. Prevent water from gypsium to enter resin
2. Prevent monomer penetrate into mold

Types of separating medium:
1. Tin foil
2. Na silicate
3. Soft soap
4. Silicon rubber
5. Na alginate: Na alginate + Na phosphate + glycerin +alcohol

- react with Ca in cast to make Ca alginate which form separating medium membrane

Diatroic – improve mechanical retention – shear bond
Packing, Lucitone “199”

- P/L ratio is 3:1 - ↑p/l – inadequate filling by monomer, porosity, weak
- ↓p/l - ↑shrinkage – poor fit – light color
- Mix for 45s – wet 7-10m in seal container
- 5 stages: doughy – mass pliable (stickness test) and ideal for packing
- Horse shoe dough shape over teeth – cellophane sheet over – pack open remove flash and packages until no flask produce
- press at flask 15000-45000 psi until metal to metal contact
- place in spring clamp and hand-tighten (35Ncm)

Curing – bench cure (30-60m) – equalized pressure to monomer penetration
2 curing cycle:
- long – place flask in water bath at room temp - ↑tempup to 73°C ‘165 °F’ for 9H – boil at 100°C for 30m (9.5h)
- short – at73°C for 90 min – boil for 30m (2h)

Jerolinov – high residual monomer with rapid cure compare with overnight cure
Benchcool produce ↓Distortion than quenched “Chen”

Deflasking: remove denture with cast without fracture
Lab remount using index

CAD/CAM denture – KanaZuwai – Goodacre

Treatment Planning Consideration

Reynolds, 1968 – Abutment selction for fixed

Dx procedures:

1. Dx cast: must be correctly oriented to THA and plan of occlusion
   -evaluate: occlusal relation, rotate, malposition teeth, form and contour

2. Roentgenograph exam: PA and BW are most important

- PAN: to dissociate hidden area and structure such as impacted, supernumary teeth, alveolar bone

3. Clinical examination

Factor influence abutment selection, it will receive their load and pontic load

1. C/R ratio: 1:2 ideal amount in bone and out bone' 1:1 is minimum
   -longer span and greater torque in abutment – more favorable C/R ratio is must be
2. Surface area: combined surface are of perioligament of the abutments ≥ teeth to be replaced
3. Long axis relationship: no more than 25 to 30° from parallel – ortho upright
4. Arch form – longer lever arm – more abutment needed
5. Rigidity – flexture cause damage to abutment and loosening retainor and fatigue metal
6. Margin location: when it is possible, keep margin away from gingival
7. Pontic design: convex, smooth &free from porosity

Brehm, *1973* – Dx and Tx plan for fixed:

1. Radiograph: a PAN is not enough for final detail
   Full mouth and BW: size, shape, length of root –size and shape and position of pulp chamber, amount and thickness of PDL, amount and nature of alveolar bone,
2. Photograph: preoperative record
3. Mounted Dx cast: show length of edentous space, vertical distance b/w arches, form, size and position of abutment tooth and observe occlusion in cast and verify in months and if adjustment needed do it in cast first
4. O. H. and vitality of teeth: perio-probing and dental charting and caries detection, caries risk assessment
5. Condition of soft tissue and saliva: tumor, attachment and unattachment gingiva at pontic area
   Serous saliva is easy to make impression and low caries index than mucus saliva
6. Pt history: medical history, CVD, anticoagulant, DM, occupation

Treatment plan: it might modify during treatment due to condition discovered

- Ideally: missing teeth should be replaced immediately to prevent drifting,
- Fixed should be the treatment selected when it is possible,
- Factor for RPD or FPD:
- 1. Span length
- 2. Distribution and number of abutment teeth

- 3. Condition of abutment teeth: sufficient crown length, C/R ratio and good alveolar support
- 4. Health of pt. allow FPD procedures
- 5. O. H.= pt must be able to clean FPD

Retainers selection:

1. Amount of tooth structure of abutment
2. Functional stress to which retainer subjected – length span, pt habit
3. Esthetic consideration
4. Laboratory facilities
5. Caries index and O.H. habit = full coverage crown are precaution for high caries index and poor OH
6. Economic consideration

Binkley, *1987* = describe full mouth rehab using full mouth in quadrant and segments

<u>Abutment Evaluation</u>

p89

Abutment teeth absorb their stress and pontic stress.
Tooth has pulp capped shouldn't be use as abutment for FPD until endo treatment done to avoid any need for endo after.
Tooth be used as abutment for FPD shouldn't has any mobility and evaluated for

1. Crown to root ratio
2. Root configuration
3. Periodontal ligaments area

C/R ratio: ratio b/w length of the tooth above alveolar bone compare with length embedded in bone

- Lever arm increase when bone move more apically and produce more harshful force
- Optimum C/R ratio is 2:3 and minimum is 1:1
- The occlusal forces of opposing teeth exerted on the prosthesis must be taken in consideration:
  26Ib for RPD
  54.6Ib for FPD Klaffenbach, JADA 1936
  150 Ib for natural tooth
- Less force when opposed by mobile or perio involve tooth
- C/R ratio alone is not adequate criteria for abutment evaluation

Root configuration:
- root broader BL > MD are preferable than round root
- divergence multirooted teeth offer better support than convergence fuse rooted
- root with irregular configuration and curvature at apex are better than taper root

Periodontal Ligament Areas:
- root surface area or area of PDL of root to bone provides better bear to added stress
- root surface area as reported by *Jespen* (1963) is highest for canine (273mm^2, mx) and 433mm^2 for mx molar (1st) and mn canine (268mm^2) and 431mm^2 for mn 1st molar
- *Tylman* stated that two abutments could support two pontics
- Ante's Law by Johnston (1971): root surface area of abutment teeth had equal or surpass that teeth being replaced with pontic
- any FPD replacing more than 2 teeth should be consider high risk

Biomechanical Considerations:
- Longer span are more prone to bending forces
- bending directly related to length and indirectly to height of pontic
- compare to FPD with one pontic

2 pontic bend 8 times
3 pontic bend 27 times

- By ↓ height of pontic to ½, it will bend 8 times
- Dislodged force on FPD is tend to act in a M-D direction
- Dislodged force on single amount is tend to act in a B-L direction
- Grooves for FPD placed on buccal and lingual for this purpose

Double Abutments;
*2nd abutment must have at least as much surface area and favorable C/R ratio as primary abutment (e.g: canine (2nd) and 1st pm (primary abutment)
* retainer on 2nd abutment must be at least as retentive as primary abutment since it will be under tensil force when bridge flex.

Arch Curvature

- When pontic place outside intraabutment axis line – pontic act as lever arm which produce a torque movement (e.g. missing 4 incisors)
- Solution: extend bridge posteriorly as equal as length of lever anteriorly

Pier Abutments:

- Edentulous span on bone side of abutment, create free standing pier abutment
- Faciolingual movement of teeth range from 56 (1st molar) to 108mm (central) – RUDD, 1964 and intrusion of 28mm (by Partiff, 1960)
- Teeth in different segment move in different direction
- Since teeth move in different direction and magnitude, prosthesis will flex and stress concentrate on abutment
- Pier abutment will act as fulcrum and force will transmitted to terminal retainer and it might creat
- 1. Intrusion of abutment
- 2. Caries at terminal abutment due to open margin
- 3. Loss of retention of short abutment
- Solution: use non-rigid connector to neutralize forces
- -movement of non-rigid connector prevent forces transfer from one segment to another (stress breaking mechanism)
- Use rigid connector for perio involve teeth b/c it distribute force evenly than non-rigid
- Place keyway on distal of pier abutment and key on pontic due to mesial angular movement of posterior teeth and when it move it set key in keyway (Shilingbaug & Fisher)
- 98% of posterior teeth tilt mesially under occlusal force (Picton, 1962)

Tilted Molar abutment: solution

1. Ortho uprighting (give better position and reduce M bony defect)
2. Proximal half crown: 90° rotated ¾ crown, no distal restoration
3. Telescopic crown: need bony reduction
4. Non-rigid connector in distal of premolar: box prep of D of molar

Important Classsification

Miller Classification of Recession Defect
Cl I: Recession doesn’t extend beyond MGJ with no bone loss in interdental area
Cl II: Recession extend to or beyond MGJ with no bone loss in interdental area
Cl III: Recession extend to or beyond MGJ with some bone loss in interdental area or malposition
Cl IV: Recession extend to or beyond MGJ with severe bone losss in interdental area or malposition

Clickman Furcation Classification:
Grade I: incipient furcation, no radiographic
Grade II: horizontal component
Grade III: through and through but soft tissue still
Grade IV: through and through

Lindhe & Nyman Classify Furcation to:
Cl I: furcation defect <3mm
Cl II: furcation defect ≥3mm but not through and through
Cl III: through and through

Miller Tooth Mobility Classification:
Cl I: tooth move <1mm in BL or MD
Cl II: tooth move ≥1mm in BL or MD with no vertical
Cl III: tooth move ≥1mm in BL or MD with vertical

Tissue Control

Loe & Silness, 1963 – force use to pack string should be minimum (2 dogs)
Reiman, 1976 – describe technique of prep above gingiva, then place cord and prep
Tupac & Neacy, 1981 – compare cord with gingitage technique (15 dogs)

Gingitage: simultaneous subging tooth prep and intentionally rotating diamond instrument curettage of inner lining gingival sulcus (by Moskow)

- No significant difference b/w 2 technique, gingiva should be healthy before impression taken

Azzi & Lorranza, 1983 – recession induced by rotary gingival curettage only
Weir & Williams, 1984 – no significant difference b/w racemic epi and Al Sulfate cord

- Hemorrhage control with cord saturated was effective than water saturated for 10 minutes
- Racemic epinephrine cord wasn't superior to Al sulfate cord, so eliminate potential systemic effect

Nemetz & Donovan, 1984 – describe technique like what we do now adays

Devitre, 1985 – review: 80% of dentist used cord containing epinephrine

- Amount of epi absorption depends on exposure of vascular bed, length and concentration of impregnated cord, length of time
- Equally affecting alu sulfate and alu chloride with epi with no systemic effect
- Zinc chloride cause tissue destruction (Harrison, Woychesin) and decalcify tooth structure (Negatan)
- Hemodent keep sulcus open longest and widest compare with epinephrine and 100% aluminum (Ramadan et al)
- Al Cl (10 and 15%) cause more destruction than hemodent b/c hemodent has ingredient neutralized consideration of AlCl (Ramadan)

Benson & Hoffman, 1986 – review of tissue displacement method

- Requirements: clean dry field free of fluid and debris, retract tissue to expose margin
- Lateral displacement create bulk for impression and vertical to expose uncut portion of tooth apical to finish line
- Techniques:
- 1. Mechanical, by physical displacement tissue by placing material in sulcus
    - Rubber dam, surgical silk, cotton, unwax floss, cord (plain or threaded), rubber band
- 2. Mechanomechanical, place cord dry then apply or use impregnated cord
    - 21% and 8% racemic epi, 100 alu solution (potassium Aluminum sulfate), 5 and 25% AlCl, 13.3% Ferric Sulfate, 8 and 40% zinc chloride, 20 and 100% tannic acid, 45% regatol solution
- 3. Rotary curettage (gingitage) – use diamod burs and cord after
    - Goal is to eliminate trauma of pressure packing and need for electrosurgical
- 4. Electrosurgical M "troughening"

- Technique: proper pour, quick pass of electrode, adequate time intervals b/w strokes (5 seconds)

Crown Lengthening

Gingival Biotype Assesment in the Esthetic Zone (Joseph Kan et al, I J of perio and resto dentistry, 2010, V30)

- Gi biotype: it used to describe the thickness of Gi in FP dimension
- Lindhe and Siebert gave term of biotype
  -correlated with Gi recession following surgical restoration procedure
  -thick: Gi is dense, fibrotic
  -thin: delicate, friable and translucent

- to assess Gi biotype by:
visual, probe, direct measurement after extraction (thick>1mm, thin≤1mm)

Stability of Gi crest after surgery (Wise et al, 1985, JPP, V53)

- *Schluger et al* suggest to wait 6 months prior to final crown
- M & M: 15pt, after 6wks – coronal movement of .23mm, after 8 wks – apical movement of .43mm, at 20 wks – apical movement of 0.9 mm ± 0.21 'clinically not sig"
- Result: definitive crown shouldn't be done before 20 wks, impression will be taken if ginigival crest stabilized for 1month

Clinical crwon lengthening 'CL' in esthetic zone (Paulo et al, CDA journal, 2007)
- *Rosenberg*: final impression not less than 20weeks
- Intermediate step: after CL do not touch teeth at least 6wks to allow early healing and avoid foreign material
- New intermediate finish line is at least 4mm from bone
- Gingevectomy technique: when there is H bone loss or ↑soft tissue depth

<u>Gingival esthetic</u> (Goodacre, 1990, JPD)

- It is review article for all factor related to Gi esthetic
- Placed margin when possible away from gingiva by using partial veneer crown, subragingival margin, colorless margin
- Indication for subgingival: previous caries, restoration, fracture, esthetic, retention
- Adequate tooth reduction: when margin of .8 to 1.5mm for esthetic and contour
- Minimize time of retraction – displace tissue apical)
- Direct relation b/w retraction time and adverse Gi response such as recession
- It has been suggested by Dykema and Goodacre not exceed 15-20min
- *Loe & Silness* show necrosis of crevicular epi in days of retraction exceed 10min and it heals in 7-10 days
- Epinephrine produce no permanent change but it affect heart rate and blood pressure if gingival is not intact
- *Silness* gave probing and bleeding index

Gingival Retractions

Vasopressor effect of topical epinephrine in certain dental procedures (by Gogerly, 1957, "Dogs Study")

- The absorption of epinephrine depends on amount of vascular exposure (gingivectomy>lacerated>intact)
- Use 4 or 8% of epi in lacerated tissue didn't increase blood pressure

The response of Systolic & Diastolic blood pressure to dental Stress (by Ship, JPD, 1960)
-there is no significant difference on high BP related to dental procedure (contact, operation and oral surgery), it is related to patient scares

Effect of retraction materials on gingival sulcus epithelium (by Harrison, JPD, 1961)

- Mechanical or chemical retraction injure Gi epithelium and it heals 7-10 days
- 1:1000 epi is safe retraction for 5-30mins
- 5 – 10 mins for retraction with 100% Alum solution or 8% epi

Tissue reactions to string packs used in fixed resto (by Loe, 1963)

- Epithelium heals in 6-9 days. 8% Zn chloride necrose tissue

Histopathology response of Gi tissue to hemodent & alum chloride solutions as tissue displacement material (by Ramadan, 1964)

- Use 5% of alu chloride is safe if retraction time <7minutes
- Use of 10% of Alu chloride is safe if retraction time <3minutes

Gingival tissue regeneration following electrical retraction (Klug, 1966)

- Electrical cause more damage and permanent loss of .1mm of FGM

Systemic hemodynamic effects of R. epinephrine gingival retraction cord in clinic patients (by Phatak & lang, JP oral therapeutic and pharma, 1966)
-2, 4, 8% of epi doesn't affect HR or BP

Absorption of epi during tissue retraction (Pague & Harrison, JPD)

- There is systemic absorption of epi with radioactive in dogs

Blood pressure responses to epi related gingival retraction strings in the rhesus monkey (JADA, 1969 by Forsyth)

- With lacerated gingiva, there is increase in BP

A histological and electronic evaluation of electrosurgical cement: Non-filtered full wax modulated cement (by Ralph Sozio, JPD, 1975)
- electrosurgery take longer time to heal than blade cut due to electrosurgery heal by 2nd intention
- after 2 weeks – both heal the same

Gingival recession with electrosurgery for impression making (Coelho, Cavallero, 1975)
- .23mm recession in 6 months with electrosurgery

Human blood pressure and pulse rate response to racemic epi retraction cord (by Pelzns. JPD, 1978)
- Extraction increase Bp with 4% epi, 8% epi: increase in BP for 25mmHg for 25-30
- Increase in pulse rate is related to patient phobia not procedure

In School,
- Viscostat – 20% of ferric sulfate
- Viscostat clear – 25% of ferric sulfate
- Hemodent – 21.3% hemodent – Al Cl
- Astringedent – 15/5% ferric sulfate

A comparison of gingival inflammation related to retraction cords (by Germaro, JPD, 1982)
- 8% of epi and Alu Chloride doesn't show difference in inflammation
- Al Sulfate show least inflammation

Gingival response to retraction by Ferric Sulfate (Astringedent) by Shaw, open D, 1983)
- Cord soaked in 13.3% ferric sulfate result in severe change on connective tissue were it resolved in 2 weeks

Comparative study of gingival retraction methods (Azzi & Carranza, JPD, 1983)
- Gi recession was great with rotary Gi curettage, less with electrosurgery and none with a retraction cord with no medicament (10 min)

Fluid absorbency of retraction cords after soaking in AlCl solution (by Runyan, JPD, 1988)
- Soak cord in Al Cl solution doesn't affect ability to absorb fluid

Inhibition of polymerization of PVS by medicament used in Gi retraction cords (by Camorge, JPD, 1993)
- Ferric sulfate or AL Cl doesn't inhibits reaction
- Latex gloves inhibit polymerization by contamination of chloroplatinic acid by sulfur compounds

Epinephrine absorption from commercial Gi retraction cords in clinic (by Kellam, JPD, 1992)
- Epinephrine absord in sulcus range b/w 64-94%
- Average of 71mg/inch absorb by tissue which is equivalen to 3.9 cartridge (1:100,000 epi)

In Vitro kinetic study of absorbency of retraction cord (ferenc csempesz, 2003)
- 20 minute of soaking after a bubble removal ensure liquid uptake of cord

YAG laser for gingival rretraction in fixed prosthesis (Gherlone, JD laser, 2004)
-laser teeth provide less bleeding than conventional(double cord)

Dose related effects of epi on human Gi blood flow (Sillage, JPD, 2007)
-0.01% of epi is optimum to prevent hyperemia and Gi fluid and without systemic effect (compare 0.001, 0.01, 0.1)

Endodontics Literature Review I

- **Are endo tx teeth different?**

  1. Physical properties:
     a. no degradation of physical or mechanical properties- Huang
     b.loss of hardness and strength – Sedyley & Messer
     c.loss of moisture
  2. remaining volume of teeth structure – due to caries, resto, fracture
  3. proprioception – pain threshold is 2x higher than vital – possibility of fracture by force 'Randow'

- Does post reinforce teeth? No (Lovdahl & Nichols)

- endo tx teeth under no post and natural crown demonstrate greater strength than pin retain amalgam core and cast post and core
- pimary purpose of post: retain core and disperse occlusal forces

Treatment Plan:

A. Position and functional load of tooth
   1. Anterior or posterior:
      anteriror – no significant in clinical success rate b/w ant crown and non crown teeth (Sorenson & Mortinoff)
      Posterior – clinical success improve with coronal coverage of post teeth
   2. Abutment for RPD or FPD:
      subjected to greater forces and functional stresses
      Success rate for endo tx abutment: >95% single, >89% FPD, >77% RPD (Fernandes)
   3. Baxism and proposing occlusion:
      Parafunctional habit apply greater force and stress on teeth
      Fracture rate is higher when opposed natural dentation than CD – Bergman
      Crown not necassry if opposite RPD or CD – Ingel
B. Remaining Tooth Structure
   1. Anterior:
      - minimal coronal damage = no need for crown/access opening or small restoration
      -Significant coronal damage = post, core and crown if large caries or restoration and unsupported enamel
   2. Posterior: minimal = small access, less force, limited proximal wall destruction- Core 'amalgma or composite", & onlay or crown
      Significant = little remaining structure, high risk of fracture, abutment (FPD or RPD) –post, core and crown (Gorig & Mueninghoff)

- Minimum 1mm thickness of dentin 'Tjan'
- Ferrule effect: minimum of 1.5mm of ferrule height significant improve crown resistance (Libman & Nicholls)
  - Minimum of 2mm as clinical minimum to ensure long term survival
  - No significant difference b/w post fabricated tecniuqe and core material if you have 2mm ferrule and crown (Pilo)

- No significant difference b/w prefabricated and custom made post if you have 2mm ferrule and crown (Assif)

In order to get 2mm ferrule for inadequate ferrule height

1. Crown lengthenin – short clinical crwon with coronally displaced tissue
2. Ortho force – displace gingival level and attachment aparatuis coronally = esthetic
3. Combination – when force eryption is desired without alter tissue height

Selection of post system:

1. Prefabricated = use for enough coronal dentin, one visit
2. Custom made = one piece and ease for multiple teeth, need more than one visit

Studies:

No significant difference b/w prefab and cpc after 10 years of follow-up (Gomez-polo)

Survival rate is the same (Heydecke)

Factors to consider:

1. Post length, longer post provide better retention and stress distribution
   -equal to clinical crown (Shillinbang, Harper)
   -longer than crown (Silvestein)
   -1/2 root length (Barban)
   -2/3 root length (Hamilton)
   -4/5 root length (Barnell)
   -1/2 way b/w crestal bone and root apex (Silvestein)
   -As long without disturbing apical seal (Henry, 1977)
   -↑post length improves resistance to fracture (Trabet, 1978)
   -high function rate when post length is short (Holmes, 1996)

2. Post Diameter
a. shouldn't excedd 1/3 of root width (Johnson, Stern)
b. minimum of 1mm of solid distance around post (Caputo & Stanllee)
c. presurve tooth structure - ↓risk of perforation and ↑resistance to fracture
-post retention ↑ by ↑diameter (Shillingbang, Turner)
-no difference in retention (Standlee, Kurer, Hanson)
3. Post design = shape (parallel or taper), surface (active or passive)
- parallel side is 4-5 times retentive than taper (Johnson)
- parallel side post has greater stress at apex and taper at coronal shoulder (Craig)
- Flexipost has greater stress at shoulder and coronal surface than parapost (Burns)
4. Material – metallic = precious, base metal, SS, titanium
- non metallic = carbon fiber, glass fiber, wover fiber
-flexible post shows restorable failures and low fracture resistance than stiff (Hayashi, Aggrewal)
5. Post adaptation: 'Sorenson and Engelman compare 4 groups:
a. post with only 1/3 (3mm) in intimate contact had mean failure thresold equal to parallel and taper with only cement failure
b. Taper post has higher incidence of root fracture than parallel

-Assif: adaptation post to canal and thickness of resin didn't affect retention
6. Luting agent = resin cement has less leakage than Znph and Gi (Bachicha)
7. Core Material = comp core has fracture resistance comparable to amalgam and CPC with more favorable fracture (Pilo)
8. Esthetic = fiber, 2r, Prefab comp, opaque porcelain over CPC

Endodontics Literature Review II

Guzy & Nicholls, 1979 = no significant reinforcement by post into endo tx teeth

Kane, 1990 – amalgam extention into root canal space should be confined to teeth with less than 4mm of chamber wall height (3mm for amalgam pin), if more, no need b/c risk of perforation

Abrams, 1974 = hemi-section – key success is pt maintain good OH

- Perio principal of strategic extraction:
  1. endo-untreated, 2. severe caries lesion, 3. furcation control, 4. control of combromised embrasure due to root proximity
- Indication for root separation: 1. to eliminate untreated caries or endo, 2. control furcation environment, 3. Divide prognosis of root in a given teeth
- Contraindication: 1. Fused root, 2. Close proximity, 3. Inability to restore it, 4. Mobility to treat root by endo

Zmenex, 1980 = 1. Les leakage when keep >4mm of apical seal

2. No significance found b/w immediate or 48 H after RCT for post prep

Goerig, 1983 = factors control management of endo Tx tooth is:

1. Location of tooth in arch: Ant – depends on lesion, post – cuspal coverage for all endo tx tooth
2. Root morphology: post length and diameter, 4mm at least for apical seal
3. Degree of coronal destruction: amalgam pin – post & core
4. Amount of occlusal stress
5. Whether or not tooth as abutment

<u>Prefab vs. CPC</u>

- Prefab: easy to place and prep at the same time
- CPC: is made to fit tooth and suppress adaptation while prefab alter to fit root
- Criteria for CPC:
  - 1. Length: a. ideal 2/3 root length or at least 4mm of seal, ↑retention and distribution of stress through root
    - b.or post at least ½ length to root in bone

    2.minimal alteration of canal anatomy

    3. enough ferrule effect

4. should be closely fit but passive
5. vent post to ↓hydraulic pressure of cement

- Criteria for prefab post:
  - 1. Length(same)
  - 2. Parallel in shape = taper will wedge canal
  - 3. Cemented not screwed in to ↓internal stresses
  - 4. Serrated or rough
  - 5. Vent

Chan, 1982: cemented post with composite or amalgam and crown shows less fracture than CPC

Abou-Rass, 1982 **–** lack symptoms doesn't indicate a good endo tx. tooth should be evaluate for quality of endo to assure it provide risk-free, permanent and solid foundation for restoration
= it is necessary that before restoration procedure a complete endo evaluation for vital pulp with repeated damage (**stress pulp**), operation, trauma or other pathological condition-chemical erosion

Millstein & Nathanson, 1987: cement ↑retention of post (Zn phosphate>composite), use of lentulo spiral will ↑ retention

Camp, 1983 - dowel prep with heat, peso or gates show no statistically sign in apical seal

Plasmans, 1986: all amalgam with or without post are acceptable alternative to CPC

Endodontics Literature Review III

Resistance to root fraction of dowel channel with various thickness of buccal dentin wall (by Tjan, 1985, JPD)

M&M: 4 groups of each ten, CPC with 1, 2, 3mm dentin and last with 1mm of remaining dentin with bevel (60°)
Result: 1. Remaining dentin thickness of 1mm is not significantly different than 2 or 3mm or 1mm with bevel in failure load
2. 2 or 3mm is better than 1mm remaining thickness
3.contrabevel it doesn't enhance fracture resistance (not work like ferrule)

Ferrule design and fraction resistance of endo treated teeth (Sorenson & Engelman, 1990, JPD)
M&M: 60 mx central incisors, 6 groups (90° shoulder + No coronal dentin + 1mm of dentin at shoulder, 90 shoulder + no coronal dentin, 130 shoulder, 90 shoulder + 1mm 60° bevel + no coronal dentin, 90 ° shoulder + 1mm bevel (60°) + 1mm coronal dentin, 90 ° shoulder + 1mm bevel (60°) + 2mm coronal dentin + 1mm contrabevel
Result: 1. 1mm of coronal dentin above margin ↑ significantly failure threshold
2.preparation of coronal wall should be parallel for maximum resistance form
3.contrabevel at either tooth core junction or crown margin doesn't improve failure threshold
4.axial width at crown margin didn't significantly ↑ fracture resistance

Ferrule
Ferrule: encircling band of cast metal
Effects: is 360° metal collar of crown surrounding parallel wall of dentin extending coronal to margin
Purposeof ferrule in pulpless tooth;
1. counteracting of lever forces
2. counteracting wedging effect of the prep post
3. counteracting lateral forces during insertion of post

Effect of crown ferrule on fraction resistance of endo tx teeth (by Pereira, JPD, 2006)
- presence of 2mm of ferrule length significantly increased resistance of fraction for prefab post and composite core

The effect of distance b/w post residual gap on clinical outcome of endo tx (by Moshonov, 2005, clinical research tech)
-M&M: 94 endo tx teeth with 3 group (0, 0-2mm, >2mm gap)
-Result: tx outcome were evaluated radiographically 1 and 5 yrs
0 gap (83.3%), 0-2mm (53.6%), >2mm (29.4%)

A radiographic study o post retained crown in pt attended dental hospital (by McAndrew, Br dent Journal, 1993)

- gap present: 57% of cases, when gap more than 2mm = clinical outcome decreased significantly

Post prepation technique and their effect on apical seal (by Haddix, JPD, 1990)

-M&M: compare 3 methods of gap removal technique on apical seal with different level of Gap (3, 5mm), 172 mx canine, 6 group of 27 each
-result: less apical leakage with heated plugger technique at 3, 5mm level compare to gate glidden and GPX (parapost drill)

Survival time of cast post & core: A 10 years retrospective study (by Balkenhol, 2007, JPD)

-M & M: 565 patients with 802 CPC
-Result: average survival rate of CPC was 7.3 years. Most common cause is loss of retention. High gold content post had low risk of failure

Post placement and restoration of endo tx teeth (journal of Endo by Schwartz, 2004)

1. Are endo treated teeth different?

- Huang et al. (1991): neither dehydration nor endo tx causes degradation of physical or mechanical properties of dentin.
- access preparation result in: 1. ↑cuspal deflection 2.↑possibility of cusp fracture and microleakage 3. Loss protective feedback mechanism

- Contamination of Gp by saliva cause coronal leakage and exposure lead to migration of bacteria to apex
- Immediate restoration of endo tx tooth if fast set sealer used 'Heling et al , JPD 2002'

Important principle for Posts:

1. Retention: post length, diameter, luting cement, passive OR active

- ↑length and diameter - ↑retention
- Parallel post more retentive than taper, active more retentive than passive
- Diameter is less important than other factor listed (by Nergiz, Journal of oral rehab, 2002)

2. Resistance: remaining tooth structure, length and rigidity, antirotation and ferule
3. Preservation of tooth structure
4. Ferule effect: vertical band of tooth structure at gingival aspect of tooth preparation

- ferrule of 1mm has double resistanace to fracture than 0mm
- Maximum benefit of ferrule when it is 1.5-2mm (Lidman, IJP)

5. Retrievability: metal and fiber is easy to remove not like ceramic

Prognosis for endo tx teeth:

- it is difficult to compare but Mentien et al report 82% success in 516 patient teeth restore with metal post for more than 10 years
- Success rate of post and core of endo tx teeth and vital with crwon in 25 years are the same (Valderhaug, JPD, 1997)

Type of Post:

1. Active and passive: active is more retentive and introduce more stress than passive
2. Tapered or Parallel: parallel more retention and less wedging effect than tapered, tapered used for taper and thin root
3. Material

Prefabricated Post and Core

- Stainless steel, nickel, chrome alloy or titanium alloy
- Passive and tapered post give least retention and can be used with length in more than 8mm and tapered root which provide less removal of dentin (max premolars)
- Titanium post: used to avoid corrosion but it has low fracture strength (not strong)

Custom Cast Post and Core

- Used on misaligned teeth, no enough tooth structure to retain core, easy to retrieve
- Disadvantage: contamination of canal

Zirconia and ceramic post: high esthetical and difficult to remove

Fiber post: more flexible than metal and equal to dentin in modulus of elasticity

Preparing Post Space:

- Minimal enlargement of canal beyond shape created by endo, better prepare by endodentist because he is familiar with internal anatomy
- Post length:
  - Goodaere: ¾ of root length or at least equal to length of crown
  - Sorensen and Martinoff: 97% success of post length equal to crown length
  - Neagly: 8mm minimum length required
- Post should entered apically beyond crest of bone and stress concentration
- Abramovitz et al: 4 or 5mm of Gp (3mm is unpredictable)

Luting Cement:

- Zinc phosphate, resin, GI, RmGIC
- Resin cement: ↑retention, less leakage, short term strengthening of root
- Disadvantage of resin: technique sensitive (contamination), eugenol can't be used

Core material:

GI: lack adequate strength, used with post not indicated just to fill out
Amalgam: strength is good, delay preparation 24 hours, esthetic, mercury
Composite: high strength, preparation is immediate, bonded to wall

Clinically Significant factor in Dowel Design (Sorenson & Martinoff, JPD, 1984)

Objective: 1. Compare clinical success of 6 coronal radicular stabilization methods, 2. Record failure and effect on endo tx teeth, 3. Determine effect of post length and success rate

- Literature review:
  -Colley et al: 5.5mm parallel side serrated post are more retention than 8mm taper post

-self threading or screw post produce high stress and root fracture
-Standlee et al: with photoelastic methods illustrate taper post created wedging effect while parallel side post create maximum apical seal
-Johnson & Sakamura: ↑length of post from 7-11mm = ↑retention by 30%
- <u>Guidelines for optimum Dowel length:</u>

1. Equal to half length of remaining root (by Standlee)
2. Equal to 2/3 of toot length (by Pickard)
3. Equal to length of clinical crown (Shillingberg)
4. Have 3mm of Gp for apical seal and entered as apical as possible (Shillingberg)
5. Half length of root in the bone (Perl & Muroff)

- Strength of endo tx to be directly related to bulk of remaining dentin
- M&M: 6000 pts in nine dentist, **1273** endo tx teeth
- <u>Conclusion:</u>

1. Teeth with post length equal or greater than crown length has a success rate that excedd 97%
2. Tapered cast post & core display high failure rate
3. Cast parallel side serrated post & core or with amalgam or composite core show high success rate

5.Tapered post & core cause fracture of tooth but parallel side did not

<u>The mechanics of load transfer by retentive pins (by Caputo & Standlee, JPD, 1973)</u>

- Test stress pattern of different kinds of pin at depth of 1, 2, 3, and 4mm
- Longer pin in dentin distribution load more uniformally than short
- Pins placed 2mm a part produce less stress than 1mm apart
- Cemented pin transfer load uniformally than threaded and friction-lock
- Place pin at angle from long axis of tooth lead to high stress at surface
- Cemented pin is least retentive (it needs longer depth)
- Cemented pin = .025” diameter pin in .027” channel
- Friction lock = .022” diameter pin in .021” channel
- Self-threading = .031” diameter pin in .027” channel

<u>Retentive properties of post & core systems (by Newberg & Kameijes, JPD, 1976)</u>

- Different post and core systems subjected to tensile, shear and torque force
- All composite core alone is weakest in all loaded
- Highest tensile (pulling) force resistance is 4 pins and comp core follow by steel post and 2 pins and comp core
- Highest sheer (parallel force) resistance force is cast post & core and steel post 2 pins and comp core
- Highest torque (twist) resistance force is 4 pins & comp core follow by cast post & core
- Retention of comp core with 4 pin compares with others is good

<u>Pin-retained amalgam cores VS cast-gold Dowel cors (by Lovdahl & Nicholls, JPD, 1977)</u>

- Use central incisors in 3 groups (endo tx natural crown, cast post & core, 3pins and amalgam core)
- Endo tx tooth – strongest (55kg) than cast (18.1kg) or pin (23.7kg)

- Pin retained amalgam core were significant stronger than cast gold core

Retention of Dowels subjected to tensile and torsional forces (by Ruemping & Schnell, JPD, 1979)

- Compare taper smooth, parallel smooth, parallel serrated and parallel threaded
- Under tensile force: threaded more retention than unthreaded
- Under torque force: threaded and serrated dowel more retention than smooth side
- Depth (3 or 8mm) less influence retention than surface configuration
- Because less force cause dislodgement under torque, antirotation should be incorporated

In vitro comparison of intact endo treated teeth with and without endo-post reinforcement (by Guzy and Nicholls, JPD, 1977)

- post doesn't reinforce teeth
- Teeth without post fracture at middle or coronal 1/3 of root
- Teeth with post fracture through body of post

Retention of endodontic dowels: effects of cement, dowel length, diameter and design (by Standlee & Caputo, 1978)

- the greatest factor affect retention is design of post = threaded, parallel side dowel follow by serrated parallel side and least is smooth taper post
- 2^{nd} factor is post length, ↑length = ↑retention
- Cement type only affect taper post (Zn phosphate give high retention)
- Post diameter had no significant effect on retention

Tooth Fracture – a comparison of endo and restoration tx (by Trabert & Abou-Ross, J of Endo, 1978)

- No significant differences in resistance to fracture b/w untreated and endo tx teeth
- Factor effect of fracture resistance in MD width of root, length, width of preparation chamber
- Increase root length = ↑resistance to fracture

A comparative evaluation of three post and core techniques (by Hong & Dwyer)

- Full coverage crown is more significant than methods of post & core

Post & core foundation for endodontically tx teeth (by Chan & Bryant, JPD, 1982)

- Amalgam and composite core with cemented post are superior to cast post and core
- Amalgam and composite specimens show fracture of core but cast post & core show post & core dislodgement and root fracture

Intracoronal reinforcement and coronal coverage: A Study of endo tx teeth (by Sorensen & Martinoff, JPD, 1984)

- Retrospective of 1273 endo tx tooth
- No significant increase in resistance to fracture gained with post & core compare with composite, amalgam core and no post (for endo tx teeth)
- Coronal average of anterior teeth is not indicated
- Coronal average of posterior teeth is significantly improve clinical success rate

Clinically significant factors in dowel design (by Sorenson & Martinoff, JPD, 1984)

- Cast parallel-sided serrated post & core & parallel sided post including composite and amalgam core recorded high success rate
- Taper post & core (cast) show highest failure rate
- Parallel sided serrated post have failure by tooth fracture whereas taper cast post & core required extraction of 1/3 of fracture teeth
- Teeth with post length equal or high than crown length had >97% of success rate

Effect of complete veneer crown on compressive strength of endo tx post teeth (by Gelfand & Sunderman, 1984)

- Compare 5 post & core systems with and without crown with natural tooth
- Placement of crown is most significant than post & core systems

Resistance to root fracture of dowel channels with various thickness of buccal dentin walls (by Tjan & Whung, 1985)

- Compare 1, 2, 3mm of remaining buccal dentin and 1 mm RBD with 60° bevel
- No significant difference b/w groups, 1mm need less force to fracture
- Bevel not equal ferrule(bevel not improve fracture resistance)

In vitro comparison of dowel and core technique for endo tx molars (by Plasmons, J of endo, 1986)

-amalgam core with amalgam post or pin is comparable to prefabricated post with amalgam core

Retention of serrated endo posts with a composite luting agent: Effect of cement thickness (by Assif, JPD, 1986)

- Adaptation of post to canal is not crucial
- Composite cement thickness to .5mm doesn't affect retention
- Diameter of post doesn't affect retention

Effect of post adaptation on fracture resistance of endo tx teeth (by Sorenson & Engelman, JPD, 1990)

- Cement thickness (20p) doesn't significantly affect failure load
- 1/3 of post in intimate contact had equal failure load to post in intimate contact to entire length
- Taper post result in more extensive fracture and should be used with caution

Ferrule design and fracture resistance of endo tx tooth (by Sorenson & Engelman, JPD, 1990)

- They have 6 groups
- 1mm ferrule significant increased failure threshold
- Bevel in not equal to ferule
- Axial width of tooth at crown margin didn't ↑fracture resistance
-

Fracture resistance of amalgam coronal-radicular restorations (by Kane, JPD, 1990)

- Study effect of pulp chamber depth (2, 4, 6mm) and extention of amalgam in root
- When pulp chamber height >4mm, need for amalgam in root
- When pulp chamber height <4mm, amalgam post request
- Greater fracture load for more tooth reduction and less pulp chamber height

Are endo tx teeth more brittle? (by Sedyley & Messer, J of Endo, 1992)

- Endo tx teeth is not more brittle than vital teeth
- amount of tooth removal is only factor affecting strength of teeth

Fatigue life of 3 core materials under simulated chewing condition (by Kovarik, JPD, 1992)

- amalgam core with prefabricated post had significant lower failure rate compared with composite and GIC (100% failure of GI, 83% of composite, 33% of amalgam)

Effect of post adaptation in root canal on retention of post with various cement (by Chan, Austral, D.J.,1993)

- compare retention of prefabricated post in well and loose fitting, use Panavia, Zn Phosphate, polycarb and GIC
- high relation of post cemented with resin
- Loose fitting post (.5mm) are more resistant to dislodgement, irrespecte to cement type than well fitted post

Effect of post design on resistance to fracture of endo tx teeth with complete crown (by Assif, JPD, 1993)

- crown coverage is significantly important than post & core system
- try to preserve tooth structure and use suitable retention for core material
- don’t use dowel of remaining tooth structure with retain core

Effect of restorative procedure on the strength of endo tx molars (by Linn & Messer, J of Endo, 1994)

- evaluate significance of retaining intact marginal ridges and selective cuspal coverage
- it is important to cover cusps than to preserve marginal ridges in endo tx tooth

Cuspal deflection in molars in relation to endo and restoration procedure (Panitrisac & Messer, J of Endo, 1995)

- cuspal deflection increase with cavity size increase and was greatest after endo access
- cuspal protection is important in endo tx teeth

Survival rate and failure characteristics for 2 post designs 9(by Torbjorner, JPD, 1995)

- Loss retention was most common post failure
- higher post failure rate in anterior max, male and older patient
- higher post failure rate in single crown or RPD abutment or cantilever
- parapost post & core had higher success rate than taper CPC

Load Fatigue of teeth restored with cast post & core and complete crown (by Libman & Nicholls, IJP, 1995)

- 4 groups of ferrule, .5, 1, 1.5, 2mm with CPC and crown
- When ferule ≥ 1.5mm, crown had more load cycles to fail than <1.5mm

Periapical status of endo treated teeth in relaton to the technical quality of root filling and coronal restoration (by Ray & Trope, J of endo, 1995)

- Crown is important than quality of endo
- 61% lack periapical pathology with poor endo in good crown

Assessment of principal and clinical status of crown teeth over 25 Y (by Jokstad & Norheim, JD, 1997)

- Similar success rate of crown of vital and endo tx tooth with high quality endo and good post & core system

In vitro fracture resistance of endo treated central incisors with varying ferrule heights and configuration (by Tan & Aquilino, JPD, 2005)

- Cental incisor restored with CPC and crown had an equal fracture strength to vital or endo tx tooth with crown when it has 2mm uniform circumferential ferrule
- 2mm uniform ferrule has more fracture resistance than .5 – 2mm ferrule and both significantly better than no ferrule groups

The effect of post & core, crown type and ferrule presence on the biomechanical behavior of endo tx bovine anterior teeth (by Da Silva, JPD, 2010)

- When there is 2mm ferrule, core didn’t influence biomechanical behavior of endo tx teeth
- When there is no ferrule, cast post & core is better than fiber post

The effect of elastic modulus of endo posts on static load failure (by Stewardson & Marquis, I. Endo J., 2011)

- Stainless steel post has significant high failure load than glass and carbon fiber post
- No significant difference b/w fiber posts alone
- Choosing more flexible post will not by itself ↓clinical failure

Emergence Profile, Retraction

Emergence profile in natural tooth contour (by Croll, JPD, 1984)

- Straight emergence profile improve effectiveness of oral hygiene

Gingival enhancement in fixed prostho (Sorenson, JPD, 1991)

- Used 12% chlorhexidine gluconate (GHX) will significantly reduced plaque level and enhance gingival health (compare control group and experiment group 2x a day)

Relationship of crown margin placement to gingival inflammation (by Ritcher, JPD,)

- M&M: compare supra and subgingival margin in 12pts
  - Full crown on first molar(1/2 subgingival and ½ supragingival)
  - Evaluation up to 3 years basd on plaque and probing index
- Result: no significant difference on health of gingiva, sulcus depletion, gingival contour and plaque accommodation

In vitro kinetic study of absorbency of retraction cord (by Csempesz, JPD)

- The cord should be soaked for at least 20 minutes prior to use and air should be removed before soaking to optimize effect

Inhibition of polymerization of PVS by medicaments used in retraction cord (by Camargo, JPD, 1995)

- Latex gloves inhibit reaction by contamination of chloroplatinic acid catalyst by sulfur component
- Neither ferric sulfate not AlCl cause any inhibition to reaction

Clinical trial of Gi retraction cords (by Jokstad, JPD, 1999)

- Clinician unable to detect any clinical advantage of using epinephrine over AlSu

Review of pH of hemostatic agent (by Woody, JPD, 1993)

- Hemodent 21.3% AlCl = 1.7
- Restringent 25% $AlSo_4$ = 3
- Astringent 15% Fe So_4 = 1.6

Comparative study of gingival retraction method (by Aziz & Carranza, JPD, 1983)

- M&M: 12 dogs, compare retraction cord, rotary curettage using bur, electrosurgical instrument, Cl V preparation
- Result: no permanent loss of attachment
- Gi recession was greater with gingival rotary curettage, less with electrosurgery and non-existence with cord
- All minor destruction heal within 14 days

<u>Impression</u>

- ADA spec #19 for non-aqueous elastomeric impression material
- Classify to Type I, II, and III base on elastic properties and dimentional change
- Time:
  - 1. Mixing: time required to make homogenous mixture and uniform color
  - 2. Working: means from beginning of mix when apparent viscosity increase
  - 3. Setting: transitional time at which plastic properties are lost
- For all elastomeric material: maximum mix time 1 min and minimum work time is 2 min
- Detail reproduction: .75mm for high viscosity, .20mm for medium and low viscosity
- Elastic recovery: 2.% for type I and II, 5.5% for type III

Trays and adhesion: polymerization shrinkage and residual stress relaxation in autopolymerized acrylic resin can cause distortion of impression

- Philip: 20-24 Hours before impression
- Pagniano: 9 Hours
- Mowoery: change up to 180 days
- Fehling: at least 40 minutes

Polyether and addition silicon show higher bond strength than condensation and polysulfide
Peel and tear strength: add > polyether > polysulfide > condensation

Stackhouse, 1987: air bubble can be minimized by fast push of syringe content in mixing pad or distance intraoral site

Dahl, 1985: acceptable working cast produce with pour impression alginate within 3 H and store in 100% humidity

Johansen & Stackhouse, 1987: polyether is stable at bench cure but swelled during immersion

- PS and silicon and cond PVS shrink .3% to .4% during 16H but no different b/w wet and dry status

<u>Factors that affect the accuracy and dimensional stability of the Mercaptan Rubber base impression material (by Myers, JPD, 1960)</u>

- For more accurate cast use custom tray and pour it immediately

<u>Distortion of irreversible hydrocolloid and mercaptan rubber base impression (by Hosoda & Fusayama, JPD, 1961)</u>

- disinfect of alginate in Zn So_4 for 30 sec and pour it immediately – most accurate
- distortion of mercaptan increase with time due to thermal shrinkage and distortion not significant in first hour
- Irreversible hydrocolloid had less distortion than mercaptan if it is pour in room temperature but mercaptan has less distortion if it pour in moist temperature using thermoplastic box

Elastomeric impression material (by Wilson, British D.J., 1966)

- Silicon has higher elasticity than polysulfide

Rheology of dental composition (by Braden, J. Den. Res., 1967)

- Compound viscosity is depend on temp, 5°C temp change cause tenfold change on viscosity, at 60 C the viscosity is at least like heavy body polysulfide impression paste

Studies of synersis and inhibition in reversible hydrocolloid (by Swartz & Philip, J. D. Res., 1957)

- Agar not stable depends on storage media (air, water, disinfect)

Factors affect setting time of ZnO2- eugenol post (by Viera, JPD, 1959)

- Disappearance of tackiness (or stickness) should not be use as sign of setting
- Length of spatulation, temperature, P/L ratio affect setting time
- Water shouldn't be add because it shows in some product is ↑ and another ↓ setting time

The accuracy of correcting a defective rubber base (by Shevlin, JPD, 1970)

- To maintain accuracy of impression which correct RB is unpredictable due to hydrostatic pressure of wash material and compress material return to unstressed state and give small dye

Accuracy of the laminated single impression technique with silicon materials (by Fusayama, JPD, 1974)

- Laminated technique: heavy and wash mix at same time and wash over heavy in tray
- Laminate and double step technique (relief) gave an accurate dye

The accuracy of highly filled elastomeric impression material (by Reisbick, JPD, 1975)

- Use patty or heavy body with stock tray eleminate need for custom tray

A comparison of elastic impression material (by Stackhouse, JPD, 1975)

- No significant difference between all elastic impression material if it pour within 30 minutes
- Die pour immediately from hydrocolloid impression didn't significant difference than elastomeric material in 30 minutes
- Polyether is most stable material within 24H

Accuracy of six elastic impression material used for complete arch fixed partial denture (by Stauffer & Meyer, JPD, 1976)

- None of test material allows ideal fit FPD from one master cast, section and solder was needed (they use 4 teeth with Ap spread)

Viscosity of elastomeric impression material (by Herfort, JPD, 1977)

- Rheology: study of flow characteristics of viscous material
- shear rate: speed at which liquid flow under internal force
- Viscosity decrease with increase on shear rate
- Omniflex and impregam has extreme shear thining property which is useful

Addition curing silicone rubber impression material (by McCabe, BDJ,1977)

- Addition silicone has longer working time and superior dimensional stability

Preliminary evaluation of the histotoxicity and radiopacity of lead containing elastic impression material (by Gettleman & Natahnson, JADA, 1978)

- Lead containing material are radiopaque and more toxic material

Viscoelastic properties of elastomeric impression material part II (by Inoue & Wilson, J oral rehab, 1978)

- Setting time decrease with ↑ quantity of activator while ↓ in modulus value
- Control setting time by changing temperature but not change ratio
- part III: elastic recovery after removal of strain applied at setting time
- Remove impression from mouth should be performed as quickly as possible especially with rubber base b/c it has less modulus of elasticity

The combined reversible hydocolloid / irreversible hydrocolloid impression material (by Appleby, JPD, 1980)

- Combined technique proved to be easy and practical technique
- Bond b/w reversible and irreversible is weak and affects dimension stability

Elastomeric impression material: effect of bulk on accuracy (Eames, JPD, 1974)

- Compare 2, 4, and 6mm spaces: 2mm produce most accurate impression for all material

Accurate and dimentional stability of elastomeric impression material (Eames, 1979)

- Poor material immediately has a good stability
- Amount of contraction of material within 30 minutes is .11 to .45%

The effect of delayed and second pours on elastomeric impression material accuracy (by Luebke, JPD, 1979)

- No significant difference b/w first and second pour if it is at the same time
- Delay pouring of silicon and polysulfide adversely affect accuracy

Comparison of elastomeric impression materials used in fixed prostho (by Ciesco, JPD, 1981)

- Use custom tray and adhesive had superior result with all material
- Polyether has superior result with and without tray

Time-dependent accuracy of elastomeric impression material, Part II (by lacy, JPd, 1980)

- PVS are most stable and its optimize by using custom tray
- No difference b/w single and double mix technique for polysulfide

Linear dimensional change of acrylic resins used in the fabrication of custom trays (by Pagniano, JPD, 1982)

- Ideally , wait at least 9H after fabrication of cold cure custom trays
- If it is necessary to use tray, put it for 5 minutes in boiling water and cool it to room temperature and pour impression immediately

An evaluation of the time dependent dimentional stability of 11 elastomeric impression materials (Williams, JPD, 1989)

- PVS has superior dimentional stability due to lack by product such as water and alcohol which is produce by condensation silicon and polysulfide
- Greatest accuracy of all material when it is pour immediately
- PVS has excellent stability for all storage media (1, 4, 24H)
- polyether shrink during setting and produce small die
-↓ bulk of material improve stability by using custom tray reversible hydrocolloid

The accuracy of PVS impressions made with stand and reinforce stock trays (by Wessel, JPD, 1991)

- Heavy and light body give more accurate impression than patty light impression

Three dimentional investigation of accuracy of impression material after disinfect (by Kern, JPd, 1993)

- Disinfectant didn't affect dimensional stability of tested material
- Cavicide: isopropanol / isopropyl alcohol

The dimensional stability of dental impression material following immersion in disinfectant solutions (by Martin, J dental material, 2007)

- All disinfectant result on acceptable level with dimentional stability

Wettability of silicon and polyether impression materials characterization by surface tension and contact angle (by Grundke, 2008)

- To measure wettability (ability of unset material to flow and wet moist surface
    1. High surface tension (polyether double PVS)
    2. Contact angle (polyether 10 to 20° and PVS 60-120°)
- Add surfactant to PVS produce it at beginning and when it is set but not during setting process

The effect of Chlorine-based disinfectant on wettability of a vinyl polysiloxane impression material (by Blalock, JPD, 2010)

- ↑ contact angle with time of contact with disinfectant increase, which lead to depleted of surfactant and affect wetting character of PVS

Clinical fitting of CAD / CAM zirconia single crowns, generated from digital ____ impression based on active wave front sampling (Cardill, 2011)

- Single crown fabricated from digital impression have good accuracy

Full arch scans: conventional VS digital impression (by Ender, I J comp den, 2011)

- Compare accuracy of digital (Lava, Cerec) and conventional polyether
- Accuracy by mean of:
    a. Trueness: to have model same as original “master”
    b. Precision: many model equal to each other
- Accuracy of digital impression is similar to conventional impression
- Use conventional of CAD/CAM for inlay, onlay, crown, FPD (up to 4 unit)
- Use conventional for full mouth cases still superior

<u>Impression Material</u>

<u>Chapter 12: Craig & Power p.330</u>

- Impression material use to accurate replica of hard and soft tissue
- No impression material fulfill all of these requirement:

1. Pleasant odor and taste
2. absence of toxic or irritant content
3. adequate shelf life
4. cost
5. easy to use
6. setting meet clinical requirement
7. elastic properties with freedom from permanent deformation after stain
8. adequate strength so it will not break or tear on removal from mouth
9. dimentional stability over temperature and humidity in clinic or lab
10. compatible with cast or die material
11. readily disinfect without loss of accuracy

<u>Alginate Hydrocolloid</u>

Contents:

1. 18% potassium alginate: dissolve in water and react with Ca ions
2. 14% calcium sulfate: react with potassium alginate to form Ca alginate gel
3. 2% Na Phosphate: control marking time
4. 56% silicate or diatomaceous earth: control consistency and flexibility

- manufacturer adjust concentration of Na phosphate to produce regular or fast set alginate and they adjusted concentration of filler to control felixibility of set material
- change W/P ratio will alter consistency and setting time but also also will affect strength and quality of impression
- only change of temperature to control setting time but it should be with this range 18 to 24˚C, by change temp of 10˚C, setting reaction will be doupled
- loss of surface tackiness indicate setting, impression should be left 2-3 minutes after loss tackiness because tear strength and resistance to deformation is 98.2%, (ADA specify the permanent deformities should be <5% or recovery of morethan 90%)
- permanent deformities is time dependent, high accuracy (low deformation) control by
    1. compression percent is lower
    2. shorter time under compression
    3. longer recovery time
- Flexibility: ADA specify 5 to 20% at stress of $1000 g/cm^2$, alginate has 14% (for ease removal)
- Strength: compression and tear is time dependent, compression strenght of alginate range from 5000 to $9000 g/cm^2$ (ADA spec, at least $3570 g/cm^2$), tear strength measure by force/thickness ration, for alginate 380 to 700 g/cm
- Alginate impression should be rinse in cold water to remove saliva and blood and then disinfect
- if alginate will be poured immediately within 30 minutes, all water should be removed before pouring

- if alginate will be poured in 30 minutes or more it should be store in moist paper towel and seal in plastic bag to avoid moisture loss after that it should be rinse in cold water to remove any surface exudate due to synersis, which might retard setting of gypsium
- Impression should be separate from gypsium within hours since contact of Ca sulphate dehydration with alginate gel containing water affect surface quality of model
- For maximum accuracy, impression should be pured as soon as possible
- Advantages: hydrophilic, low cost, long shelf life, clean and pleasant
- Disadvantages: not accurate/rough, tear easily, pour immediately, can retard setting of gypsium

Elastomeric impression material:
- Polysulfide introduce on 1950, cond silicon in 1955, polyether in 1965 then addition siliconn 1975
- Elastomeric material are available in 3 consistency (low, medium and high)
- 3 type of mixing: hand, mechanical, static automixing

Polysulfied “Mercaptan”
- Base: 80-85% polysulfide polymer, 16-18% TiO_2 or silicon
- Accelerator: 60-68% lead dioxide, 30-35% dioctyl phthalate
- Slight exothermic reaction (3-4˚C↑), had byproduct and reaction continue for hours
- Advantages: long working time, high tear resistance, modest cost,
- Disadvantages: required custom tray, pour within 1hour, odor and stain clothing
- immediate pour (Philip) within 30 minute

Condensation Silicon
- Base: polydimethyl siloxane, filler (calcium carbonate or silicon) – 35% for low consistency and 75% for putty
- Catalyst: Stannous octate suspension – alkyle silicate
- Advantages: good working time, putty for custom tray, clean and pleasant
- Disadvantages: high polymerization shrinkage, low tear strength, hydrophobic, pour immediate (by-product)

Addition silicon:
- Base: dimethyl siloxane polymer
- Catalyst: divinyl polydemethyl siloxane
- No reaction byproduct, 2nd reaction between moisture and hydrite silicon
- Can develop hydrogen gas which can be solve by:
  1. Manufacturer add scavenger like nobel metal (platinum or palladium)
  2. Wait at least 30 minute (Craig) or at least 1 hour (Philip) before pouring
- Sulphur containing latex gloves inhibit reaction of material
- Advantages: ideally elastic, pour repeatedly, stable/ delay pour, clean and pleasant
- Disadvantages: hydrophobic , low tear strength, cost, no flow of sulcus is moist
- Surfactant added to paste to make surface hydrophilic

- It wet soft tissue better and produce better detail, also it enhance ability of gypsium to capture maximum detail
- Impression required dry field even with surfactant

<u>Polyether</u>

- Base: polyether, polymer + silicon
- Catalyst: alkyl sulfanate
- Advantages: least hydrophobic, good stability, delay pour, fast setting
- Disadvantages: strength high modulus, absorb water, high cost

Properties:

- Impression trays: Williams, Eames
  - Use custom tray to reduce quantity of material and any dimentional change
- Removal of Impression:
  - Inject material in space not in field of operation, probe material within blunt instrument from time to time when it is firm and return completely to original contour and impression is suffiecient elastic to be removed
  - Quick snap to remove impression to minimize plastic deformation
- Working and setting time:
  - Polysulfide have longest time (8-10min), silicon (3-6min), polyether (6min)
  - Working and setting time decrease as viscosity increases
  - Snap-set: clearly defined working time with sharp transition into setting time and only for polyether
  - ↑temperature and humidity with shorten setting and working time

<u>Dimentional Changes</u>

5 major source of dimentional change: STIPD

1. Polymerization shrinkage
2. Loss of byproduct
3. Imbibition
4. Thermal contraction “oral-room temperature”
5. Incomplete recovery from deformation

- Shrinkage of material at 24H:
  - *Craig*: Add silicon (.15%) polyether (.2%), polysulfide (.40%), cond silicon (.38 - .60)
  - *Philip*: Add silicon (.14-17), polyether (.19-.24), polysulfide (.40-.45) con silicon (.38-.60%)
- Tear strength (N/M): resist tear in interproximal area or subgingival
- It is maximum force needed to pull specimen apart divided by thickness of specimens
- Polysulfied (7000) > polyether (3000) > silicon (add and cond)
- Stiffness: polyether > additional silicon > cond silicon > polysulfide
- Distortion in removal: polysulfide > cond silicon> polyether > addition silicon
- Hydrophilicity & wettability:
  - Contact on gel with water: polyether (49) < addition silicon (98/53-surfactant) < cond silicon (98)
  - No truly hydrophilic because all contact angle >45˚

Dies and Casts

- *Toreskog & Philie, 1996*: stone was superior in dimentional accuracy
- *Schneider, 1984*: dies mix with gypsium hardners like whip-mix hardner and stallite shows sign ↑ in surface hardness and compression strength
- *Miranda, 1976*: index system deviate slight less than di-lock system but bo significant difference
- ***Eames, 1978***: seating crown without cements 17 **μm**, 10˚, relieved biting force
    - Crown without relief shows unsatisfactory seating
    - Venting improve seating – aqua rugea etching improve seating
    - Relief enhance seating and ↑retention by 25%
    - Retention value of uncemented casting give no indication of retention value after cementation
- *Stackhouse, 1981*: describe electrodeposit technique
- *Myers, 1882*: compare 4 technique of removable dye – no stat sign
- *Compagni, 1982*: ideal amount of casting relief to achieve maximum retention is not known
- ***Eames* suggest 25μ, Fasuyama suggest < 30 is undesirable and use 40μ**
- More complete seating ↑retention from 14-32% = Jorgenson said variation from 20-140 μ hand only moderate effect on retention
- More investigator exceeded 25μ, for type 1 cement
- Die spaceTru-fit and 2 Coat = 26μ, 4 coat = 58μ, 6 coat = 77μ
- Seating ↑ up to 70μ and then plateau after
- *Donovan, 1984*: apply die spaceer in one direction – apply in groove areas doesn't affect resistant and relation form
- *Lyon, 1986*: strength of dry gypsium , diestone is roughly twice that wet die stone
- *Tjan, 1992*: Tray space (up to 6mm space) and up to 3 pour of PVS Implant didn't affect dimentional accuracy

Hydrocolloid and Casts

- *Rudd & Morrow, 1969*: describe same way we do for alginate impression, add base when it is warm and separate at 45 to 60 minutes = keep it longer, alginate make surface rough and pitted
- remove early = stone contact with impression not set
- use 2% of potassium sulphate for no more than 5 min = make it harder quickly by accelerate setting of stone
- *Skinner*: hardness of stone doesn't ↑ by mixing hardening solution instead of water with stone
- ideal to wait 3H or more after separation to start trimming = 1H is minimuim
- cast shouldn't be wet, rinse or soak in water since it is saturated and not dissolve stone
- remove alginate impression from month after loss of tackiness by 2 minute after

Young, 1975: Fluid stone be pour and allow to set vertically and if it is inverted before set it will lead by gravity to rough and more void cast

Harris, 1969: alginate mix with water at 3, 10, 20˚C have some accuracy = control setting by changing temperature not ration (P/L)

Kaiser & Nicholls, 1976 = double & single pour as accurate except at one point double is better

- Double pour technique (advocated by Rodd & Morrow) had a significant higher superficial hardness, value than single
- Slurry water were significant produce higher hardness stone cast than distilled water

Morris, 1983: impression smooth with wet finger produce less bubbles than in smooth

Brukle, 1984: impression smooth with wet finger doesn't change surface hardness of stone

Woodward & Morris, 1985 = perforated tray produce more accurate cast than rim lock "non perforated" tray

Spingman: cement and adhesive used to joint fracture part of stone

1. Cyanoacrylate cements produce strongest bond and ZnPh cement is weakest
2. Bond strength is greater after 24H

Roraff & Stansburg, 1972 = dimentional change in monitoring procedure is enough to cause a concern

- Solutions use least expansion stone or use articulator less space between upper and lower membrane

Die Spacer (Part II)

Effect of resistance cement of full cast crown (by Fusayama, JPD, 1964)

- Objective: study influence of cementing load, taper, height of prep, relief space inside crown on marginal adaptation
- First one used manicare liquid (die spacer)
- For internal relief compare manicare liquid and tin foil growp
  1. Increased load from 15kg to 50kg doesn't improve seating
  2. Marginal seating gap decreased when taper increased
  3. Relief spacers decreased marginal gap and no difference between tin foil or manicare liquid
  4. No significant difference was found between relief spaces on BL or full surface
  5. Less cement composed for shoulderless crown margin

Measurement of paint-on die spacers used for casting relief (by Compagni, JPD, 1982)

- Objective: determine thickness of three paint-on die spacers
- Use different color (silver, gold, silver) over each other to see which part are not cover
- Thickness of die spacer if different than manufactured number
- Each die spacer give different thickness according to application

An evaluation of marginal adaptation of entracoronal restoration during cementation (by Pascor, JPD, 1983)

- Asymmetrical seating of crown not affect gab
- Bevel margin reduce marginal opening but not allow complete seating

Effect of die spacer on seating of completely cast gold crown with groove (Compaigne, JPD, 1986)

- Die reliefs (6 coat used on study) of 20-40µ improve seating of crown ± groove
- Grooves didn't disrupt seating when die spacer is completely or partially applied

Film thickness measurement of paint-on die spacer (by Oliva, JPD, 1988)

- Using same die spacer and coating technique on a number of dies will not produce uniform film thickness

The effect of multiple layers of die spacer on crown retention (by Passon, Operative Dentistry, 1992)

- Compare retention of no, 2, 4, 8, 12, 16 layer of die spacer
- Up to 16 coats (151µm) of die spacer doesn't affect retention

The effect of selection die spacer placement technique on seatability of casting (by Hager et al, JPD, 1993)

- Objective: evaluate 3 technique of die relief
- Additional relief at axis-occlusal line angle doesn't improve seatability of crown
- Conventional relief providing a better seatability

Cementation Phenomena

The degree of zinc phosphate cement coverage of complete crown preparation and its effect on crown retention (by David Assif et al, JPD, 1992)

- M&M: in vitro, 6 groups according to cement application, 60 specimens of clear acrylic crown. Retention and seal of crown measure
- Results: retention of crown increased when cement cover all retention surface area which are affected by shear forces
- Present of cement on occlusal area doesn't affect retention but it affect marginal seal
- Cement applied at apical half of tooth has good retention and marginal seal

Factors affecting the film thickness of zinc phosphate cement (by Jorgensen, Actu Odont, 1960)

- 5 factors affect film thickness and will be study
  1. Cementation pressure: ↑pressure = ↓film thickness = more than 5kg doesn't affect
  2. Duration of process: pressure more than 1 min doesn't affect film thickness
  3. Viscosity and temperatute of cement: powder/liquid ratio has great effect
  4. Taper of preparation: greact effect if no vent (↑taper = less film cement)
  5. Occlusal perforation: ↓film thickness

Cement thickness between cast restoration and preparation wall (by Fusayama, JPD, 1963)

- Measure film thickness of U I and II inlay and crown, different expansion, direct and indirect wax pattern
- ↑ film thickness when space created by oversize cast <30μ, slight ↑ in film thickness if space created >30μ

From Shillingberg page 367

- Gold alloy shrink 1.5%, Ni-Cr 2.4%, to composed for that:
  1. Setting expansion: crystal growth "due to silica" = 4%
  2. Hydroscopic expansion: expansion of investment material when set in water = 1.2-2.2%
  3. Wax pattern expansion: when wax warmed above temperature at which form (chemical reaction of investment)
  4. Thermal expansion: when investment heated on burnout over (up to 1200°F)
- Gypsium bonded investment: for alloy fused <1975°F
- Gold, phosphate = alloy fused >1975°F

Measurement of cement film thickness beneath full crown restoration (by Dimashkieh, 1974, British dent journal)

- Study effect of taper prep (2°, 5°, 10°) and venting on Zn phosphate film thickness
- Venting crown is less critical when greater taper angle used (10°) and it is mandatory for parallel wall prep

Technique to improve the seating of casting (by Wilmer Eames, JADA, 1978)

- Study effect of taper, cement type, venting, internal relief by using aqua-regua acid technique and die spacing on cast seating
- Internal relief using die spacer improve seating of casting upon cementation and retention increase by 25%

Pressuring techniques and cement thickness for cast restoration (by Koyano, JPD, 1978)

- Study effect of pressure on film thickness of inlay restoration
- Vibratory pressure produce thinner film at margin than static load
- Best cementation when used combination of static (l0 second), horizontal vibration (5 second) then static load (15 minutes)

Intracoronal pressure during crown cementation (by Hoard and Caputo, 1978)

- Study role of intracoronal pressure at crown cementation
- Most of pressure released
    - I minute for Zn phosphate (it never reach 0)
    - 1.2 minutes for Zn polycarboxylate – it reach 0
    - 10 second for zno eugenol – reach 0
- Viscosity is main factor affect pressure

Influence of surface roughness on retention ability of 2 dental luting cement (by Oilo & Jorgenson, 1978, j Oral Rehab)

- Roughness improve retention of 2 cement but will be more with Zn Phosphate

Influence of some factors on fit of cemented crown (by Ishikiriama, JP, 1981)

- Study effect of amount of cement, vibration, venting or etching on crown fit
- Don’t fill crown by cement, use camel brush – give better fit
- Mechanical vibration, venting, internal relief by acid etching produce better fit

Effect of internal relief, vibration and venting on vertical seating of crown (by Nortwick & Gettleman, 1981, JPD)

- Study effect of occlusal venting, internal relief and horizontal vibration on seating
- Horizontal vibration doesn’t affect or improve seating with crown
- Venting and internal relief improve seating and work best when combines
- Disadvantages of venting: add step to close hole, the filling may wear or leak at margin, weaken porcelain

Effect of multiple axial grooves on marginal adaptation of gold crown (by Tjan, JPD, 1981)

- Presence of groove affect seating of crown (no die spacer)

The internal escape channel: a solution to incomplete seating of crown (by Millar & Tjan, JADA, 1982)

- Place one escape channel and blockout groove improve seating of crown (no die spacer used)

Improve marginal seating of lost restoration using silicon disclosing medium (by Shane White & Sorenson, IJP, 1991)

- By using 2 time of fit checks = margin closed *37μm or 39%* which clinically not detectable by explorer

In vitro micro leakage of luting cement for cast crown (by Shane White, JPD, 1994)

- Crown for perio compromised tooth, compare 3 cement, extraction after 6 months and compare microleakage
- Zn phosphate cement significantly leaked (978μm) more than resin composite glass ionomer with bonding agent (133.9) or without bonding agent (87.9)

<u>Retainer Preparation</u>

<u>Craig, 1967</u><u>: experimental stress analysis of restoration (5 parts)</u>
I: 2D photoelastic shows with MOD box prep, round axiopalatal line angel ↓stress
II: 1. multiple point contact to ↓ stress at central fissure area of crown
    2. Full shoulder is recommended to ↑bulk at margin to redistribute tensile stress at margin
    3. All line angle should be round to ↓ stress
IV: round axiogingival line angle in shoulder design ↓stress by 50%

<u>Smith, 1970</u>**<u>:</u>** altering roughness of prepared dental surface will range with 5-10μ doesn't significantly affect retention

<u>Collett, 1974</u>: protect dental pulp in fixed partials

- Severity of pulp response to injury influence by contact of abutment prep and thickness of remaining denture
- TRD of 2mm preclude irreversible pulp damage
- Factors affect pulp response:
    1. Speed, size and type of rotating instruments
    2. Amount of pressure
    3. Depth of remaining dentin
    4. Vibration
    5. Coolants
    6. Desiccation
- Temperature should be within 10°F of 98.6°F to prevent pulp from necrosis (↑ of 10°F = 15% necrosis)
- Temporary condition of final crown for several month to allow for reparative dentin and protect against acidity of Zn Phosphate (50 days require to form reparative dentin)

<u>Koth, 1982</u>: gingival inflammation surround full crown controlled regardless of Gi margin placement when gingiva is healthy, restoration is adequate and put in recall program

<u>Belser, 1985</u>**<u>:</u>** there is no significant difference in fit of beveled metal, butt margin of metal or porcelain before and after cementation (in vivo study of SFM)

<u>Guyer, 1970</u>**<u>:</u>** multiple prep for fixed
4 elements of tooth prep

1. Occlucal reduction: uniform reduction to provide adequate thickness of metal without jeopardizing pulp
2. Axial reduction:
   - extracoronal restoration – taper converge 2-5°,
   - intracoronal restoration – taper diverge 2-5°
3. Margin: 4 type: feather edge (shoulder less), shoulder, bevel shoulder, champer
4. Means of R&R form: parallel in opposing wall, grooves, box, pin

- Why occlusal reduction first: initiate prep in easy access when bulk will be removed and better access to remaining axial reduction

- Only axial proceed occlusal of tooth has short OG highet of crown
- Indication for box: eleminate caries or restoration, space for intracoronal connector, correct alignment

Principles of preparation:

Parker, 1991: resistance form of prepared teeth ↓ from central (96%) to molars (46%)
- Evaluate resistance form by putting manual pressure 4 side of crown and noting dislodgement
- Molar is difficult to have enough resistance form because restrict access and visibility to tooth and ↓ height to base ratio
- Grooves provide resistance form, M&D grooves resist BL displacement and vice versa

***Kent*:** mean taper of 418 prep is 14.3°

Pasco*: Rosner*, *1963* describe concept of ↓marginal opening by use bevel finish line
- Least marginal discrepancy was with slight oversized casting

Gilbo & Teteruck: Fundamental of tooth prep
- Primary factor of retention and resistance form
  1. Parallelism: 2-5° provide optimum R&R form, most effective
     -as it reach parallelism-↓ displacement from tensile and shearing stress
  2. length: ↑length=↑R&R form
  3. Surface area: larger cervical diameter = ↑ surface area = ↑ resistance to dislodgement

- 2nd factors requirement for placement: 1. With line of withdrawal 2. As far as possible from reciprocal feature 3. At a point which permit max length

***Dodge, 1985*: effect of convergence angle in R&R form**
- Taper angle: only on axial wall, convergence angel = combined of taper angle of opposite wall
  1. Resistance is more sensitive to change in TOC than retention
  2. 16° of TOC provide adequate R&R form
  3. TOC of 16 and 22 is most advantages from R&R form and complete sealing of crown (less parallel = high seating)

Tjan, 1984: internal escape channel enhance seating of crown

<u>Porcelain Fused to Metals</u>

<u>Gingival marginal cinfigurations: (Hunter & hunter, 1990, JPD)</u>

- *Churfer*: width >.3mm, obtuse angle at gingival termination
- Bell et al defined champer as prep with reduction of 1.5mm, round internal line angle, Cafo-srface angle of 135°

Shoulder: it is one that form 90° angle with vertical axial wall

<u>Bevel</u>: geometric principle to minimize marginal discrepancies

- It is defined as: angel between created bevel surface and surface has been beveled or angle between bevel surface and internal surface of tooth

<u>Classification of margin design:</u>

A. Based on Geometry
- Champer, shoulder, bevel

B. Based on width
- Knife edge (<.3mm), champer or shoulder (>.3mm)

<u>*Kuwata* Classification</u> based on marginal angle (angle between vertical projection of internal surface and prepare surface)

1. Bevel margin 0-30°
2. Champer 31-60°
3. Shoulder 61-90°

<u>Marginal discrepancy</u>

1. Vertical discrepancy: marginal opening measured vertically " seating"
2. Horizontal discrepancy: marginal opening measured horizontally "sealing"

- Sealing and seating is same in horizontal design (e.g shoulder and chamfer)

<u>Gavelis et al, JPD, 1981, v45</u>

- Compare finish line with seal and seat
- High sealing: feather-edge, parallel bevel > shoulder
- High seating: shoulder > 45°shoulder > 90° shoulder with 45° bevel

<u>Shwarth</u> said that for each 1µm increased in cement thickness = 11.5µm increased in seating discrepancy

<u>Slip-Joint Principle</u>

- When seating discrepancy is limiting factor in crown fit, then sealing discrepancy can be reduced to lower figure by right angle triangle
- From that, greater bevel angle are more effective to decrease sealing discrepancy
- But greater bevel make it more deep in gingival
- Advantage of bevel: reduce inherent defects, burnishing after cementation, development of circumferential retention, protection of enamel rod

Analysis of geometry of finish line (Pasco, JPD, 1978)

- Theoretically basis for using bevel to provide sliding joint effect was only valid where adaptation of casting is exact and where it purely vertical placement
- Only when there is exact adaptation did bevel exhibit slip-joint geometry and smallest discrepancy produced by shoulder margin on slight oversized casting

Improved seating of crown by:

1. Venting (Tjan et al, 1985, JPD): improved seating for all prep design (high with shoulder + 45 bevel> light chamfer) but sealing gap is more in bevel margin
2. Internal spacing: oversized die or die spacer

Prep design and marginal distortion in PFM (Shillingberg et al, 1973, JPD)

- Shoulder finish line with or without bevel produce less distortion in labial margin compared with beveled and non-bevelled champer (study compare 4 design at different fusing cycle)

Distortion related to margin design in PFM (Faucher & Nicholls, 1980, JPD)

- Compare MD & BL marginal discrepancy of 3 group
- Result: shoulder design (±bevel) has less distortion than champer (labial margin distort lingually and when placed on tooth is flex labially and porcelain break down " tension force"

Change in marginal fit (Ritchor Snupp, JPD, 1988)

- Compare bevel shoulder and 45° slope shoulder, nobel and non-nobel material
- Result: margin design, alloy type and porcelain proximally from margin doesn't affect fit of crown

Effect or repeated fining on margin or ceramometal alloy (Bachanan, JPD, 1981)

- Marginal discrepancy is more in non-precious alloy

Marginal fit change during porcelain firing cycle (Gemalmaz, 1995)

- Compare Ni-Cr and Pa-Cu, shoulder and champer
- Result:
    1. High marginal fit change occur in degassing stage because stress released is high
    2. Less marginal fit change occur in non-precious alloy (high creep resistance)
    3. Marginal fit change independent in marginal design and porcelain proximity

Analysis of all ceramic (Wanserski, JPD, 1986)

- Compare all porcelain margin with metal supported margin
- Result: clinically acceptable all ceramic margin can be achieved

Improving fit of crowns with die spacer (Craigower, JPD, 1989)

- M&M: extracted molars, covers with one to 5 layers of new and old spacer
- Result:
    1. Application of spacer to shoulder margin of die ↓ elevation of cast

2. The elevation is proportional to spacer thickness until it reached 70µm and ↑ die spacer more than that will ↑ cement thickness but without any effect on marginal elevation
3. Optimal thickness of spacer is thinnest layer that result in minimum elevation of the margin
4. New or old die spacer give different thickness

- Average thickness of spacer give space true fit is 19µm when it is old, it reach 32µm

Marginal fit of gold inlay casting (Christensen, JPD, 1966)

- M&M: extracted PMs, mounted to adjacent to each other – ten experience dentist at Washington resto dept examined it with explorer and xray
- Result:

1. subgingival margin with opening up to 119µm are acceptable
2. Subragingival margin is acceptable up to 39µm
3. Main conclusion: subgingival margin difficult to detect than supragingival and use another method with explore to detect subgingival margin

Effect of cyanoacrylate on die stone (by Habib et al, JPD, 1983)

- Apply one layer of cyanoacrylate at margin and apically to:

1. ↑ thickness of die by 1µm which clinical insignificant
2. ↑ surface hardness by 150%
3. ↑ scratch resistance by 48%
4. Closed pores and produce shining surface

Film thickness of die coating agent (by Richardson, 1991, JPD)

- Mean thickness of permanent bond is 92µm

<u>Metal Ceramic (Part II)</u>

<u>An analysis of margin in configuration for metal ceramic crown (by Donovan & Prince, JPD, 1985)</u>

- Objective: to achieve excellent esthetic at cervical gingival margin is mainly the problem for PFM crown, this article discuss problem and provide solution
- Problem: PFM crown margin has a different design to resolve esthetic problem due to: a. presence of metal collar: blue gray, cyanotic appearance or b. presence of opaque porcelain at margin which has high value and inadequate space to diffuse light and produce high esthetic
- <u>Requirement to select margin design:</u>
  1. Provide excellent esthetic
  2. Maintain good marginal closure
  3. Promote periodontal health
- Margin will be discussed as: beveled shoulder, slope shoulder, all porcelain
  1. Beveled shoulder
     - Advantages:
       a. Marginal closure: it provide a good sealing and minimize cement exposure but it feel to seat (vertical) and to ↓ marginal opening = bevel angle should be increased and that will lead to ↑ thickness of metal collar to hide that you need to go deep or sulcus = difficult to retract and take impression and possible violate to biological width
       b. Less distortion: during porcelain fining
       c. Polished surface at margin
     - Disadvantages:
       a. Bevel must be steep to be effective
       b. Esthetic
     - Indication: non-esthetic regions
  2. Sloped shoulder
     - Esthetic is minimum metal displaying and not deep subgingivally
  3. Simplified lab porcelain
     - Disadvantages: 1. difficult tooth prep: hand instrument need to be used to create margin 2. Potential distortion (thin metal) and 3. Rough material at margin (opaque and unpolished material)
     - Indication: esthetic for palate with good hygiene due to potential plaque absorption
  4. All porcelain labial margin: prep should be 90° shoulder because porcelain at least 10 times stronger in compression than in tension
     - Advantages: esthetic (no metal collar, no opaque surface), glazed porcelain at margin (less plaque accumulation), acceptable marginal closure
     - Disadvantages: difficult technical procedure,
     - Indication: esthetic area

<u>Mumfold</u> **<u>(1965) suggest several reasons for PFM distortion</u>**

1. Contracting of porcelain with metal deformation
2. Contamination of casting

3. Contamination of internal space of casting by porcelain
4. Gain growth of alloy

<u>Preparation design and margin distortion in porcelain fused to metal restorations (by Shillingberg & Hobe, 1973, JPD)</u>

- Objective: to determine amount of distortion in PFM crown with different marginal design
- M&M: 4 different design (champer ± bevel and shoulder ± bevel)
- Chrome cobalt metal: measure of labial opening in micron measured before degassing, after degassing, after spacer, 1st body, 2nd body, and after glazed
- Result: 5 cast for each design
  - Shoulder finish line ± bevel produced less distortion in labial margin than champer ± bevel (S+B=5.8µ < S (10.7µ) < heavy champer + bevel (29.3) < C (47.1)
  - When added this distortion to initial opening before adding porcelain that will exceed clinical acceptability
  - ↑ metal thickness at margin = ↓ distortion

<u>Fit of three PFM marginal design in vivo SEM study (by Belser, 1985)</u>

- Objective: compare clinically fit of 3 PFM crown design
- M&M: 27 patient need 36 PFM crown
- 2 prosthodontist did study in 3 groups: a. beveled metal margin with 20°bevel for .5mm length, b. metal butt joint, c. porcelain butt joint
- Precious metal alloy used for casting
- Porcelain applied in 4 stage (obaque, 2 body and glaze)
- Impression made for PFM crown before and after cementation
- SEM used to determine obenning in microns
- Result: before cementation all margin opening is <50µm and ↑ after cementation
- amount of marginal opening for metal butt joint is 45µ and porcelain butt joint is 46µ which is significant
- Porcelain butt joint can be used which give high esthetic by cut-back metal to axiogingival line angle and use platinum of 25µ during porcelain backing

<u>Evaluation of 45° labial bevel with a shoulder preparation (by Panno, 1986)</u>

- bevel used in crown prep to reduces margin opening and to compensate for incomplete seating of crown
- bevel less than 60° doesn't close angle
- objective: evaluate margin adaptation after cementation of 45° bevel margin compare to 80° bevel with and without application of porcelain to collar
- M&M: 20 ivorine tooth, margin is 1mm shoulder ± bevel
- 7 teeth = 45° bevel cover by porcelain to collar
- 5 teeth = 80° bevel cover by porcelain to collar
- 8 teeth = 80° bevel, metal collar
- Silver-palladium alloy used, crown cemented and embedded on resin and non-sectional
- Result:

- Cement thickness for 80° bevel and metal collar =27.6µm, 80° bevel with porcelain to margin = 29.6µm and 45° bevel with porcelain – 29.5µm
- No statistical difference between group
- Study shows most application of porcelain to margin doesn't distort metal
- Contour and color of 45° bevel is acceptable
- My opinion: 45° bevel will places deep margin which is not good for perio health, opaque at surface will be rough and not good esthetically

Butt joint vs beveled gold margin in PFM (by MClean & Wilson, J biomedical material research, 1980)

- Article discuss theory, advantages and disadvantages of bevel and butt joint margin
- Function of bevel has been described by Rosner:
  - Reduced inherent defect on casting and cementation
    - To ↓ marginal opening and microleakage, bevel should be at least 70-80° (80° = 9.9 opening, 0° = 100 opening leakage)
    - But when bevel ↑: metal become thin and during porcelain application, distortion will happen, also, difficult to make it and take impression and possible injury to biological width
  - Allow for burnishing
    - Burnishability number = Brinell hardness number / % of elongation
    - Burnishability depends on hardness and elongation
    - Moon & Modjesk: stated 10.9 for type III gold is consider high limit for burnishability (more than that is difficult0
    - Alloy use for PFM is usually harder and difficult to burnish, if high pressure apply – porcelain will crack
    - Burnishing should be done before cement set to avoid cement break and leakage
  - Protect enamel rod and ↑ circumferential retention:
    - Protect enamel rod is applicable for inlay but for crown it could be in enamel or cement
    - Retention depend on parallel wall and its surface area
- If metal collar used minimum thickness of 1mm independent of bevel to ↓ distortion

Recommended designs:

1. Flat shoulder: with round internal line angle
- Advantages: esthetic, less stress concentration, more room for porcelain and metal
- Disadvantages: different marginal fit if use porcelain butt-joint than gold collar
2. Deep champer
- Adv: less stress concentration, easy prep and provide slip joint
- Disadv: high chance of creep if no metal collar, esthetic
3. 135° shoulder: round internal line angle
- Adv: esthetic, less stress concentration, provide slip joint and disappear subgingivally
- Disadv: fit of porcelain butt margin

In vitro failure load of metal collar margins compared with porcelain facial margin of metal-ceramic crown (by Gardner et al, 1997)

- M&M: in vitro, compared metal collar margin and porcelain facial margin, 1.5mm shoulder in facial surface of maximum left canine
- Result: failure load on Newton law
    - Porcelain margin = 1890±180*N*
    - Metal collar = 1350±94*N*
- Load required to fracture porcelain face margin is significantly higher than load required to fracture metal collar margin
- The failure load of both crown exceed recorded biting force

Variable reduced metal support for colorless metal ceramic crowns: new mode for strength evaluation (by Lehnor, IJP, 1995)

- M&M: in vitro, compared 3 margin design for fracture strength
    1. Metal supported porcelain, 2. 1mm unsupported, 3. 2mm unsupported
    - 12 specimens load at 3 angle: 90°, 45° an 6°
- Result: Resistance to fracture was higher when load occur at 90° and no significant difference between 3 group (291.6mpa, 320.2mpa, 335.9mpa)
    - Significant lower fracture resistance found on all specimen at 45° and 6°
    - Colarless metal ceramic crown has up to 2mm of unsupported porcelain could resist same axial pressure of metal supported

The porcelain fused to metal restoration (by Mumford ,JPD, 1985)

- Failure to get color harmony due to:
1. Insufficient reduction for metal and porcelain
2. Use more than adequate metal
3. Use too thin layer of opaqure to mask
- *Shell* in 1962 theorized 3 factors took part in bonding
    1. Mechanical bond
    2. Van der Wals forces
    3. Chemical bonding: Ionic bond- play major role
    4. Thermal compression (from Shillinberg)

Tooth Preparation

Retention and resistance of preparation for cast restoration (by Potts, Shillinberg, JPD, 1980)

- Objective: evaluate the effect of prep designs on retention and resistance
- M&M: 5 prep design (3/4 crown ± axial groove,7/8 crown ± groove and full veneer crown with no groove
- Prep: 6mm length, 6° taper, axial groove (5.5x1mm)
- Retention test by tensile removal and resistance by compressive removal
- Result; by adding grooves and/or extension of axial surface coverage produce small increased in retention but it increase resistance value
    - Extension of axial surface from ¾ to 7/8 to full crown it double retention

A method for determining adequate resistance form of complete cast preparation (by Weed & Baez, JPD, 1984)

- Factor need to be evaluated for crown prep:
    1. Length
    2. Diameter
    3. Total occlusal convergence
- Objective: determine effect of TOC on reistance form
- M&M: 50 stainless steel crowns of TOC of 10, 13, 16, 19, and 22°
- Result: when length and diameter of tooth prep is disturb, resistance form will be improve by ↓taper or TOC
    - E.g: for same width but height change, when you have 3mm height you need maximum of 8° TOC but when length is 4mm = maximum of 12°TOC

The relationship between prep convergence and retention of extracoronal restorations (by Wilson and Chan, JPD, 1994)

- Obj: study effect of TOC (0-44°) on retention of crown
- Result: 6-12° convergence (TOC=12-24°) is optimum for retention of crown
    - >25° of TOC, are less retention
    - >6° of convergence is not desirable even if it is clinically achievable (difficult to seat and cement escape)

Factors influence retention of cemented gold casting (by Kaufman, Coelho & Colin, JPD, 1961)

- Obj: study effect of height, TOC, surface area and opening (vent hole) of cast in retention
- M&M: height of 4.7 and 10mm, TOC of 11, 5, 10, 15 and 20°
- Diameter from .175 - .375 inch at internal of .025"
- Result:
    1. Difficult to seat cast and to escape cement when TOC reach parallelism
    2. Increased retention in less mark when ↑height
    3. Linear ↑ in retention by ↑ diameter

4. In convergent prep, gingival portion has greater proportion to retention than occlusal part
5. By venting crown, 19 to 32% increased on retention

The effect of tooth prep height and diameter on resistance of complete crown to fatigue loading (by Wiskott et al, IJP, 1997)

- Linear relation between resistance and abutment height and width
- Resistance ↑ by using composite resin follow by GIC

Fundamental of extracoronal tooth prep: part 1: retention and resistance form (Gilboe & Teteruck, JPD, 1974)

- Retention counteracts tensile stress and resistance counteract shearing stress
- Principles of retention and resistance form:
    1. Primary: axial surface
    2. Secndary: grooves, box, pinhole and combination
- Parallelism is most effective factor in retention and resistance
- Short prep: keep it as parallel as possible + secondary factor

The effectiveness of pins with complete cast metal crown (by Chan, JPD, 1984)

- Pin increased retention for short, malposition and malformed tooth
- Pin increased retention by 79.4% for 30° taper crown
- Pin increased retention by 32.5% for 7° taper crown

Retentive properties of parallel pin restoration (Moffa & Philip. 1967)

- Threaded wrought pin are more retentive than smooth cast pin
- Direct relation between number and length of pin and retention
- 0.75mm diameter pin has greatest retention than .55 and .65mm

Photoelastic analysis of inlay and onlay prep (Fisher & Shillingberg)

- Indication for inlay:
    1. Difficult to control moist in subgingival and esthetic is concern
    2. Cavity is large for direct restoration
- Obj: evaluate stress distribution of seven prep design in cast gold restoration: onlay±bevel, modify onlay, onlay and inlay on cement base, inlay, onlay on endo Tx tooth
- Result: stress will be minimized by covering cusp and wedging effect will be avoided

Influence of prep factor on retention and resistance (Kisomot & Shillingberg, JPD, 1983, part 1)

- Obj: 4 prep design study for retention and resistance
- M&M: 4 prep design: proximal flares, isthmus and flares, boxes, boxes and isthmus
- Result:
    1. High retention and resistance when isthmus and boxes are incorporated
    2. No difference in resistance for boxes and isthmus alone
    3. Boxes more effective in ↑ retention than isthmus

Part II

- M&M: ¾ crown design compared for retention and reistance
- Prep design: lingual groove, V groove, 4 groove, boxes
- Result:
    1. Prep with boxes or 4 groove are most retentive of ¾ design
    2. Lingual placement of proximal groove enhance retention
    3. V shaped groove are least resistant to force (not good)

<u>Restorative Contour</u>

- Contour: outline especially of a curving or irregular figure
- Emergence profile: contour of tooth or restoration
- Main 3 theory of axial contour:
    1. Food deflection theory (Wheeler, 1961): proposed convexity should be created in cervical third and this will deflect food from gingiva
    2. Muscle action theory (Herland & Morris, 1962): muscle molding and cleaning rather than food impaction – axial contour design based on mastication
    3. Anatomic theory (Kraus, 1969); anatomic and biologic concept of tooth contour which simulated natural healthy self-protected tooth
- *Perel*: compare under and over contour in dogs = over produce inflammation and under is not
- *Yuodelis*: from literature and clinical case = greater degree of bulge and more plaque, flatter contour – less plaque
- Final restoration after crown length or prior surgery should follow root contour not crown contour
- *Parkinson*: there is an ↑ in FL dimension of PFM and cast crown compare with control and ↑ in plaque retention
- *Ehrlich*: compare width before and after restoration and he found that an ↑ of BL width of .7-1mm is clinically acceptable and any sign of Gi inflammation is because of margin not width
- *Essimana*: margin should placed in tooth surface which are fully exposed to cleansing action

- **Gingival Esthetic:**
    - *Wagman*: subgingival contour should be slight convex and not exceed ½ thickness of Gi at height of attachment
    - *Jameson*: review shows ↑ inflammation of subgingival margin, avoid over contour, follow fluting areas in furcation
    - *Goodacre*: discuss method of optimize Gi appearance and height before treatment and minimize Gi trauma
- Which chemical in retraction cord cause unacceptable Gi injury? **Zinc Chloride**
- <u>Emergence profile: described by *Stein & Kuwata* as part of axial contour extend from base of Gi sulcus past free margin of gingiva to height of contour</u>
    - Gingival 1/3 is straight to 15 degree concave
- <u>Interproximal tooth contact by *Eissmann*</u>

1. Contribute to stability of dental arch
2. Prevent food impaction
3. OG length of contact may affect food retention
4. Cosmetic and phonetic consideration
5. Protect interdental papillae

Research review interproximal embrasure or interdental space
Skierov: well contour provitional in adequate tooth preparation = establich healthy embrasion
Linkow: most important function of proximal contact = to protect interdental papillae

Pontic

- **Physiologic pontic contour – designs with following boundaries (Eissman)**
  1. Edentulous space
  2. Opposing occlusal surface
  3. Musculation of tongue
  4. Musculation of cheek and lip
- Three pontic design
  1. Saddle: maximum comfort and support, unacceptable from hygiene point of view
  2. Modify saddle: compromise, more obtuse embrasure than ridge lap
  3. Ridge lap: minimum tissue contact with acceptable esthetic and proper cheek support and questionable lingual design (little support to tongue)
- Three accepted design for non-molar pontic
  1. Sanitary-contour pontic
  2. Saddle pontic – violate hygiene
  3. Sanitary pontic – favorable price
- Furcation involvement use as abutment by Hurzeler
- Ten rules for develop crown contour in restoration by Bursh, 1971
  1. FL crown no more than 1mm larger than FL width at CEJ
  2. Facial contour: no bulge more than ½ mm beyond CEJ
  3. Lingual contour: greater convexity not more than .55mm lingually
  4. Proximal contact in acclusal 1/3 of crown and buccal to central fossa except between maxillary molars (at junction of occlusal 1/3 and middle 1/3, and contact contact in middle 1/3)
  5. Proximal surface between marginal ridge and CEJ are flat or slight concave
  6. Axial transitional line is straight between proximal contact point and CEJ
  7. Marginal ridge at same height and lingual embrasion is large
  8. Crown margin is subgingival except for esthetic, caries, R&R form, sensitively
  9. Thickness of restoration subgingivally to provide support to gingival unit
  10. Crown margin no enchroah biological width

Pontic Designs

***Stein, 1966*: based on clinical and micropoligical method**

1. >33% of all pontic upon examination revealed some evidence of inflammation
2. 95% of all pontic area after removal found an inflammation
3. Ideal design for posterior = modified ridge lap
   Anterior = lap facing with pinpoint contact in facial slope of residual ridge
4. No difference found between porcelain, gold or acrylic = it should be smooth, confex
5. Discuss different design: ridge lap, modified ridge lap, sanitary, bullet lap facing

Perel, 1972: modify sanitrary pontic = concave mesiodistally and convex BL, wide connection resist flex

Henry: no evidence to show glazed porcelain is superior to unglazed porcelain or polished gold as for as tissue tolerance even though glazed porcelain is superior in esthetic and ease of cleaning

Clayton, 1970: roughness test – glazed porcelain > polished acrylic = polished gold

- All material shows plaque accumulation and pontic should be as smooth as possible

Hood & Craig, 1975: photoelastic study shows high shear stress of conventional > sanitary > modify sanitary

- Modify sanitary reduce stress at connection and required less gold

Becker: modify ridge lap = posterior with open embrasure, minimum tissue contact and gingival health
Lap facing = anterior with open embrasure, minimum tissue contact and gingival health

Tripodakis & Constantinidas: tissue response under hyperpasm convex pontic when patient floss underneath doesn't promote inflammation

Mortin & Natkin, 1990: subpontic hyprostoses due to local irritation, functional stress and genetic factor

- Common site is in premolar and molar region

Framework Design

Hobo & Shillingberg, 1973: PFM combine strength and accuracy of gold with appearance of porcelain

Land, 1887: develop concept of PFM using swedge platinum reinforce

A. Material: 4 factors affecting sucess of PFM:
   1. Porcelain-metal bond: bond strength is main factor of ↑ popularity of PFM which will provide a material with greater strength and resistance to fracture
      - Four form of bond: vander walls, chemical, mechanical and compression
   2. Difference between melting opoint of metal and fusing temperature of porcelain
      - Minimum difference is 300-500°F – to avoid solding problem
   3. Difference in CTE – gold have high CTE of $14x10^{-6}$°C and porcelain has low CTE $2.4x1^{-6}$°C
      - A difference of $1.7x10^{-6}$°C would produce sufficient shear strength to cause failure
      - Optimum difference would be <$1x10^{-6}$°C
      - To correct that:
         - ↑ CTE of porcelain to $7\text{-}8x10^{-6}$°C by adding alkali (litium carbonate)
         - ↓ CTE of metal to by $7\text{-}8x10^{-6}$°C adding platinum or palladium
   4. Metal strength: Metal deformation cause failure of porcelain and to solve that
         - Metal must be hard as practical (gold after casting has 130-160 brittle hardness number)
         - Metal coping must be design to insure optimum bulk of rigidity

B. Preparation design: enough tooth structure must be removed to provide adequate space for porcelain for pleasing appearance and bulk of metal for adequate strength – 1.2mm fabricated reduction
      - Used bevel shoulder labially and champer margin lingually and interproximally

C. Coping design: 3 factors to be consider
   a. Extention of area covered by porcelain
   b. Bulk of metal substructure
   c. Placement of occlusal contact

- Porcelain should be kept at minimum thickness and support by rigid metal is strongest (.3-.15mm thick)
- Junction of porcelain to metal should be right angle to avoid burnishing of metal and fracture of porcelain

D. Occlusal contact: contact in metal has greater precision and less mean of opposing

- Contact of the anterior should have:
   - Centric contact should at least 2mm from junction
   - Junction shouldn’t extend too far incisally. It will destroy incisal translucency and weaken porcelain
- If contact in porcelain = metal collar should be 3mm height

***Miller, 1977*: framework design in CMR**

- Metal design should provide even thickness of porcelain and has proximal strength for support

***Laus & Yamada*: framework design and *Marrow, Rudd & Eissmann*, Dental laboratory procedure, 1980**

- Framework design should
  1. Provide strength for restoration
  2. Provide support for restoration
  3. Allow development of esthetic, contour and occlusion

Chou, *1986*: use microscope for trimming to final fitting to produce good casting

Fish, *1983*: angle between porcelain and metal should be ≥ 90 to avoid failure (not 60)

Porcelains

***Anusavia & Lee, 1989*:** underfire ceramic caused slight increase in fracture toughness (<30° C)

***Denry & Rosenstiel*:** ion exchange (potassium for sodium ion) will put metal under compression stress = ↑flexural strength

***Newitter, 1982*:** use finishing wheel follow by porcelain finishing paste produce smooth surface of unglazed porcelain

***Jones, 1985*:** porcelain disc get damage by exposed to acidulated phosphate flouride gel
- Use for patient has PFM = 4% nitrate fluoride or sodium fluoride

Jacobs & Goodacre, 1987: no significant difference in chrome or value between Ni-Cr, Au-Pd-Pt and high palladium alloy
- Visual and spectrophotometric difference were noted when different thickness of dentin (.5, 1. 1.5mm)
- No difference between 1 and 1.5mm thickness – use 1mm thickness produce a good esthetic
- Examination with anomalous color vision has ability to detect value difference but not chromatic color

Monsenego, 1993: fluorescence of dental porcelain

Studel, 1991: shows that natural teeth emit strong blue fluorescence under ultraviolet beams
- This make teeth brighter and whiter in daylight – fluorescence spectrum of natural teeth is 420 nm
- This study shows shade guide didn't give fluorescence close to natural teeth

Frejlich & Goodacre, 1992: a technique of apply opaque over metal post score

Sorenson, 1988: describe technique of applying porcelain for PFM
- Area at margin or at middle due to under preparation - opaquer will produce high light relection = ↑valum and ↓chrome

Zeghir & Denry, 1992: ion exchange ↑ resistance to crack propagation with little effect on apparent surface hardness

Mclean, 1978: describe technique of forming new metal ceramic crown by using tin oxide coating and platinum foil bond to aluminous porcelain and form inner protection skin

Prince & Donovan: describe a technique of mix wax with porcelain for all porcelain labial margin mix wax ration of 6:1 and can be used with early 3 technique describe

1. Platinum foil
2. Refractory die
3. Direct left technique

Philip (page 589)

Metal-ceramic thermal compatibility

- Thermal compatibility: ability of metal and veneering porcelain to contact at similar rate and porcelain has low thermal contraction than alloy
- Mismatch of thermal contraction lead to crack propagation in porcelain veneer
- Transient stress: instantaneous stress at given temperature during casting cycle
- Residual stress: stress distribution at room temperature
- Fracture toughness: resist of material to rapid crack propagation

Methods of strengthening ceramics:

-Minimize effect of stress increase by one or more of the following (↑fracture resistance

1. select stronger porcelain

2. develop residual compression strength by

a. mismatch of COTE&C between metal and porcelain

b. thermal tempering: rapid cooling of porcelain putt outer surface in compression stress and inner (molten) core in tensile stress

3. minimize number of firing cycels

- ↑ fining cycles - ↑COTE &C of leucite beyond metal – crack formation

4. minimize tensile stress by optimum design of ceramic prosthesis

5. ion exchange (chemical tempering)

- Na containing glass placed on bath of molten potassium nitrate – Ka exchange with Na (Ka is 35% longer than Na) create large residual compression stress

6. dispersion strengthening is reinforce ceramic with dispersed phase" leucite" of different material (e.g: leucite, lithium disilicate, aluminum, Zr) able to stop crack

7. transformation toughening: Zr transfer from t-m (3% volume increased)

Alloys

***Carr, 1993*: 5 high palladium alloy tested**

- Heat treatment simulate porcelain fining cycle cause ↓ hardness with small clinical significant

***Kelly, 1983*: non precious alloy in fixed Prosth:**

1. High fusing temperature
2. High sag resistance than precious alloy – less marginal distortion
3. Less thermal conductivity (Ni is 4x less than gold)
4. ↑ hardness and strength – difficult to polish
5. High chemical reactivity under casting condition
6. Porcelain bonding- debating = thick oxide layer

Hamaguchi, 1982: compare marginal distortion of 4 margin design, champer or shoulder ± bevel

- No significant difference in implant distortion between 4 designs (two metal gold or white gold ceramic)

Campbell & Pelletier, 1992: .8mm facial metal collar had significant less distortion than .1 or .4mm

- All of distortion occurred during first thermal cycling of alloy (oxidation cycle)

Compagni & Faucher, 1984: sprue diameter should match casting volume (large pattern = thick sprue)

- When reservoir used = no intermediate sprue should be used

***Campbell & Pelletier, 1992*:**

- all distortion occurs during thermal cycling (oxidation)
- specimen had cold work after investing – finishing green and white stone – air abraded 50µm AlO_2 – thermal cycling (oxidation) has more distortion than specimens under initial thermal cycling completed after devesting and after cold work
- primary cause of thermal cyclic distortion was release casting induce stresses coupled with synergistic effect of cold working
- try in of cast should be after initial thermal cycling since all distortion occur in oxidation phase
- two methods describe to ↓ distortion:
    - thermal cycling at oxidation temperature immediately after divestment with no cold work (no manipulation)
    - heat treatment of casting in the investment for 20 minutes at oxidation temperature before divestment

Byrne & Goodacre, 1986: casting occur of silver after high palladium alloys was equivalent to gold-platinum-palladium alloy with marginal opening < 50µm as described by Fusayama

***Covington*, 1985**: high dissolution of Nickel and beryllium leakage and hazard effective patient, dentist and technician

Beryman **–** spectrophotometry shows nickel release and accumulation in surrounding tissue

Metal – Ceramic : "Patric Naylor Textbook"

Chapter 2

Porcelain: non-crystalline glasses by Mclean, 1979

Feldspallic porcelain: because major component is feldspar

Classification of dental porcelain:

- based on fusing temperature range (Philip, 1982)
  - high fusing (1288 to 1371℃) – denture tooth
  - medium fusing (1093 to 1260℃) - prefab pontic
  - low fusing (871 to 1066℃ or 1600 to 1950℃) – PFM

- chemical component of porcelain: it include crystalline mineral such as:
  1. Feldspar: form glass matrix (K_2O-Al2O_3- 6 SiO_2 & Na_2O-Al_2-6 SiO_2)
     - It is mix of potash feldspar and sodium feldspar
     - Potash: translucent quality
     - Control flow of porcelain
     - Na feldspar: low fusing temperature
  2. Quartz (SiO2)
     - Has high fusing temperature
     - Act as framework and stabilize mass
     - Strength porcelain
  3. Kaolin "clay"
     - Act as binder and ↑ mold ability of unfixed porcelain
     - Kaolin is opaque and not found in enamel
  4. Alumina (Al2O3)
     - Hardest and strongest oxide
     - Glass modifier (K, Na, Ca) oxides add to raise CTE
- To create bottle powder: crystalline mineral mix with glass modifier – fire at high temperature – quench in water – molten glass shatters in contact with cold water and produce Frits (non-crystalline solids)
- Fritting; term describe process of melt, blend, requenching glass to produce non-crystalline powder
- Devitrification: recrystalline of structure due to disruption O2 bond and produce cloudy appearance

Opaque Porcelain:

- It contains insoluble oxide to make it opaque (e.g. SnO_2, TiO_2, ZrO_2, ZnO_2)
- 8-15% metallic oxide
  1. Mask metal color
  2. Initial shade
  3. Wet metal surface and establish bond
- .2mm to .5mm maximum (ideal .2-.3mm) depends on metal color

Body Porcelain: 4 type of body

1. Dentin: major determinant of shade and bulk of porcelain buildup
2. Enamel (incisal porcelain): violet to gray range, true and illusion translucency
3. Translucent: it is not transparent (not allow all light to pass)
- Give translucency without modify body color
4. Modifiers: metal oxide pigments e.g black by iron oxide, blue: cobalt oxide

Glaze:

- Colorless low fusion porcelain
- Fill porosotive and produce glassy appearance
- Internal staining at body more esthetic than enternal staining

<u>Role of some elements in metal</u>:

Aluminum : lower melting range and influence oxide formation
Beryllium: lower melting range, improve castability and polishability, control oxide form
Boron: deoxidizer, hardening agent
Chromium: hardening agent, corrosion resistance to its passivation ratio
Cobalt: strengthen and ↑CTE if added to high Pd alloy
Copper: lower melting range, hardening and strengthening, help to form oxide layer
Gallium: ↑CTE
Gold: corrosion and tarnish resistance, ↑ melting range, impose workability and color (yellow)
Indium: oxide scavenger, ↓ melting range, oxide form in nongold alloy
Iridium: grain refiner, tarnish resistance
Iron: oxide former and hardening
Manganese: O2 scavanger and hardening
Nickel: resist corrosion and has good CTE like gold

- Sensitize and allegyical (female sensitivity from 9-31.9%)

Palladium: ↑ strength and hardness, corrosion and tarnish resistance

- ↑ melting range and improve sag resistance
- Strong whitening effect

Palatinum: same as Pd
Ruthenium: like Iridium
Silicon: oxide scavenger and hardening agent like Mn
Silver: ↓ melting range, control CTE

- Discolored of porcelain, high affinity to O_2 absorption (porosity)
- Zinc and Iridium add to silver alloy to control O_2 absorption

Tin: ↓ melting range, hardening, O_2 former
Titanium: ↓ meting range and improve castability, hardness and influence O_2 formation
Zinc: ↓ melting range, O_2 scavanger

Chapter 4

- Porcelain-metal junction should be at least 1.5mm (Rosenstick, 1988) or 2mm (Dykena, 1986) from centice contract
- Minimum of 1mm and maximum 2mm of porcelain thickness since porcelain should be supported because porcelain strong under compression
- Minimum thickness of metal is .3mm and .2mm for base metal (Weiss, 1977)
- No maximum limit for metal it based on messing part of tooth
- Contact in centric of anterior teeth in mutally proctected occlusion should be 25µm or 2 thickness of shimstock (Shillingberg)
- Solder gab of .3mm (solder strip)
- Build porcelain 10-15% larger and when it will shrink
- More light = high value
- Submeter color mark in extrinsic staining (pigments)
- Natural glaze "self glaze": fired to a temp equal or slight higher than original firing temp
- Overglazed: low fusion porcelain heat 20-60°C lower than body temperature

ROSENSTIEL: Chapter 17, p 431

Requirements of cast "working"

1. Reproduce prepared and unprepared tooth
2. Teeth adjacanet in free of void
3. Reproduce soft tissue
4. Allow articulation precisely for IG

Requirement for die:

1. Exactly reproduce prepared teeth
2. No bubbles or voids in any surface
3. .5 – 1mm of unprepared tooth visible below margin – axial trimming
4. Adequate access to margin

Material for working cast or die material

1. Gypsium
   2 requirement are critical of cast and die material
   a. Dimentional accuracy
   b. Resistance to abrasion

- Calcination: hemihydration of gypsium is manufactured by heating the dihydrate under control codition to drive off some water of crystallization
- Improve physical properties of gypsium product
- Type 4 and 5 able to reproduce 20µm of groove ADA
- Greatest disadvantages of gypsium is poor resistance to abrasion to overcome: 1. Use gypsium hardener (colloid silicon) 2. Use low viscosity resin (cyanoacrylate)

2. Resin: epoxy resin or polyurethane
- Use it to overcome low strength and abrasion resistance of die stone
- Amount of shrinkage is equal to expansion of gypsium – tight fit crown
- Detail reproduction is better than gypsium
- No compatible with polysulfide and hydrocolloid = use with PVS and polyether
3. Electroplated die
- Use in the past to overcome poor abrasion resistance of gypsium
- Deposit coat of pure silver or copper on impression – then immers in electroplating path
- Compatible with many material – only used with polysulfide

Advantage of use material (type V)
1. Dimentional accurate
2. Strong
3. Abrasion resistance
4. Compatible with impression use and separating agent for waxing up
5. Reproduce detail accurately
6. Color is contrast with wax

Disadvantages: ↑ expansion, low abrasion resistance

Methods
A. Removable Die
- Die is component of master cast and can be left from cast to facilitate access
- Precise relocation of die
- If single dowel used should have at least on flat surface for antiresistance
- Two ways: 1. Dowel place in die before it set, 2. Dowel place in die by drilling – pindex system
- Serrano et al, 1998: compare 4 techniques
    - Similar accuracy of 4 removable die system
    - Brass dowel pins produce least O-G reseating discrepancy
    - Pindex system produce least horizontal movement

B. Solid cast with individual die: 2 pour
C. Alternative technique:
- *Diolok Technique*: use special articulated tray for pouring - no pins
- DVA Model system and Zeiser model system – use precise drill and special base plate that are aligned and drilled to provide die removal

Choice:
1. Technician and dentist familiar with technique
2. Buccal and precise relocation

Technique:
1. Place dowel in impression by paper pins or sticky wax or prefabricated wire tube
2. Place water before powder to ↓ bubbles, vacuum mix
3. Guide material with instrument to cast by tilting impression
4. First layer – fill impression and of dowel cover by stone
5. Allow stone to set for minimum of 30 minutes
6. Coat it under separating mechanism (10% Na silicate)

7. Pour 2nd layer to act as base and relax dowel – tip of dowel should be exposed or if need should be cove by wax to facilitate removal
- For pindex system – short pin is highest

Verify mounting:
1. Compare material in patient mouth or in cast (Shimstock)
2. Take 2nd record and compare it use split cast technique
3. Use veri-check

<u>Wax Patter – Lost Wax Technique</u>
Chapter 18

<u>Correction of Defects</u>
1. Intra-orally: block it out use any material (GIC)
2. Extra-orally in working cast: use Zn Phosphate or photopoly resin or autopolymerizing resin (defect should be at least 1mm from margin)

<u>Cement space</u>:
- Internal relief of 20-40µm per wall is ideal for provided room for luting agent and allow seating of crown (Eames & Fusyama)
- ↑ cement space by:
  - Shrinkage of pvs material
  - Die spacer
  - Stone expansion
  - Expansion of investment material

<u>Die Spacer</u>: for adequate marginal adaptation, band of 1mm must left in parallel to prevent leakage and distortion of cement (2 coat of true-fit - 26µm)

<u>Marking margin</u>: use colored pencil in contrast with color of wax (red pencil for green wax)

<u>Hardening agent</u>: low viscosity cyanoacrylate resin immediate blown dry

Wax

Inlay casting wax (name use for all pattern cast)

1. Paraffin (40-60%): main compound
2. Dammar resin (↓ flaking)
3. Carnauba, curesin, candelillawax (raise melting temeperature) or beeswax

ADA classify waxes in two types

1. Type I: medium wax – use for intraoral direct technique
2. Type II: soft wax – use for indirect fabrication

- Occlusal indicator powder – Zn stearate
- Heat shanking of instrument to control flow

Technique:

Lubricate die with clean brush – internal surface (melt or dipped pot)

- Remove and evaluate – proximal surface – axial surface – occlusal – marginal finish
- Inspect on microscope
- Contact area: large – difficult plaque control, small – unstable and drifting
- Proximal contact: all on occlusal 1/3 of crown except between mx molars at middle 1/3
    - Mx at buccal 1/3 except molar at middle 1/3
    - Mn at center
- Height of contour: at gingival 1/3 except mn molars in lingual surface at middle 1/3
- Emergence profile: (Stein & Kuawati) – flat or slight concave
- Each contact has 4 embrasures – G, O, L and B
- Most adult with Cl I occlusion of unwarn teeth has cusp margin edge scheme – cusp – fossa present only in Cl II malocclusion
- When M-D relation favor use cusp-fossa relation since
    - Prevent food impaction
    - Force at long xaxis
    - Stability (tipod contact)
- Evaluate curve of spree: Mn cusp get taller when go distally, Mx cusp get shorter when go distally
    - Curve of Wilson: centric cusp tall than noncentric cusp

Wax Cut-back: provide even thickness of 1mm for porcelain with maximum support – proximal struts and contact in porcelain (esthetic and hygiene)

Connector:

1. Esthetic: as highest as possible
2. Mechanical: as large as possible
3. Biologic: as small as possible away from Gi tissue

Metal Selection

Chapter 19

- Metal structure must be design to put porcelain under compression and tensile stress
- To avoid fracture: no more than 2mm of porcelain and minimum of 1mm for esthetic pleasing restoration
- At porcelain metal interface: at least .5mm thick porcelain
- At least 1.5mm from center contact to prevent porcelain fracture from deformation of metal
- Porcelain-metal interface should be 90° butt-joint

Selection based on:

- Mechanical properties: modulus of elasticity, yield strength, tensile strength, hardness, thermal contraction and expansion (difference of $.5x10^{-6}$°C)
- High nobel alloy: Au – Pt – Pd, Au – Pd – Ag, Au – Pd
- Nobel metal: Pd – Ag, Pd – Cu – Ga, Pd – Ga
- Base Metal: Ni – Cr, Co – Cr

<u>Pontic Design</u>
Chapter 20

Requirement:

1. Biologic: cleansable, no pressure on ridge, access to abutment
2. Mechanical: Rigid, strong
3. Esthetic – look-like tooth, grow out of ridge, support space for porcelain pontic design: 1. sanitary/hygienic (2mm space), 2. saddle-ridge lap, 3. Conical, 4. Modify ridge lap, 5. Ovate esthetic, biological)

<u>Investing and Casting</u>
Chapter 22

Sprue: 6mm length by 2.5mm for Molars 2mm for PM's requirement

1. Allow wax to escape
2. Allow molten metal to flow
3. Maintain heat long than mold to componsate shrinkage

- Location: bulkies part of pattern – not in functional cusp
- Attachment: smooth
- Venting: auxillary sprue or vents to improve casting of this pattern – gas escape
- Crucible former: made of rubber
- Sprue multiple unit: 1. Rubber bar 2. Separate sprue

A. Casting ring and liner

- Asbestos use in past but it has health hazard
- Wet liner (celloid) cause ↑ hygrospic expansion and dry also ↑ expansion by absorption of water from mix

B. Ringless: paper or plastic allow unrestricted expansion

INVESTMENT

1. Gypsium

- Gypsium is binder and cristobalite as quartz as refracting material
- Gypsium is not stable chemically above 650°C (1200°F)
- Use for convent ioned type II, III, IV gold alloy
- Has 3 expansion types
  - a. Setting expansion: affected by pattern, ring use and compressibility of linear
    - W/P ratio - ↑ ratio = ↓ expansion
  - b. Hygroscopic expansion:
    - Submerging ring after initial set of investment in water of 37°C (100°F) for up to 1 hour
    - Wet ring liner also load to ↑ expansion (hygroscopic)
  - c. Thermal expansion:
    - As the mold is heated to eliminate wax
    - Silica is responsible for that
    - Cristobalite change from α – β above 200°C
    - Quartz transform >575°C

2. Phosphate bonded investment

- Most metal ceramic fused at ≈ 1200°C (2300°F)
- Binder in MgO_2 or ammonium phosphate
- It is chemically stable >650°C
- Can be used with special liquid (colloidal silica) - ↑ Liquid - ↑ expansion

Selection of casting alloy based on:

1. Intended use: Type I – inlay, type II – olay, type III – crown and FPD, type IV – RPD, porcelain
2. Physical properties: classify based on hardness as ADA to type I – soft, II – medium, III – hard, IV – extra hard
- High nobel has similar hardness like Type III and base metal binder than type IV
3. Color: gold (yellow) prefer more than silver color
4. Composition: at least 3main ingredient
- No significant difference in tarnish resistance of high (77%) and low gold (27.6%)
5. Cost: financial capability of patient
6. Clinical performance: biological (no irritation or corrosion) and mechanical
7. Laboratory performance: casting accuracy, surface roughness, strength sag resistance, M.C bond
- Ni – Cr has lower casting accuracy and greater surface roughness than gold but Ni – Cr has higher strength and surface resistance

Technique:

- Investment set for 1H – remove crucible former and metal sprue
- Wax elimination – heat at 200°C for 30° m
- Follow manufacturer recommendation but heat can ↑ to 650° if hygroscopic technique used – 1H bench set – casting machine given 4 clockwise turn and lock in position with pin- place metal in machine – gas-oxygen torch (6g – premolar Ant, Ag – molar, 12g – pontic) – melt it first
- Place investment – control heating – release pin – centrifugal force causing melt to mold cavity
- Wait until red glow disappear – casting ring placed under running water than in rubber bowl
- Picking in 50% hydrochloric acid to remove casting impulse and oxide
- Inspect casting in microscope before try out in die

Deffects on casting

1. Rough cast: improper wax finish, improper W/P ratio, excess surfactant
2. Nodule: large – air trapped during investing
   Multiple – inadequate vacuum during investment, improper brush technique – lack surfactant
3. Fins: cracks in investment fill with molten metal because - ↑W/P ratio – pattern near edge of investment –too rapid heating
4. Incomplete casting – thin wax pattern less than .3mm
   - Inadequate metal or heating – inadequate wax elimination
5. Porosity: suck back – metal in sprue solidify before mold metal cause: a. narrow or long sprue, b. improper pattern position
- Back pressure porosity – air pressure in mold when molten metal enter
6. Marginal discrepancy: wax pattern distortion, uneven expansion

<u>Metal-Ceramic Restoration</u>

Chapter 24

- Metal should have sufficient thickness to prevent distortion at firing
    - Minimum of .3mm for nobel metal and .2mm for base metal
- Investment removal:
    - Remove with ultrasonic with airborne particle or with steam
    - Concise hydrofluoric acid to remove silica for phosphate bonded investment
- Oxide removal: either use acid or air abrasion
- Metal finishing:
    - Should be finish in one direction to avoid debris trap – rubber wheel and carbide bur
    - Finish expose metal to rubber wheel first then finish surface with , – use stone and tungeston carbide bur
    - Air abrasion and protect margin by soft wax
- Oxidizing: to establish chemical bond between M&P, control oxide layer must be created in metal surface – place coping in porcelain furnace to temp exceed firing temperature of porcelain will produce oxide element to surface (e.g. tin, indirium, iron, gallium for nobel metal
    - Hold it for 2o min (follow manufacturer)
- For base metal alloy - ↓ excess oxide layer (use air abrasion or HFL)

Porcelain

- Classify to high (>1290°C), medium and low (870-1070°C)
- Metal ceramic veneer fixed in range of 950-1020°C
- Powder can be used with water or water based glycerin to form base of workable consisting several condensation technique (vibrating or blotting)
- 27 – 45% volumetric shrinkage (by Rasmussen, 1997)

Opaque

- Two function: mask alloy color and responsible for bond
- Has more oxide to mask alloy color (tin, titanium and ZrO_2)

Body

- Has some translucent and provide bulk of shack

Incisal

- Usually translucent

** degassing is improper term used because procedure propose us to oxidize metal surface
** use airborne particle to create surface irregulation to provide mechanical interlooking

Possible Mode of Fracture of metal-porcelain (Obrien)

1. Adhesive: M-P, Mo-P, Mo-M
2. Cohesive: P-P, Mo-Mo, M-M

- Opaquer thickness is not exceed .1mmand one firing cycle and it could be more of enough space is present and to mask color
- Minimize cycle to prevent devitrofication and cloudy appearance (3-5 cycle)

Porcelain labial margin teeth:

1. Platinum foil: good marginal adaptaion, smooth surface, time consuming
2. Porcelain: wax technique – separatensity - less accurate fit
3. Direct lift: less time – porcelain should be needed and rough ways

Common reason for failure of MC restoration

1. Fracture at bisque backe
    a. improper condensation
    b. poor framework design
    c. improper moisture control
    d. incompatible M-C combination
2. Bubbles
    a. Too many firing
    b. Poor metal prep
    c. Poor casting technique
    d. Moisture control
3. Unsatisfactory appearance
    a. Too many firing
    b. Opaque is too lack
    c. Inadequate reduction
4. Clinical fracture
    a. Poor framework design
    b. Improper metal preparation
    c. Too close from C-O stop

<u>Resin Bonded FPD</u>

Chapter 26

1. Cast perforated resin-relieved FPD: mechanical retention (by Rochette)
2. Etched cast resin-relieved FPD: micromechanical retention = Maryland bridge
3. Macroscopic mechanical resin-relieved FPD: Virginia bridge =lost salt crystal
4. Chemical bonded resin-relieved FPD: adhesion bridge

<u>Sequence of Evaluation</u>

Chapter 30

1. Proximal contact
2. Marginal integrity
3. Stability (no rocking or rotating)
4. Occlusion
5. Characterization and glazing

- Rosenstail use plaster to register location before elastomeric pick up impression

Luting Agent
Chapter 31

- Zn oxide = eugenol
- Biocompatible = excellent seal
- Adhesive resin: high retention strength, adhesive and low solubility
- Disadv: film thickness, history of use, moisture control
- Studies:
    - Low microleakage: White (in vitro and in vivo), Tjan et al
    - Crown retention: adhesion resin had consisted greater retention than Zn Ph (Tjan & Li, Mausner et al, Ayed et al)
    - Compression strength: higher for resin cement (White & Yu, Miyamoto et al)

Metal (my case, 550 SL)

1. 52% gold
2. 35% palladium (Pd)
3. 5.1% silver (Ag)
4. 6.5% indium (In)
5. 1.5% gallum (Ga)
6. .05% lithium
7. .05% Ru

Properties:

- Vickers hardness 285
- Melting range 2085-2335°F (1140°C)
- Casting temperature 2450°F(1345°C)
- Density 14.1g/cm^3
- Elongation 15%

For CD – metal framewok
Vitallium
Co – 63.1% ↑ fatigue resistance hardness and modulus of elasticity
Cr – 28.5% corrosion and tarnish resistance
Mo – 6% Molybdenum

Casting

Studies on the wear of porcelain, enamel or gold (By Monasky & Taylor, 1971)

- Define correlation between porcelain roughness and result rate of tooth wear. Both glazing and polishing porcelain reduce wear.
- Only combination of polishing and glazing reduce wear as equivalent to tooth.
- Glazing of rough porcelain not enough to decrease wear.
- Of glazes broke → ground surface of porcelain should be polish.

Topography and distortion of trace surface metal (SN, IN) (By Stewart, JPD, 1977)

- Tin and Indium added to gold alloy (</%) to ↑ bond strength of porcelain to metal (tin and indium oxich ↑ bond to silicon in porcelain)
- Tin and indium deposit in alloy surface by heating of alloy, use HF acid will remove erosive particle and weak bond.
- Careful treatment of alloy to maintain IN and SN at surface.

Measurement of distortion in FPD result from degassing (By Bryant & Nicholls, JPD 1979)

- Degassing & process to eliminate impurities from metal. This performed by heating framework in furnace to 1900 °F (1038 °C) & hold this temperature for few minutes. At this temperature, absorb gas are released from metal & surface container burned off. The number of bubble formed at PFM surface ↓ with ↑ temperature time of degassing but high temperature could cause plastic flow of metal.
- Accumulation amount of distortion from soldering, degassing and porcelain firing will be clinically significant of precaution not followed.

Distortion related to marginal design in PFM restoration: (By Faucer & Nicholls, JPD 1980)

- Shoulder ± level design s had less distortion than chamfer.
- Labial margin distortion and lingually when seating it flex & porcelain chip.

Distortion of ceramic metal FPD during firing cycle (By Bridger & Nicholls, JPD 1981)

- The greatest distortion changes occur during degassing stage & final glaze stage of porcelain firing cycle (due to high temp)
- Metal rebound from distortion at glazing after removal of porcelain.

The effect of repeated firing & strength on marginal distortion in two ceramic metal system (Buchanan, 1981)

- Marginal opening in metal mark by high strength metal (Non-precious) increase more than low strength due to thick oxide layer & degassing change.

The effects of enamel wear on metal-porcelain interface (By Fisher, JPD 1983)

- Acute angel of metal (60°) at metal porcelain interface was more conductive to crack formation more than 90 & 135°
- Porcelain is less resistance than metal when opposing enamel.

High-Temperature behavior of Pd-Ag Alloy of porcelain (By Mackert, J.Dent.R 1983)

- At degassing, Pd-Ag nodules format surfaces, Tin & Indium found internally. Porcelain attach to this metal by mechanical interlocking with enternal nodule.
- Problem of porcelain discoloration can be explain by vaporization of silver from metallic surface.

Improving the casting accuracy of FPD (Hinman, 1985)

- Investment mold compression & pattern distortion effect accuracy of multi-unit casting but pattern has greater influence.
- All wax spruing system produce less pattern distortion than plastic runner bars.
- Bench set of investment produce less pattern distortion than hygroscopic technique.

Effect of porcelain-metal junction angulation on porcelain fracture (Woods, JPD, 1985)

- P.M Junction angulation from 45 to 135° have no effect on amount of compressive force to fraction porcelain.
- Contact area should be away from PMJ at least 1mm due to metal burning effect (by Junction in metal)

The wear of enamel opposing shaded ceramic rest (Delong & Douglas, JPD 1992)

- Externally shaded porcelain has a wear that 15x greater than enamel oppose gold
- The rank of material according to enamel removal, gold < porcelain < Dicor + Shading < porcelain + shading
- The rank of lost vertical
  Gold ≤ Dicor < porcelain <Dicor + shading = porcelain shading

Thermal cycling distortion of metal ceramic Part 1: Metal Collar (By Campbell, JPD, 1992)

- All distortion occurs in first thermal cycle (degassing)
- 0.8mm facial metal collar had sig less distortion than, < 0.4mm
- To minimize large distortion at degassing stage.

A) Thermal cycling immediately after divestment (No Cold Working)
B) Heat treatment of casting in investment at oxidation temperature before divestment.

An in vitro investigation into wear effect of unglazed, glazed & polished porcelain in Human enamel (By Jagger & Harrison, JPD, 1994)

- Glazed & unglazed porcelain produce same amount of wear
- Polished porcelain produce least wear on enamel
- Glazed surface removed in less than 2 hours of test.

Effect of Surface finish on Flexural Strength (By Giordano, IJP, 1995)

- Over glazed, grinding & polishing all significantly ↑ flexure strength by 30% compare with self-glazed
- Recommend: Ion exchange will be placed after all adjustment (Polishing, glazing)
- Ion exchange ($K \rightarrow Na^{+}$) = Chemical tempering

Soldering

Philip (p608)

Metal Joining divided into 3 categories.

1) Brazing: required heating temperature above 450 °C (840 °F)
2) Soldering: Required heating temperature below 450 °C
3) Welding: Not required filler metal (metal fuse locally)

- Soldering should take place below solidus temp of substrate metal.

Soldering Flux:

- It is a compound applied to metal surfaces to dissolves or prevent the formation of oxide & other undesirable substances.

3 Types of Flux According to Primary Used:
Type I: Surface protection: cover metal & prevent oxide formation
Type II: Reducing agent or reduce any oxide present.
Type III: Solvent or Dissolve any oxide present.

- Flux for pre-soldering is different than post soldering.
- Fluoride flux for pre-soldering & borax flux for post sold.

A) For Noble Metal:
- Boric or borate compound (every borax) use to work as type I & II (prevent& reduce)

B) For Base Metal:
- Fluoride Flux (Type III) used to dissolve stable oxide
- Usually contain besides as glass former (protcetion) & fluoride dissolves any metal oxide.
- Flux, it is either painted on front metal or into surface of filler.
- Use minimum amount of flux to avoid weakening of joint (of entrap into metal) or discoloration & bubbling of veneering porcelain.
- Sand Blast joint follow by 5min boiling in water to remove residual glass.

Anti-Flux: Prevent flow of melted solders in area coated by substrate (being graphich or rayen in Chloroform).

Soldering (Brazing) Filler Metal:

- Filler metal dissolve in composition than prevent metal but it should be compatible in 3 primary properties:

1) Sufficient low flow temperature in at least 100°F (55.6°C) below.
2) Ability to wet substrate metal.
3) Sufficient fluidity at flow temperature.

Other Feature**:** Color, hardness, strength & corrosion resistance.

- For pre-soldering alloy high melting temperature is needed to avoid melting of joint at porcelain firing.
- Gold based solders most common used

Heat Source for Soldering:

1) Flame Temperature
- Gas air or gas-oxygen torch is common.
2) Hydrogen
3) Natural Gas
4) Acetylene
5) Propane
6) Over (Furnace) Temperature

Technical Consideration:

Gab: It never been defined but between 2-3mm
Larger Gab → Strong but distort more
Smaller Gab → weak but less distortion

Flame: 4 Zones:

1) Oxidizing Zone
2) Reducing Zone: Most heat & most efficient.
3) Partial combusting Zone
4) Color mixing Zone

Shillingburg:

Gold Solder Classification Based on:
Finesse: Good fine solder = Good parts gold per 1000 or 60 % gold
Carat: Part per 24 (e.g. 18 carat = 75% gold)

Requirement for Soldering:

❖ High firnness >580 to resist corrosion

❖ Low firing temperature (100°F below), Strong (↑ firmness →↓strength)
- Gab of bisness cord (2mm) to ↑ Stronger & ↓ Distortion.

Accuracy of FPD made by various Soldering Technique & one piece casting (by Fusayama, JPD 1964)

- Compare various soldering technique (3 gab, 2 gab, 1 gab) & one piece casting (.30, .27, .26, .20mm marginal misfit)
- Fewer error with less steps

Pre-ceramic & Post ceramic solder joint (by Stade & Preston, 1975)

- Compare torch (pre-ceramic) & oven (post ceramic) of .31, .51, .76mm gab
- Gab of .31mm is given a good strength & minimum .2 distortion
- Longer gab has more strength & more distortion due to large shrinkage.

Comparative distortion in 3 unit FPD joined by base welding Conventional Soldering or casting one piece (by Huling & Clark, JDR, 1977)

- Compare 3 joint porcelain; base, soldering & one piece casting
- Less distortion with base welding & one piece casting.

Comparison of Accuracy of Soldering Induces for fixed prosthesis (by Moon, 1978, JPD)

- Plaster index is more accurate than <resin index
- If rarely used → try to poor model with in 1hour & use less material to minimize distortion.

Distortion in dental soldering as affected by Gab Distance (By Willis & Nicholls, JPD 1980)

- Compare distortion of 0, .15, .13, .45mm gab
- Minimize gab distance without contact is desirable

Post Ceramic Soldering of Various Alloy (By Sloan & Preston, JPD, 1982)

- Base metal alloy give comparable strength to pre-ceramic alloy
- Base metal alloy is difficult to treat & flux material should be soldered carefully.

Soldering Non nobel Alloys (Towensend, JPD, 1983)

- Solder base metal alloy is Not predictable & inconsistent (more than ⅓ of solder joint fail)

A Comparison of strength of base metal & gold solder Joint (by Kriebel & Goodacre, JPD 1984)

- Most of specimen fail though solder joint which proved the solder joint is weakest in FPD.
- Base metal alloy has high strength than gold base

Accuracy of one piece casting, pre & post ceramic soldering (By Ziebert, JPD 1986)

- Longer span give more distortion
- 3 unit FPD one piece as accurate like section & solder
- Pre & Post ceramic is accurate equally.
- 4 & % unit FPD assemble by casting seating better than one piece.
- Marginal discrepancy more MD than BL & more at distal margin of post retainer & medial margin of any retainer.
- No addition distortion in porcelain firing cycle of pre-ceramic solder.

Tensile strength comparison of pre-solder & post solder golds (By Monday, JPD 1986)

- No significant difference between pre & post ceramic in tensile strength.

Mechanical & Elemental Characterization of solder joint & welds using gold palladium alloy (By Wiskott, JPD, 1997)

- Under tensile stress in laser weld > pre-ceramic > post-ceramic joint
- More of strength under flexure stress: pre-ceramic > post-ceramic & laser
- Neither mechanical nor handling properties of infrared or laser welding appear to be superior to furnace or torch soldering.

Soldering in prosthodontics (Gerard Byrne, Zolo, JP)

- To overcome misfit, there is only two way
1) Brazing / Soldering OR 2) Welding (purest metal joint together)

- Rationale for Soldering:
1) Overcome distortion in metal based FPD
- As length ↑ beyond 3 unit, distortion ↑ significally
2) Join Component of dissimilar metal (bars, close)
3) Overcome firing distortion in metal-ceramic FPD "post-soldering"
4) To add proximal contact to gold crown

Objective of Soldering:

1) Maintain accurate relation between parts
2) Produce strong, nonporous, noncorroding joint
- Brazing of temperature >450 ℃ (850 ℉)
- Pre-soldering = Pre-ceramic soldering = high fusing joint
- Post soldering = post ceramic soldering = low fusing joint
- All content in soldering alloy 58-61 % (.580-.615 F)

Factors affecting distortion in soldering:

1) Indexing/ Connecting : ZOE or plastic is better
2) Investment connecting compound
3) Joint configuration "the edge or parallel"
4) Gap width (.1 - .3mm, business card)
5) Assembly heating & cooling.

Cementation & Delivery

Abdel, 1980

- In Phosph & Polycarboxylate significantly more retentive than EBA & resin cement.

White, 1992

- 9 material satisfy ADA type 2 (<25µ) → GI, Znph, polycarb
- 5 material satisfy ADA type 2 (<40µ) → GI, resin cement, Znph o ph
- 6 resin cement record >40µm film thickness

Wortey, 1982

1) Not removing all temp cement → doesn't affect retention of crown (maybe seating)
2) Significant improve retention by grooving restoration
3) Primary factor of retention is adhesive or mechanical interlocking of cement to crown.

Cagidiaco, 1992

- Methylene blue in crown after teeth extracted shows

1) Marginal discrepancy in palatal margin were in acceptable range of 20µm → beveled margin.
2) Marginal discrepancy in buccal porcelain but joint was >120µm than metal range

Vermlyea, 1983

- Die relief result in 32% reductive in force

Myers, 1983

- Marginal leakage is least with Znph & GI will varnish to protect it from discoloration

White, 1993

- Marginal leakage is least with GI <Zp <Polycarboxylate <resin (333µm high or Gab)

Dihs, 1985

- Znph with amalgum core, ploycarb with metal alloy cores.
- Resin = Composite or gold core.

Felton & White, 1987

- Teeth prepared by using diamond bur has 31% greater retention than carbide bur
- If use carbide for efficient cutting → alternative features should be used.

Halperin, 1982

- Occlusal registration strip should be <21µm & possess plastic deformation & hot brittle
- That is allow registrate without tearing → accuFilm No. 1 is 21µ with ink.

Eggleston

- Describe remove & technique for fixed using plaster pick up procedure.

Newitter, 1982

- Firm porcelain by wheel follow by pumice or porcelain polishing paste procedure smooth surface. This importance of no glazing.

Cementation

Studies of the solubility of certain dental material (By Norman & Phillip, J.D.Res.1957)

- Material more soluble in acid than in distilled water
- More dissolution in acid at pH4 than pH5.
- Zn phosph more soluble than silicate cement

Studies on film thickness, solubility & marginal leakage of dental cements (By Norman & Phillip, J.D.Res.1963)

- Compare ZOE, Zn phosph, silicate
- Film thickness of all material is <40µm
- Zn phosphate more soluble in dilute acetic acid
- Sealing properties ZOE is superior to Zn phosph & silicate.

Role of Cavity varnishes & buses in the penetration of cement constituents through tooth structure (By Smarts, Philip, JPD, 1966)

- Varnish didn't prevent electrical conductivity or denture permeability but it reduce it.
- Both CaoH & ZOE provide a good barrier again acid
- CaoH neutralized acid effects of cements.

Bacterial growth & pulpal changes under inlays cement with Zn Phosphate cement & epoxy (by Brannstrom, 1974)

- Zn phosphate doesn't irritate the pulp & irrilation come from residual bacteria in the leakage from oral cavity.
- Microbicidal or tubulicid suggested to be used to eliminate debreis & bacteria

Adapting & lasting cement to enamel, dentin & restorative material (By Gudbr & Oilo, 1977)

- Wore of cement (Polycarb, Zn phosph, composite, EBA) able to fill space between crown & abutment
- Polycarboxylate was only cement exhibit good adaptation to enamel & dilution & leave gab at cement / alloy interface.
- Composite resin show gap at cement / tooth interface.

Pulpal Reaction to Ppolycarb & Zn Phosph cements used with inlays in deep cavity pep (Brannstron & Nyborg, 1977)

- Neither polycarb nor Zinc phosph has any irritation effects on pulp.
- Irritation after cementaion caused by debris containing bacteria.

The content of slits at the interface between lasting cements & enamel, denture & alloy (By Gudbr & Oilo, 1977)

- Zn phosph & Polycarb exhibit slight to moderate slits formation
- Comp resin has tendency to slit formation independent to film thickness

Factors relating to the rate of fluoride-ion release from GIC (By Kuhn &Winter, 1982 J.Dent)

- Dimension of cement exposure doesn't improve fluoride release (large exposure of GIC to environment doesn't occur)

Long-term monitoring of micro leakage of dental cement by radiochemical diffusion (By Powis, 3PD, 1988)

- Adhesive cement (e.g. GIC & polycarb) more effective in reduce leakage
- Silicate & Zn phosp is the worst.
- No crown margin at old or new restoration due to multiple interface well lead to different in thermal construction (**marginal percolation**) which will lead to micro leakage & recurrent caries.

Fluoride release from Glass Ionomers used as heating agent (Bernard Muzynsky, JPD, 1988)

- GIC release a significant quantities of fluoride & independents on brand
- Cement with low P/L ration produces more fluoride due to more solubility
- More fluoride release mean dissolution of cement which is not good.

Marginal seal of infection – molded ceramic crowns cemented with three adhesive system (Shortall, 1989, JPD)

- By using chemical marker, minimal micro leakage with component used with denting bonding pretreatment.
- High leakage with GIC.

An evaluation of film thickness of resin luting agents (By Wendi, Levine, JPD, 1989)

- Most of resin luting agent has film thickness of 20-40μ
- Working time affect film thickness

Analysis of GIC (Swift, JPD, 1990)

- GIC introduces by ***Wilson*** Kent, 1970
- It is hybrid of silicate & polycarbox cements
- Acid base reaction of polyoacrylic acid + Ca AL si glass.
- GIC has fluoride release & adhesion to tooth
- Factors affect fluoride release is acid conduction & high temperature.

Good Glass Ionomer Cements as of fluoride release system in VIVO (By Goran Koch & Kofman, Swed dent J, 1990)

- 36 child receive 1-6 GI restoration
- Baseline concentration of fluoride between cores in crown to .8 for chem fall II 1.2 ppm for Ketac™ full & Vitrebond™. Fluoride reduce with time.
- After 6 weeks, fluoride core is still 10 times high than baseline.
- prevelance of S. returns ↓ after placed of GIC.

In Vitro fluoride release from light cured GIC (Mitra, 1991, J Den Res)

- Light cure doesn't affect fluoride release

An Investigation of dental luting cement solubility as a function of the marginal gab (By Jacobs, 1991, JPD)

- Compare cement dissolution at 25, 50, 75, 150µ gab
- <150 µ of gab has No significant different in cement dissolution.

Marginal leakage of cast gold crown luted with an adhesive resin cement (By Tjan, 1992)

- Least micro leakage with panavia compared with Zn Phosphate.

Film Thickness of New Adhesive Luting Agent (by Fukihe, JPD, 1992)

- Rapid mixing of Zn Phosphate on frozen glass slab increased working time & decreased the setting time.

Effect of Seating Force on Film Thickness of New Adhesive tubing agents (Shane, White, 1992, JPD)

- For all cement increase seating force →↓ film thickness

Early Erosion of Glass Ionomer Cement at Crown Margins (by Steven, Curtis, ISP, 1995)

- leaving band of excess cement (GI) at margins for 10 minutes prevent erosion of material.

Marginal fit of Restoration before & after cementation in Vitro (by Matthias Kern, IJP, 1993)

- 12 patient, parallel study designs, telescopic crown, coping cemented by Zn Phosphate or G.I.C.
- All coping has marginal opening of 30µm before cementation
- They increase significantly after cementation to 86µm in Zn phosphate but only 47µm in G.I.C.

In Vitro Micro Leakage of Luting Cements Ion Cast Crown (Shane, white, JD, 1494)

- Compare Zn Phosphate, Composite – GI with or without bonding in molar teeth of periodontal diseases tooth. (After 6m, extraction & SEM)
- Zn Phosphate leak significantly more than other cements.

Pulp

Early human Pulp Reactions to full crown prep (by Seltzer & Bender, JADA, 1959)

- Crown prep alter dentinal structure
- Pressure, temperature & vibration are damaging pulp
- Use high speed with copious water reduce pulp reaction

Biological effect of various cutting methods in cavity preparation: The part pressure plays in pulpal pressure (by Stanley, JADA, 1960)

- Increases pressure above 8 ounces →↑ severity of pulp inflammation even with copious amount of water.

The Hydro Dynamics of the dental tubal & of pulp fluid (by Brannstorm, Caries Rest, 1967)

Purposes to provide evidence of hydrodynamic mechanism in pain transmission.

- Air blast on exposed dentin lead to rapid movement of liquid, the same when apply cold to enamel & opposite effect when apply heat
- Cold water of warm air immediate drop pulpal pressure
- Author suggest that transmission of pain stimuli to pulp may have hydrodynamic mechanism, a rapid movement of fluid in dentinal troubles & pulp acting as mechanic receptor.

Cavity Treatment with a microbicidal Fluoride Solution: Growth of bacteria & effect on Pulp (by Brannstorm, JPD 1973)

- It has been found by Brannstorm that construction of restoration result in space contain adverse accumulation of bacteria & bacterial toxin by product are responsible for pulp inflammation, not chemical irritation of material.
- Microbicidal fluoride solution eliminate all bacteria in cavity without irritating of pulp.
- Human pulp response to acid pretreatment of dentin & to composite restoration (by Stanley, JADA, 1475)
- ↑ Dentin permeability when it is treated by acid of remaining dentinal thickness (RDT) ≤ 1μm in respect to type of duration.
- Use CaoH base or line to coat dentin

The effect of rotary instrumentation on the permeability of dentin (by Boger, J Deri Res, 1981)

- Permeability of dentin decreased after cutting by diamond & carbon.

Bacterial leakage around dental restorations, its effect on the dental pulp (By Bergenho H2, J. oral Path, 1982)

- Bacterial leakage under restoration couse pulpal inflammation
- No laeakage with ZOE, Intermediate with (Ana, Coup, GPP) & highest with silicate filling.

Dentin hypersensitivity-Areview (by Dowell, J. Clin. Perio, 1983)

- The main theory for pain & dentin sensitivity;
    1) Nerve ending theory: Study shows, nerve may not penetrate all dental tubules or even built of dentin (Seltzin, 1971)
    2) Odontoblast & their process act as dentinal receptor mechanism
- Not right because its description of odontoblast leave dentin sensitive
    3) Protein precipitant don't ↓sensitivity of dentin to osmotic stem
    4) Hydrodynamic mechanism (Brannstorm, 1962 & 1966).

The Hydrodynamic theory of dentinal Pain (Brannstorm, J Endo, 1186)

- fluid movement is associated with pain.
- fluid movement is from 1 to 15 μm in the tubule
- Rapid outward flow of fluid in dentin tubule installed by story capillary forces.
- 10-14μm of gab at cervical composite restoration with enamel is minimum
- Dental sclerosis: obstruction of tubule by Ca phosphate crystal

Temperature rise in the pulp chamber during fabrication of provisional crowns (by Tjan, 1589, JPD)

- Compose MMA, EMA, VMA, Bis-GMA, 3 Matrices (Addition Condensate Silicon & Bakelite)
- Amount of heat produce during polymerization is sufficient to injure pulp & odontoblast.
- Protemp (Bis-acryl) produce lowest temperature increased.
- No Significant difference between group.
- Using addition or condensation silicon putty significant reduce heat
- Crajomer et al said using silicone putty reduce heat in pulp

Temperature change in the pulp chamber during compatible crown preparation (by Laforgia, JPD 1991)

- Compare diamond & TDA diamond, water coolant or air coolant or heat generation on the pulp.
- Using air-water spray result in lowest temperature on pulp (up to 25°C)
- Using air-coolant result in rise temperature on pulp (up to 45.8 °C)

pulp injury follow heat rise (Zach & Cohen,1965, Oral Surgery)

- 15% pulp necrosis when temperature increased by 5.5 °C
- 60% pulp necrosis when temperature increased by 11..1 °C
- 100% pulp necrosis when temperature increased by 16.6 °C

Temperature response in the pulp chamber during ultrahigh speed. Tooth preparation with diamond bur. (by OHL, 1998, JPD)

- 4 course burs (fine → ultra course) compared on heat generator.
- 3.2°C is maximum heat generated & it is with ultra-coarse
- Cooling water temperature between 30-32°C is optimum & cooling temperature of 38°C or more didn't afford actual cooling
- Schubert said 41.5°C is critical temperature for fibroblast

Marginal permeability of self-etch or Total-etch adhesive system (by Owens, J. Operative Dentistry, 2006).

- All adhesive system perform best when bonded to enamel compose to dentin
- Scotch bond (4^{th} gen) & iBond (7^{th} gen) has less enamel leakage

NB: Difference between 6^{th} & 7^{th} generation is all self-etch but all 7^{th} gen has antibacterial

Comparison of temperature increase in the pulp chamber during the polymerization of material used for direct fabrication of provisional resistance (by Michalakis & Hirayama JPD, 2006)

- Mean temperature ↑ range from 37.76°C for PUMA to 39.40°C for PMMA
- Mean temperature for cling porcelain is 36.80°C for PUMA & 37.69°C for relining of PMMA
- Use pre-form shell or indirect technique for provision

RESIN Bonded FPD:

Simon, 1992 → proximal grooves improve retention significantly
Livaditis and Thompson (Maryland, 1982) → describe technique of etch cast
Williams, 1989: 10 y retrospective shows 31% deponding rate, caries 3%
Kern, 1992: circumferential veneering of pontic and additional proximal prep improve strength significantly
Burgess, 1989: preparation without facial wrapa-round, grooves or single pinhole were significantly less retention
Rochette, 1979: describe technique of splint Mn teeth (Ant) with missing tooth
→ no prep and based on bond between gold and etch enamel

Porcelain LaminateVeneers

Sim, 1993: fit of veneer tested as follow from best: Feldspathic using platinum foil > feld + refractory die > .5mm castable glass > 1mm castable glass

Fairhust & Thompson, 1992: polish porcelain had significant higher flexture strength than glazed porcelain

Sorenson, 1992: vertical marginal discrepancy of porcelain veneer made with platinum foil (187µm) was significant better than refractory die (292µm)

- There is no relation between vertical marginal opening and microleakage because of seal

Christensen, 1991: 3 years follow up of veneer shows 13% of veneer has breakage

Rasetto & Driscoll, 2001: high intensity light (10-155) required less time to optimally polymerized varcolink II for veneer than halogen conventional light (60s)

Hayakawa, 1992: HFL acid etch is not needed to get strong bond between composite and porocelain of silicone agent used which react with OH growing in porcelain surface

Novel Porcelain Laminate PCP Prep (Pascal Magne)

- Critical step in laminate technique is to provide sufficient thickness for porcelain.
- This can be done only by 2 ways:
  1. Depth cutters guide by existing tooth surface
     a. Disadvantage: It doesn't take in consideration amount of enamel loss due to aging, wear and it may to dentin exposure.
  2. Wax-up or Mock-up Technique
     a. Advantage: Compensate for tooth aging, preservation of enamel, more predictable bonding, biomechanics of esthetics

Obj: Discussion 2nd Technique

- Bonded porcelain restoration is different from traditional cemented crown regard retention and resistance force → minimum prep is required to facilitate insertion and position of ceramic
- Recommended thickness for laminate is:
  - Less than 0.3-0.5 mm in cervical area
  - 0.7 mm in middle and incisal thirds
  - 1.5 mm minimum in incisal coverage

Tooth Prep Strategies

Divided in 2 groups:

A. Preparation Driven by Existing Tooth Surface
   Goal: to remove a uniform layer of tooth structure
   Tech: 1. Free hand prep and silicon guide

2. Depth cutters → more accurate and time efficient

Advantage: reduced Dx steps and limit communication with technician → reproduced form and functions

Disadvantage: if enamel is thin → may be dentin is exposed → long-term fracture

Indication: change color; keep shape and form of tooth

B. Preparation Driven by Final Volume of Restoration

Indication: change in tooth shape and form

1. Used Dx wax-up to be reference for tooth reduction by using silicon index.

New Simplified Technique

2. Used mock up for provisional and depth cutting bur

Advantage *time efficient
*preserve enamel
*protect pulp from overreduction

No disadvantage

<u>Technique:</u>

1. Dx max-up
2. Silicon index from wax up
   Facial → follow contour of free gingiva
   Palatal → keep accessible for material
   Keep 2 teeth in each side as reference
3. Etch (5-10s) rinse and dried enamel before acrylic
4. Fill silicon index by acrylic (dentin) – pressure only in premolars
5. Remove access, stains and glaze
6. Check esthetic, occlusion and speech and wait 1-2 weeks
7. Used round bur for depth cut of .7mm → incisal and .5mm → middle
8. Mark it by pencil
9. Remove acrylic and start prep by taper diamond bur until pencil mark gone
10. Used silicon index to recheck clearance
11. Slight proximal separation using disk
    - ease fabrication of dye
    - Entrance proximal marginal definition
12. Round all angle by disk at low speed
13. Immediate sealing of dentin by using adhesive
14. Final impression
15. Fabricate temporary restoration using same silicon index and no cementation (friction fit and proximal undercut)

Ceramic

- Ceramic: compound of one or more metal with non-metallic element
- CTE: change in length per unit length of material for 1°C change in temperature
- Firing shrinkage: liner 11-15%, volumetric 27-45% (different particles size → ↓ shrinking
- Enamel abrasion: no difference between polished and glazed porcelain (Al-Hiyasat)
- Composition:
  1. Feildspar (K-Al-Si) 75-85%
  2. Quartz 12-22%
  3. Kaolin 3%
  4. Modifier (Leucite→ ↑ CTE, metal oxide for color)
- Vertification: absence of crystallization on cooling and solidification

- **Land** → introduced first fused porcelain inlay and crown - 1886

- **Mclean and Hughes** → introduced high strength ceramic core or glass – alumina

- **Willis glass** → porcelain veneer dicore glass ceramic

Methods of Strengthening Porcelain

1. Ion exchange
2. Add Na_2O in glass well ↑ flexture strength
3. Add barium for titanium-porcelain system → main problem is fracture at Ti_2O nd Ti or within Ti_2O layer

Types of Ceramic

1. Leucite reinforce glass ceramic (IPS Empress)
   - Contain leucite (K ALSO2)
   - IPS Empress injection molding use lost wax
   - Technique: special investment and prolonged burnout cycle → upper chamber for molding under pressure
   - Strength → flexture strength of 134 mpa – weak – good translucent
   - Use of anterior or veneer – not for post
2. Cast Glass Ceramic (Dicore)
   - Use conventional lost wax technique, use castable polycrystalline (tetrasilicate fluoromica)
     Glass ceramic → can used for coping and layering over or full shape
   - Strength = 120-150 MPa → better perform with etch and resin cement
   - Weak = high translucency - same indication and contraindication like IPS Empress
3. High Alumina Ceramic (In Ceram and In Ceram Spinell)
   - In Ceramic composed of 2-3 inter-penetrating phase → compact alumina particle in die partially sintered then infiltrate aluminum silicate over
   - In Ceram Spinell: replace AL_2O by magnesium spinell → high translucency but ↓ strength

- Flexture strength: 480-530 MPa and 280 for In Ceram Spinell
- Indication: single out anterior post, FPD → anterior
- Contraindication: post FPD and RB FPD because it is not etchable

4. CAD-CAM (Procera and CERCC)
   - Procera → die scan → information stored in computer → compute componsate for fire shrinkage and produce large die milled with CAM process → aluminum press to die, milled to form correct size and shape and form then match porcelain over it
   - CERCC → optical impression → design using CAD → milled restoration from block of ceramic by diamond wheel → glazed ceramic or feldspathic ceramic may used
   - Strength: procera → 508 MPa for core and 70 MPa for veneer porcelain
   - Disadvantage: equibment
   - Indication: single anterior or posterior ceramic → inlay - onlay - veneer
5. Precision Copy Melling (Celay)
   - Composition ceramic block (Feldspathic or In Ceram block can be used)
   - Process not computer driven → light cure composite replica of restoration in mouth or cast
   - Replica mounted in Sanning side of Celay machine while ceramic block is mounted in milling side → scanning tools surface and milling tools remove ceramic
   - Strength:
   - Advantage: 15-20 minutes to mill restoration

Al-Hiyasat, 1997 → unglazed produce highest amount of wear follow by polished and then glazed

→ no significant difference between roughness of polished and glazed porcelain

Anusavice, 1997 → all ceramic should be restricted anterior and premolars and PFM for molars

Wagner: biaxial flexure strength is:

- Procera all ceram: 687 mpa, In Ceram: 352 MPa, Empress: 134 mpa
-

Whit*e* → fit of CERCC CAD-CAM glass ceramic veneer was acceptable but nor improve by adjustment

Normann → marginal opening of CERCC II is better than CERCC I

All Ceramic - LAVA

Lava introduce in 2001 (3M, ESPE)

Zirconium coping

- 7 shade
- Fabricate using CAD/CAM of presintered Zr blanks
- Milled framework in oversize to compensate shrinkage at sintering → then sinter in high temperature furnace

Die – Scan – Design – Milled – Sinter – Veneer

- ➢ Use in anterior produce high quality restoration, esthetics, and biocompatible restoration
- ➢ Accumulation of plaque-like tooth structure
- ➢ Low thermal conductivity → unlike metal → low sensitivity

Scanning "Lava Scan"

- ➢ Non-contact, optical scanning system, PC with monitor + Lava CAD software
- ➢ 3D image well created → no wax up but it has visual wax knife
- ➢ Bite registration and adjacent can be taken into the account
- ➢ Sharp under margin, no line, no hardness at margin, block out undercut with white wax

Modeling

- ➢ Software will design the coping from library but will allow adjustment by using virtual wax knife
- ➢ Framework is design to best support veneer ceramic
- ➢ Cement gab (site/position) are assisted and can still adjusted

Milling

- ➢ 3D shape milled for pre-centered Zr blank using hard metal tool
- ➢ Milled in large size to componsate shrinkage "20%"
- ➢ 3 unit FPD takes 50 minutes

Sintering

- ➢ Manual finishing can be carried out before sintering takes place
- ➢ Coloring Zr coping using 7 shade according to veneering porcelain
- ➢ Fully automated sintering process after shading = 11 hours of heat and cooling

NB: *Connector height: $\geq 7mm^2$ for anterior and $\geq 9mm^2$ for post

Veneering using Lava Ceram (feldspathic)

- ➢ CTE specially develop to match Zr (CTE=10ppm) coping (.12ppm)
- ➢ 16 shade layering system based on vita classic range
- ➢ Avoid adjustment of Zr coping after sintering → ↓ strength

Clinical aspect:

- Due to outstanding mechanical and optical property of lava Zr and veneering ceramic

Preparation:

- ➢ Round shoulder or chamfer margin
- ➢ For optimism scanning → angle of ≥ 5°C (horizontal) and ≥ 4°C (vertical)
- ➢ Coping thickness of .5mm (posterior) and up to .3mm (anterior) are adequate

Cementation:

- ➢ Can use conventional cement (GI, adhesive count)
- ➢ In case of use adhesive cement
- ➢ Zr cannot be etch like glass ceramic → silanization "Rocatec" for bonding is necessary
- ➢ Recommended → ketac cem "phosphate not good esthetic"
- ➢ Relyx unicem → sand blast internal surface 15 second, very quick → Rocatec (sickle) or cojet sand → that well provide direct chemical bond
  - Sand blast of particle ≤ 40mm

Properties	Flexure Strength	Fracture Toughness	Modulus of Elasticity	CTE	Melting Point
Lava Frame	≥ 100 MPa	5-10 MPa	>205 GPa	12 ppm	2700°C
Lava Ceram	100 MPa	1.1 MPa	>80 GPa	10 ppm	810°C

Flexure Strength

Fleming (1267), Fischer (1345), Quinn (1066) → weibull strength

- ➢ Fleming and Curtis – shows long-term stability under aging and cyclic load of over 5 years period- 1308 MPa
- ➢ In another study → fine grinding and sandblasting <125 μ doesn't affect strength "Weibull strength"
- ➢ Chapmann and Sadan have same conclusion

Optical Properties

- ➢ Translucency depends on material and thickness
- ➢ 0.5mm of lava frame are comparable to 0.8mm of Empress II

Accuracy of Fit

- ➢ Hertlein and Frank (2005) mean of marginal opening < 50mm

Cementation

- ➢ Bulot and Sadan (2003): Relyx unicem revealed bond strength (sheer) equal or higher than other (e.g Panavia)
- ➢ Koehler and Sadan and Blatz (2003) – ground intaglio surface provide a good sheer bond

Bond Strength of Lava Ceram to Lava Frame

- ➢ Behrens (2004) –very high sheer bond strength

*Initial → 28.9 MPa *After aging → 27.5 MPa

N.B. Craig: recommend bond > 25 mpa (metal range of 35-60 MPa)

Design and Coping

- Fischer (2005) → 30% of ↑ fracture resistance of canine coping if it is anatomically designed

Cause of Zirconia Failure

- Main failure is cohesive within porcelain "shipping"
- Why fail? "SWAN"
  1. Difference: CTE of coping and veneering
  2. Fast cooling rate put veneering under tensile stress
  3. Ratio of coping to veneer "top laryer compression for small area"
  4. Design of Zirconia coping
  5. Firing shrinkage of ceramic
  6. Flaws on veneering and poor wettability of veneer

Zirconium Density

1. Fully sinter → HIP → not isostatic pressuring
2. Partially → Non HIP
3. presenterd

All Ceramic Review

Ceramic: inorganic compound with non-metallic properties composed of metallic and non-metallic element (Philip, pg. 655)
Glass: inorganic, non-metallic compound that lack crystalline structure
Glass ceramic: consist of glass matrix phase and at least one crystal phase produced by crystallization of glass
Dispersion strengthening: it is improved flexure strength and fracture resistance by adding leucite
Feldspathic porcelain: it is ceramic of glass matrix phase and one or more crystal phase (e.g. leucite)
Green state: press condition before sintering
Slip casting: process used to form "green" ceramic shape by apply slurry of ceramic particle and water to porous die material then allow capillary action to remove water and densify mass.
Spinel: crystalline mineral composed of mix oxide

All Ceramic Core Material

Glass Ceramic | Alumina | Zirconia

Feldspathic
- Vitablock
- Milled
- Only veneer or crown
- SiO_2+AL_2O_3-Na_2O-K_2O

Leucite
- IPS Empress I
- Heat pressed
- Only veneer crown
- SiO_2-A_2LO_3-K_2O

Lithium disilicate
- IPS Empress II and e-max press (Ivoclar)
- Heat pressed
- only → FPD
- SiO_2-Li_2O

Alumina (AL_2O_3)

*In Ceram
- 70% AL_2O_3
- Slip cast and milled
- Crown, FPD

*Procera (all ceram)
- 99.9% AL_2O_3
- densely sintered
- crown, FPD

**Zirconia*
- YTZP
- ZrO_2 stabilized by Y_2O_3
- Lava (3M) → green milled
- Procera → densely sintered
- Crown, FPD → abutment

Mclean add AL_2O_3 to feldspathic porcelain to improve mechanical and physical properties

- To use all ceramic system for FPD → minimum connection height of 3-4mm. (JPD, 2007 by Conrad et al)
- Contraindication - for curing all ceramic in FPD:
  1. Reduced interocclusal distance
  2. Short clinical crown
  3. Deep vertical overlap without horizontal overlap
  4. Opposing supra-erypted tooth
  5. For cantilever
  6. Severe bruxism or poor functional habit

<u>Common System</u>

<u>IPS Empress II (Ivoclar Vivadent)</u>

- Fabricated by combination of lost wax technique and heat pressed
- Glass ceramic ingot heated to 920°C and when pressed into an investment mold under increased pressure
- Used maximum for 3 unit anterior
- Veneered by fluorapatite-based veneering porcelain

<u>IPS Emax-Press (Ivoclar) → 2005</u>

- Same chemical compound as empress 2 but with improve physical and translucency
- It is available in different ingot shaded
- Can be used in monoblock to form full contour crown (staining) or to form core and layered by porcelain (layering)
- All material form by lithium disilicate should be bond to tooth like veneer

<u>Cerec: 1991</u>

- Machienable feldspathic porcelain
- 60-63% → SiO_2 and 20-23% AL_2O
- It can be etched
- Available in different shade

<u>Celay</u>

- Software to milled restoration by direct duplicate of acrylic restoration

Zirconium-based Ceramic

- It is a polymorphic material that occur in 3 form

$$\text{Monoclinic} \xrightarrow{1170} \text{tetragonal} \xrightarrow{2370} \text{Cubic}$$

- Y_2O_2 is added in 3% to control volume expansion and to stabilize it in tetragonal phase at room temperature
- Transformation toughening: at crack tip, Zr transformed from tetragonal to monoclinic with 3-5% of volume expansion which put crack under compression stresses and retard crack propagation

- In present of high stress, crack can still propagate but it gets harder for crack to propagate with this phenomenon
- Zr can be fabricated by many ways
    - CAD/CAM by enlarge coping/framework can be designed and milled in green stage or from fully sintered prefabricated blank
    - Lava 3 M → scan die → CAD design enlarge framework and milled it from softer presenter blank → 7 shaded available for coloring Zr coping
    - Cercon use wax-pattern to be scanned

Longevity of IPS Empress (Brochu and El Momafy, 2002, Journal of Canadian DA)

- Survival rate of inlay and onlay is 96% 4.5 years and 91% at 7 years
- Survival rate crown is 92% at 3 years and 99% at 3.5 years

Fracture Rate of IPS Empress (Heintze, 2010, International Journal Pros)

- Adhesive coated empress crown shows high fracture rate in molar and canine

3 Years Clinical Evaluation of 2 Ceramic Crown (Etman, 2010, JPP)

- Compare 90 posterior crown of IPS Emax, porcelain all ceram (aluminum core) and PFM

Procera All Ceram Crown (Odman, 2004, IJP)

- 87% crown in 50 patients
- 74% of crown in posterior
- Cement Zn phosphate in 79 crown and GI in 8 crown
- Result:
  - 5 Y → 97.7% survival rate
  - 10 Y → 43.5% survival rate and 92.2% success rate

Panorama of Dental CAD/CAM (Compendium, 2005 by Perng – Ru – Ka)

- 1970 with Bruce Altschuler (fast result)
- Cerec first company by Mormann
- Flexural strength:
  - 150 MPa → Feldspathic (Leucite)
  - 750 MPa → Zr O_2 by Cerec
  - Partially or fully sintered Zr → 1000 MPa

Pjetterson and Swain and Hamerle → equal success rate of all ceramic and PFM over 5 years in anterior and less success rate in posterior.

Craig's Dental Materials: Summary /Notes

Chapter 2: Applied Surface Phenomena

Titanium is biocompatible due to oxides formed on its surfaces via Titanium (Ti), Indium (In) and Tin (Sn).

Sol = a solution, but made of colloidal particles dispersed in liquid
Gel form = semisolid (i.e. agar, alginate)
Alginate (alg) = soluble K-Alg + Calcium -> Ca-Alg
Synersis = contraction and exude liquid onto surface
Emulsifier = lowers interfacial tension between two liquids
Greater tendency to wet surface = lower contact angle <45°

Factors involved in denture retention:

- Capillary forces involving liquid film between tissue and denture
- Surface forces controlling wetting of denture
- Seating forces (determines saliva thickness)
- Saliva surface tension
- Saliva viscosity
- Atmospheric pressure

Edentulous patient's (pt) saliva has lower viscosity than dentate pt.

Chapter 3: Optical, Thermal and Electrical Property

Light wavelength: (short) blue----green---yellow---orange---red (long)
400nm 700nm
Visible: 380-750nm

1. Hue: color
2. Value: black (o), White (100) high value=high white
3. Chroma: (saturation)

Rough Surface appears lighter than smooth surface
Mercuric sulfide – red pigment
*Metamerism = under some lighting conditions such colors appear to match but under other lights they would not match (2 objects)
= one object = color constancy=fair
Fluorescence = emission of luminous energy by a material when light shine on it

Chapter 4: Mechanical Properties

Force range between 400 to 800 N in molars, 300N=PM, 200N=canine, 150N=incisors

- Average ↑ in force with year is 22 N, woman biting force is 90N less than men
- Average force for CD is 100*N* in M&PM & 40 *N* in incisors
- Average force for FPD is 40% less than natural teeth

Stress: force per unit area (Pascal – 1*N*/m^2 , 1mpa=10^6pa

Type of stress:

1. Tension: body subjected to 2 set of force directed away from each other
2. Compression: body subjected to 2 set of force against each other
3. Shear: 2 set of force parallel to each other
4. Torsion: twisting of body
5. Bending: applied bending movement

Strain: deformation when body under stress = deformation / original length = %

- Stain is linearly proportion to stress

Proportional limit: highest stress that material will sustain without deviation from linear proportion of stress to strain

Elastic region: region of stress strain before proportional limit

Plastic region: region of stress strain beyond proportional limit

Elastic limit: max stress that material will withstand without permanent deformation

Yield strength: stress at which material begin to function in plastic manner
Ultimate strength: maximum stress (compression or tensile) that material can withstand before fracture

Fracture strength: stress at which material fracture

Elastic modulus: represent stiffness of material within elastic region
(stress / stain = mpa, 1000mpa = 1Gpa)

Ductility: ability of material to plastically deform (plastic strain)

Resilience: resist material to permanent deformation (under elastic region)

Toughness: resist material to fracture (elastic + plastic region)

Fracture toughness: amount of energy required to fracture

- Or ability to plastic deform before fracture stress
- mainly for brittle material

- gives relation ratio to ability of material to resist crack propagation

Transverse strength: 3 point bending

- modulus of rupture or flexural strength

Fatigue strength: stress at which material fail under repeated loading (S-N curve-'stress'-'cycle")

Hardness: resistance to surface indentation

- use Brinell, Knoop or Vicken hardness test

Wear: loss of material result from contact of two or more material

Galvanic action/shock or galvanism = difference in potential b/w dissimilar fillings in opposing or adjacent teeth.
Metal conducts heat better than nonmetal

<u>There are 4 forms of silica</u>
One is cristobalite which shows the greatest amount (amt) of expansion (exp) at the lowest temperature (temp) and quartz, which requires higher tem to develop an equal amt of exp as cristobalite.

Chapter 6: Nature of Metal and Alloys

Definitions:

Metal = any elements that ionizes positively in solution (metals generally have good ductility & malleability)
Metalloids = carbon, silicon and boron
Grain = collection of randomly oriented crystal
Anisotropy = uniformity of directional property

Most common lattice: body-centered cubic, face centered 9ex. Au, Pd, Co, ni), & close-packed **hexagonal (Titanium)**

Corrosion resistance: 1. Strong metallic bond
2. Valence electron tightly held
3. Low saturation energy

Au and Pt less likely to corrode because (b /c) valence electrons are tightly held, strong metallic bond and salvation energy is low
Na & K – weak metallic bond, valence electron loosely held and salvation energy is high

Fine-grained structure is desirable so to have alloys with uniform properties in any direction
Grain refiners: ex. Iridium, encourage even nucleation through (thru) out alloy
Grain boundaries – often contain impurities such as oxides and are sites of corrosive attack

Slow cooling rete & few impurities -> large grains
Fast cooling rate & presence of grain refiners -> smaller grains
Mechanical properties of wrought wire are superior to casting
Greater degree of cold working -> greater grain boundary deformation, unstable structure with greater internal energy
Solid solution (ex, alloy) has higher strength and hardness and lower ductility than either pure metal and has melting (melt) range, not melt. Point (pt).
"Stainless Steel" – add Cr to Fe

Chapter 7: Polymers and Polymerization

Free radical polymerixzation: no byproduct
- **3 stages**: initiation, propagation & termination
- Acclerated by heat, light and traces of peroxide

In Philip:
- Initiation: induction and activation
- Propagation
- Chain transfer
- Terminimation

Chemical accelerator – tertiary amine, n-n dihydroxyethyl-para-toludine
Inhibitors – hydroquinone, eugenol, large amounts of oxygen

Condensation polymerization (ex. Polysulfide)
- Polysulfide polymers with mercaptan –(SH groups) + lead dioxide catalyst)
- Water is a byproduct

Polymerization
1. Free radical – resin
2. Condensation: ruber base and cord PVS
3. Ring opening : epoxy or polyether
4. Hydrysolution or ionic: add PVS

Chapter 12: Impression Material

Alginate – algenic acid from marine plant; William wilding 1940., ADA #18

(Powder) calcium (Ca) sulfate dehydrate, alginate, sodium phosphate -> add water -> Ca from Ca sulfate react preferentially with phosphate from na phosphate to form insoluble ca phosphate (instead of Ca-alginate) b/c it (Na phosphate) has lower solubility. Therefore, Na phosphate = retarder, provides working time (difference b/w regular & fast setting alginate).

Filler concentration is adjusted to control flexibility of impression material

Alginate – Ingredients:

1. K-Alginate (18%) – dissolves in water and reacts with Ca ions
2. Ca-Sulfate dehydrate (14%) – reacts with K-Alg to form insoluble gel
3. K-Sulfate/Borates (10%) – counteract the inhibiting effect of hydrocolloid on setting the gypsum
4. Sodium Phophate (2%) – react preferentially with ca to provide working time before gelation
5. Diatomaceous earth (56%) – control consistency of mixed alginate and flexibility of set impression
6. Organic glycols (small amt) – dustless powder (coats powder)

High accuracy if snap removal and has reasonable bulk

4 types of elastomeric impression material:

1. Polysulfide (.4% shrinkage)
2. Condenssation silicone (.81)
3. Addition silicone (.16-.21)
4. Polyethers (.24)

Polysulfide : accelerator – lead dioxide; base = mercaptan

Condensation silicone: base = dimethylsiloxane; accelerator – stannous octate : reaction liberates ethyl alcohol -> causes shrinkage
Addition silicone: catalyst and base contains dimethylsiloxane polymer with vinyl terminal groups plus filler. No byproduct. But secondary reaction has byproduct = hydrogen gas. Wait 30 min before pouring for release of H2 gas or Pd added as hydrogen scavenger

Latex gloves: affect setting of addition silicone (sulfur poison Pt in catalyst -> no/slow polymerization

Pseudiplasticity/shear thinning = viscosity of the unset material decrease with an increase of outside force. When discontinued, viscosity increases

Working and Setting time : polysulfide > silicone > polyether
Elasric recovery : addition silicone > condensation silicone > polyether > polysulfide
Dimensional stability on setting : condensation silicone . polysulfide

Modeling Plastic Impression Compound: ADA Spec #3, 0.3% linear contraction

Rosin 30 parts	Talc 75 parts
Copal resin 30 parts	Stearic acid 5 parts
Carnauba wax 10 parts	coloring agent – appropriate amt

Chapter 13: Gypsium Products and Investment

Gypsum = Ca sulfate dihydrate
Ca sulfate ● ½ H_2O + 1 ½ H_2O -> Ca sulfate (gypsum) ● 2 water + 3900 cal/g●mol
(exothermic ╚ plaster of paris
reaction)
3 types of base raw material:

1. Plaster – fluffy, porous, lease dense (model and lab plaster)
2. Hydrocal – more crystalline, higher density (dental stone)
3. Densite – most dense (high strength dental stone)

<u>5 types of gypsum</u> : Setting Expansion (S.E.) % (ADA spec #25)

1. Impression Plaster - .15%
2. Model Plaster - .3%
3. Dental Stone - .2%
4. High Strength/low exp - .15%
5. High Strength/high exp - .16 - .30%

**** types differ in manner of driving off part of water of Ca sulfate dehydrate

Plaster:

- Beta form of gypsum
- 110 - 120°C open vat
- Porous & irregular shaped

Hydrocal:

- Dehydrated under pressure 125°C, water vapor present
- Powder more uniformly shaped and dense
- A (alpha) – dental stone (low to moderate dental stone)

Densite:

- Type IV & V: 30% CaCl solution boiling then 100°C water

Accelerators:

- K sulfate & terra alba (set Ca sulfate dehydrate)
- NaCl (decarese setting time) & increase setting expansion

Retarders:

- Sodium citrate

Borax may act as an accelerator as well as a retarder dependent on amt present

Type IV has extra salts to decrease its S.E. compared to Type V
Increasing water in mix will decrease compressive strength
Model plster has greatest amt of axcess water; its more porous than dental stone
High strength stone has least amt of excess water
Vacuum mixing – increases compressive strength

Dry stone has double the compressive strength than wet stone.

Variable	Setting Time	Consistency	Setting Espansion	Compressive Strength
↑ W/P ratio	↑	↑	↓	↓
↑ Spatulation	↓	↓	↑	*No effect*
↑ H2O temp	↓	↓	↑	*No effect*

** W/P = water/powder

** 2 effect in setting reaction: a. ↑temp -> change solubility

b.↑temp -> change ion mobility (ca&so4)

Investment Ingredients:

1. Refractory : form of silicon oxide (expands when heated), 1.e. quartz 1.4%, cristobalite 1.6%, tridymite <1%
2. Binder: α-Ca hemihydrate, phosphate or ethyl silicate
3. Other: Nacl, bric acid, K sulfate, graphite, cu

   Chloride and boric ↑ thermal expansion (T.E.) in ca sulfate investment

A. *Ca-sulfate investment* : gypsum, ADA Spec #2
   1. Refractory : 65 – 75% quartz/cristobalite
   2. Binder : 25 – 35% α-Ca hemihydrate
   3. Other : 2-3% chemical modifiers (i.e. NaCl, MgO, Cu, boric acid, graphite)

Gold casting should be below 700°C b/c if over 700°C, Ca sulfate -> SO_2 & SO_3 - > embrittle casting, so this investment is not for Pd or base metal alloys. If temp > 700°C -> use phosphate bonded investments

Type I : cast inlays & crowns
Type II: cast complete & partial denture bases

Silica expands when heated (compensates for casting shrinkage)

1. *Cristobalite* 1.6% at 250 deg C → α-form stable at
2. *Quartz* 1.4% at 600 deg C →→ room temp; β-form
3. *Tridymite* <1% at 600 deg C → stable at high temp.

Heating, cooling and reheating investment → cause internal cracks

3 types of expansion

1. *Thermal*
2. *Setting*
3. *Hygroscopic*

Increase W/P ratio → decreas S.E. (thinner mix : decrease setting, thermal and hygroscopic expansion)

FACTOR	SETTING & HYGROSCOPIC EXP	THERMAL EXPANSION
↑ W/P ratio	↓	↓
↑ Spatulation time	↑	*No effect*
↑ Spatulation rate	↑	*No effect*
Age (investment)	↓	*No effect*
Delay before immersion	↓	-
↑ H2O bath temp	↑	-
Wax strength	*More distortion*	*Less effect*
Sprue location	*More critical*	*Less critical*

Finer silica → increase S.E. and Hygroscopic expansion (H.E.)
Increase silica/stone ration →increase H.E., decrease strength of investment

Base metal alloys usually cast into mold 85-0-1100°C so use:

B. *Phosphate bonded investment* (ADA Spec #42)

- Cast high melting alloys
- 3 parts:
  - 1st part contains water soluble phosphate ion
  - 2nd part reacts with phosphate ion
  - 3rd part is refractory material – i.e. silica
- Reaction produces water → decrease viscosity as you spatulate
- Increase exp by using different silica particle size
- Special liquid = form of silica solution, ↑ exp & strength
- Phosphate investment stronger & denser than gypsum

C. Silica bonded investments : flammable components & expensive

Brazing (soldering) : ADA spec #93 (phosphate & gypsum)

- Investment:
  - Should have lower S.E. and T.E. than casting investment so parts do not shift in position
  - Need not have as fine particle size b/c smoothness is not important

**investment for all ceramic: 1. Phosphate bonded and 2. Refractory dye type

Chapter 15: Noble Dental Alloys and Solder

Noble metals:

- Retain surface in dry air
- Resist oxidation, tarnish & corrosion during heating, casting & soldering
- Gold, Platinum, Palladium, Iridium, Rhodium, Osmium, Ruthenium
- Noble metal plus silver (Ag) = precious metals but Ag corrodes on oral cavity

GOLD (Au):

- Soft, malleable, ductile, rich yellow color, strong metallic luster, low strength, dissolves in Aqua Regia (18% volume nitric acid and 82% HCl acid);
- AU must alloy w/ Cu, Ag, Pt & others to increase hardness, durability & elasticity

PLATINUM (Pt):

- Tough, ductile & malleable, - Cu hard, high fusing pt, higher melt point than porcelain, decreases so coefficient of thermal exp (C.T.E.) is closer to porcelain's C.T.E., lightens gold yellow color; increases melt temp

PALLADIUM (Pd):

- White, absorbs hydrogen (H_2) gas when heated, similar to Pt, ingredient PVS: acts as H_2 scavenger when H_2 is produced as byproduct in secondary reaction

IRIDIUM, RUTHENIUM & RHODIUM:

- Grain refiners, keeps grain size small, small grains → improve mechanical properties & uniformity of property within alloy, increases melt point so doesn't melt during casting, serve as a nucleating centers for metal as it cools; fine grain alloys achieved by adding small amount of Ir, Ru to alloy

OSMIUM: expensive, not used in dentistry

<u>Base Metals</u>: Nickel, Copper, Zinc, Gallium, Silver, Tin and Indium

Silver (Ag):

- Malleable, ductile, white, conducts heat and electricity, stronger & harder than Au, softer than Cu
- Tarnished by sulfur
- Ag catch O_2 when molten → causes pits &porosity→ leads to rough casting; add Cu to prevent pitting caused by Ag
- Add Pd to prevent corrosion
- Ag neutralizes reddish Cu color and hardens Au

Copper (Cu):

- Malleable, ductile, high thermal & electrical conductivity, red color
- Reduces melting point & strengthens alloy (for palladium base alloy)
- Ag & Cu should be balance each other

Zinc (Zn):

- Bluish white color, tarnishes in moist air, low strength, brittle
- "Deoxitizing agent"' O2 scavenger → ZnO2 = dense, lags behind when casting
- Zn can often be replaced by Indium (In)

Indium (In):

- Soft, it works as scavenger & forms of O2

Tin (Sn): when combined with Pt/Pd → hardening effect but increases in brittleness

Gallium (Ga): oxides are important to bond ceramic to metal

Nickel (Ni):

- Common in non-noble dental alloys
- Whitens alloy, increases strength & hardness

Ni allergy:

- 5-10x greater in women than men (W>M)
- 5-8% women

24 Carat (k) = 100% Au = 1000 fineness
18k = 75% Au = 750 fine

Alloy Classification:

A. *High Noble:* ≥60% wt noble, ≥ 40% Au
Noble: ≥25% noble metal
Base: < 25% noble

B. *Type I-IV*: ADA Spec #5 (I-IV differ in yield strength), yield strength is the stress at which permanent deformation occurs

TYPE		RESTORATION	DUCTILITY	ELONGATION
I	Soft	Low stress, inlays	<140	18%
II	Medium	Moderate stress, inlays & onlays	140-200	18
III	Hard	High stress, Cr's, short span FPD	201-340	12
IV	Extra-Hard	Very high stress, long span FPD, RPD	>340	10

Definitions:

Tensile Strength = defined as maximum strength of alloy
(Cu, Ag, PD: increasetensile strength)

Hardness = resistance to local permanent deformation

(If high hardness → difficult to polish; if hardness of metal is greater than enamel, enamel may wear; Ag = soft; Pd= hard)

Elongation = indicates burnishability

Yield Strength = indicate when permanent deformation occur (i.e. clasp)

Elastic Modulus = rigidity

Uses of <u>Wrought alloys</u>:

1. Soldered to previously cast restoration
2. Embedded into cast framework by "casting to" alloy

Welding = 2 pieces (pc's) of metal joined directly

Soldering/brazing = 2pc's plus a 3rd pc

- <450ºC = soldering
- >450ºC = brazing

When soldering, b/w 2 metals, want clearance of business card thickness, 0.3mm

Chapter 16: Cast and Wrought Base Metal Alloy

Cobalt (Co) & Ni are interchangeable
Co-Cr alloy = high fatigue resistance

Cobalt: ↑elastic modulus, strength, hardness more than nickel

Chromium (Cr): tarnish & corrosion resistant (≥30% of Cr in alloy makes difficult to cast due to formation of brittle phase)

Carbon (C): increasing content of C → increases hardness of Co alloy

Beryllium (Be): add 1-2% Be to Ni alloy will decrease fusion range: Be& Ni- dust when grinding

Silicon (Si) & Manganese (Mg): increase fluidity & castability

Titanium (Ti):

- Resist electrochemical degradation
- Benign biological response
- Light weight
- Low density
- Low modulus of elasticity (less rigid)
- High strength
- High melting point

- Hard to cast b/c high melting pt, metal becomes contaminated b/c absorbs gases (ease of oxidation) so must cast under vacuum shield argon
- **Stable oxide layer** → resist corrosion, biocompatible
- 4 grades of pure Ti (grades differ in O2 & iron content)
- At room temp: commercially pure (c.p) Ti = HCP (hexagonal closed pack); α- (alpha) phase
- At 883ºC: body centered cubic; β- (beta) phase → stronger & more brittle than α-phase

Ti-6Al-4V: has low melting temp compared with CpT

- At room temp: alpha & beta alloy
- Aluminum (Al) = α-stabilizer
- Cu & Pd = β-stabilizer

Implant/tissue interface: implant – heterogeneous metallic oxide – proteinacious layer – connective tissue

Plasma- spraying includes: Hydroxyapatite (HA), tricalcium phosphate & tetracalsium phosphate

Chapter 17: Casting and Soldering Procedure

Low wax technique: 1907, Taggart

Definitions:

Pickling = 50% sulfuric acid & H20; casting is pickled to remove oxides

Flux = prevents oxidation of solder, dissolves surface oxides, facilitates free flow of solder, i.e. borax, boric acid with potassium fluoride

Antiflux = prevent metal flow; i.e. graphite, rouge (FeOx), Ca carbonate

Metal shrinkage:

- Metal shrinkage occurs when molten metal solidifies; when casting cools to room temperature
- Typical metal shrinkage: 1.25 – 2.5%
- Wax shrinkage + metal Shrinkage = wax exp + S.E. + H.E. + T.E.

Sprue:

- Attachment → flare so more even flow of metal into mold, less porosity; if no flare, sharp point of investment may break off & incorporate into metal
- Directed toward margins to minimize turbulence of flow of metal & favor fine margins
- If large sprue diameter & high density metal → faster the metal should enter mold (Incomplete castings – may be due to small sprue diameter)

Wax pattern should be 6mm from end of casting ring b/c:

1. Enough thickness to contain molten metal
2. Reduces amt of investment through which gas must escape
3. Casting cools more rapidly than centrally located sprue

Ceramic paper liner: inside ring, allow for exp, 3mm short at each end so investment is locked in & uniform exp occurs
Add 5 min to burnout time for very extra ring in the oven

<u>Wax:</u>

- Highest Coefficient of Thermal Exp (CTE) of any dental material
- Organic material, made of C, H, O & N
- When heated to high temp, material decomposes into CO_2, H_2O, NO_2 which are all gases that have to escape from investment
- If sufficient O_2 available, or temp not high enough or wax heated for short time, incomplete reaction between wax and O_2 result
- For phosphate bonded investments: overfill casting ring, allow it to set, and then grind off excess. Overfilling then grinding will improve permeability of investment to allow gas to escape from mold during burnout

Casting defects:

- Difference in temp b/w outer & inner aspect of mold increase if place in hot oven or heating rate is too rapid, outer expands more than inner → **cracking**
- Voids/casting defects due to gases trapped in mold
- Dark casting b/c incomplete burnout of wax; black coating from cabon, mold in oven too long (deoxidizing agent decomposed), oxidizing flame was used or no deoxidizing agent present
- *Suck back porosity* = if solidification does not occur in systematic manner & part of alloy in sprue freezes before alloy in casting
- Positive bubble due to air entrapment during investing

Function of reservoir: keep alloy molten for a longer time period to attain complete casting

Chapter 18: Ceramic

Definitions:

Ceramics = made of nonmetallic material at high temp
Porcelain = kaolin, quartz, feldspar fired at high temp
Feldspar = K-Al-Silicate; main raw ingredients of porcelain
Leucite = high exp; adjusts/controls CTE of porcelain; increase strength of porcelain
Sintering = process of heating the ceramic to ensure densification
Glaze = thin glassy film formed by viscous flow on porcelain surface at or above body temp
Overglazing = unnatural shiny appearance, lose contour & shade modification

- 20-60% below lost temperature

All Ceramic can be process by:

1. Sintering – lava
2. Heat processing –Dicore
3. Slip casting – increases process
4. Machining

A. Sintered All ceramic: 2 technique
    1. Aluminum-Based Ceramic; As Di-core
    - Strengthen by dispersion of crystalline phase (up to 50% aluminum)
    - Aluminum has high modulus of elasticity(350Gpa) and high fractural toughness (4mpa)
    - Excellent bond b/w alu and glass phase - ↑strength
    2. Leucite-reinforce ceramic:
    - Feldspathic contain up to 45% leucite " reinforcing phase"
    - High leucite – high flexural (104 mpa) and compression strength
        -high coefficient of thermal construction
        -thermal construction mismatch b/w leucite & glass→place glass under compression stress→↑resistance to crack propagation
    - Magnesium- Based core porcelain:As In-ceram Spinell
        - High twice flexural strength than feldsparric
        - core material allow more space for veneering porcelain

B. Heat pressed all ceramic (also called "High temp injection molding"
    - High temp anf pressure to sinter and shape ceramic which allow less pores and good dispersion of crystalline with glass
    - Leucite-based = 35 – 55%
      = ceramic press b/w 1150º - 1180ºwith pressure of 3-4 mpa
      = mold made by lost wax tech
      = ingot available in different shades by two techniques: staining and layering tech (high CTE)
      = disadvantages: cost of equipment, low strength compare with other all ceramic
    - Lithium-Disilicate-Based:
      = $Li_2Si_2O_5$ as major crystalline phase (60%)
      = heat press – 89-92º
      = advantages: superior flexural strength and fractural toughness, slow process times acceptable marginal accuracy

C. Slip cast:
    - Condensation of aqueous porcelain slip on refractory dye
    - Water absorb by porous investment → put it in a high temperature
    - Less porosity, higher toughness than feldspathic porcelain
    - High opacity and long processing time

Thermal Shock: too rapid cooling of porcelain → get crack/carzing

Porcelain:

High fusing	1315 - 1370°C
Medium fusing	1090 - 1260°C
Low fusing	870 - 1065°C
Ultra low fusing	<870°C

Denture teeth: high & medium fusing
Low fusing is beneficial b/c CTE differences tolerated better in lower temperature range

Opaque layer:
1. Masks dark metal
2. Forms ceramic-metal bond
3. Opacifiers = Sn, Ti, Zirconium Oxide

Metal CTE> Porcelain CTE: to ensure ceramic is in slight compression after cooling establish better resistance to crack propagation

Manufacturer:
Potash feldspar + quartz + alkali metal carbonates (flux) → heat 1200°C → form glassy (vitreous phase & crystalline (mineral) phase (has leucite) → cooled rapidly (quenched) in H_2O → shatter into small fragments called frits
Metallic pigments:
TiOx = yellow/brown
Fe Ox= brown
Nickel = brown
Mang Ox = lavender
Cobalt Ox = blue
Cu/Cr = green

Drying:
- Porcelain placed in front of open preheated porcelain furnace to dry 5-8min: excess water is removed; H_2O diffuse & evaporate;
- If it dries too quickly → spontaneous breakage
- After in furnace, left over H_2O removed till 480°C

2nd firing - 56°C below fusing temp; bisque baked

Pores due to air trapped during sintering so fire under vacuum:
1. Improves translucency
2. Decrease surface roughness
3. Increase impact strength 50%

CAD/CAM = computer assisted design, computer assisted machining

Bond between metal and ceramic
1. Chemical bonding: due to oxide layer (silicon + oxide Layer)
2. Van derwall: attractive forces between molecules
3. Mechanical Interlock

- Ceramic penetration into rough metal surface
- ↑ surface even by roughness surface also improve chemical bond
- Sandblast – remove excess oxide and ↑ roughness

4. Compression forces:
   - Due to slight difference in thermal expansion (.5 to $1x10^{-6}$°C)
   - Place porcelain under compression when it is cool to room temperature

Porcelain denture teeth

Advantages:

1. Superior esthetics
2. Resist abrasion
3. Shade stability
4. No other solvents except Hydrofluoric acid effect porcelain
5. Porcelain dimensional stability & permanence of from > acrylic

Disadvantages:

1. Difficulty polishing after occlusal adjustments
2. Results in wear of opposing teeth
3. Porcelain harder than enamel
4. Flexural strength of dental plastics superior to dental porcelain

Acrylic denture teeth

Advantages:

1. Acrylic plastic strength > porcelain
2. Acrylic able to cushion impact force of mastication & avoid fracture caused by brittleness
3. Flexural strength of dental plastics superior to dental porcelain

Disadvantages:

1. Plastic flow of acrylic > porcelain; doesn't return to original form, it yields
2. Acrylic teeth softer than dentin

Chapter 19: Ceramic-Metal System

Requirements:

- High fusing temp of alloy > firing temp of porcelain (Na & K oxide = decrease fusing temp of porcelain)
- Compatible CTE to prevent ceramic cracking (increase CTE of porc by leucite and K oxide
- High alloy stiffness decrease stress in ceramic by decreasing deflection & strain
- High sag resistance: thin alloy coping shouldn't distort during ceramic firing
- Low fusing temp ceramic: higher than porcelain and solder
- Ceramic should wet alloy (contact angle of 60 or less)
- Good bong and accurate casting

Ceramo-metal bond due to chemisorption by diffusion b/w surface oxide on alloy & in ceramic

Bond b/w Metal and Ceramic:

1. Chemical bonding: due to oxide layer (silicone + oxide layer)
2. Van Der Wall: attractive forces b/w molecules
3. Mecahnical Interlock:
   - Ceramic penetration into rough metal surface
   - ↑ surface are by rougher surface also impose chemical band
   - Sandblast – remove excess oxide and increase roughness
4. Compressive forces:
   - Due to slight effect in chemical expansion
   - Place porcelain inder compression when it is cool to room temp

<u>**Oxide formation:</u>

- Noble metals: (resist oxidation) have **Indium** and **Sn (Tin)** added to form surface oxides
- Base metals have **Ni, Cr, Be** (form oxides during degass) but avoid too thick oxide layer
- Oxides rich in NiO → dark gray
- Too much Cr2O3 → greenish
- Opacifiers = Zirconium, Ti & Sn

Alloys:

<u>*Au-Pt-Pd:*</u>

- <u>High noble content</u> = good corrosion résistance; high stiffness (modulus of elasticity), strength & hardness; its yellow color is more esthetic than white alloy; low sag resistance; costly (b/c noble & dense)
- <u>Pt/Pd</u> = increase melting range In, Sn & Fe = oxide bond
- <u>Rhenium</u> = grain refiner

<u>*Au-Pd:*</u>

- White so difficult esthetically; stronger, stiffer & harder > Au-Pt-Pd
- In = bonding, Ga = decrease fusion temp; Rh = grain refiner; Ru = castablity

Some Ceramics use with high Ag alloy → “greening”, color shift to yellow

<u>*Base metal:*</u>

- Harder than noble metal, higher modulus of elasticity
- Be=improve castability

<u>*Ti types*</u>: hard to cast b/c ease of oxidation

Summary:
Noble alloys =good corrosion resistance but only Au-Pt-Pd = yellow color. Others are white (gray) which is difficult to mask with ceramic
Pd-Ag: greening
Pd-Cu: dark oxides (compromise esthetics)
Ni-Cr & Co-Cr = high hardness & modulus of elasticity
Metal coping heated in air or partial vacuum to produce surface oxides (Fe, In, Sn)

Chapter 20: Cements

Zinc Phosphate (ZP), Glass ionomer (GI) & zinc oxide eugenol (ZOE) can be used as a base in deep cavities to insulate pulp

ZP = mechanical retention

GI/hybrid ionomer & compomer = release fluoride & bond chemically to tooth

Resin cements = bond to acid etch enamel & dentin

Cavity varnish = more than one resin from natural gums, synthetic resin or rosin

LEAST to MOST soluble: GI, ZP, ZOE, polyacrylate

Zinc Phosphate: ADA Spec #96, 25 microns
- Powder: contain zinc oxide mainly; MnO = smoothness; SiO2 = inactive filler;
- Bismuth O3 = smoothness; Tanin fluoride
- Liquid: Al & Zn with orthophosphoric acid
- Use cool thick glass to dissipate heat of reaction
- If add H2O → rapid reaction, shorten setting time
- If lose H2O → increase setting time
- Mechanical retention b/w tooth surface irregularity & restoration
- Shrinkage on hardening, effective thermal insulator
- Initial acidity may excite pulp or thin dentin layer, pH increase; at 1 hr – pH = 6
- Final consistency: 2-3 cm

ZOE: (Temp-Bond)
- Powder: ZnOx, white rosin (decrease brittleness), Zn stearate (plasticizer), Zn acetate (increase strength)
- Liquid: eugenol, olive oil (plasticizer)
- Sedative effect
- Eugenol = inhibitor for fre radical polymerized material
- Non-eugenol: has aromatic oil & Zn oxide instead of eugenol
- Etting time decreases as temp/humidity increase
- More powder → stronger → more viscous

Zinc Polyacrylate = Polycarboxylate:

- Powder: zinc oxide &manganese oxide
- Liquid: polyacrylic acid
- Set cement bound to polyanion chain by electrostatic interactions rather than by stronger specific ion binding
- Bond to enamel & dentin, more acidic than Zp, minimum penetration to pulp
- Pseudoplastic = flow increases as spatulation increase

Glass Ionomer:

- Powder = Ca fluoroaluminasilicate glass, barium glass, Zn oxide (radiopacity)
- Liquid = H2O or dilute tartaric acid in H2O
- Bond chemically to enamel & dentin, ionic interaction with Ca & phosphate from enamel/dentin surface
- Treat dentin with acidic conditioner (removes smear layer), then treat with Fe-Cl to improve bonding; Fe deposit increase ionic interaction b/w cement & dentin
- Moisture sensitive
- Hypersensitivity caused by cement (mild to severe)

Compomers: polyacid modified composites

Chapter 21: Prosthetic Applications of Polymer

Acrylic Polymer: ADA Spec #12

1. Powder:
    - Polymer: Polymethylmethacrylate
    - Benzoyl peroxide: initiator, 0.5 -1.5%
    - Pigments: mercuric sulfide, cadmium sulfide, ferric oxide, carbon black
    - Opacifiers – zinc oxide, titamium oxide
    - Plasricizers: dibutyl phthalate
2. Liquid:
    - Methyl methacrylate (allergen)
    - Inhibitors: hydroquinone: .003-.1%; prevents polymerization by heat, light & oxygen
    - Accelerators: tertiary amines, N, N dimethyl-para-toludine
    - Plasticizers: softer more resilient polymer, plasticizer molecules do not enter the reaction but interfere with interaction b/w polymer molecules, it gradually leaks out; polymers may be plasticized by addition of higher ester to methylmethacrylate –no leaching out so remain flexible
    - Cross-linking agent: glycol dimethacrylate 2-14%; link polymers together,resist crazing, decrease solubility & water sorption

1. Pour type denture resin: smaller powder particles, fluid resin
2. High impact strength: butadiene-styrene rubber
3. Light activated: urethane dimethacrylate, photoinitiator
4. Heat Processed:

- Denture processed at 74°C
- No substantial polymerization occurs till denture flas heated above 70°C

Shrinkage:

- Volumetric shrinkage = 21% of all monomer
- If powder & liquid (polymer + monomer), 3:1 ratio = 6%
- Light activated: 3%
- Linear Shrinkage = .3 - .5%
-

Stages:

1. Sandy
2. String/sticky
3. Doughy (pack denture in doughy stage)
4. Rubbery/elastic
5. Stiff

Denture Defects:
Streaking/blanching of denture due to incomplete wetting of powder by monomer
Alcohol caused *crazing*
Excess monomer → increased shrinkage, working time and porosity
Inadequate monomer → insufficient wetting, dough difficult to manage and decrease quality of denture

Relining and Rebasing

- After ___ denture due to bone and soft tissue change retention might alter
- Retention guide by relining and rebasing if V.D or occlusion is acceptable

Relining:

- Process of film of plastic is added to antangle surface to improve fit
- In technique in making impression - flask 21
- Relining material could be permanent or temporary, porous and steri easily
- Requirement :
  a. Good chemical bond
  b. Good strength
  c. No worpage
  d. Short time
- Polymerization should occur between 74^{o} and 77^{o} C to prevent worpage
- Temporary reline material has escollium temperature 54^{o} to 79^{o} C for 6-11 minutes
- Removed to –cold water and return it back
- Disadvantage of temperature relining: escollium heat, unstable color, burning mouth (monomer content)
- ADA Spec: 17 – temperature not more than 75^{o} C and time hardening between 6-15 minutes

Rebasing:

- Dimensional relation of tooth are maintained and replace entire base.
- impression taken – cast – flask – remove base and put new material

Tissue conditioning:

- Soft elastonomers use to treat irritated and abused mucosa
- Flow slowly after application
- Use for short term and need to replace every 3 days
- Povidone: PEMA liquid: ester-ethyl alcohol (up to 30%)
- Tissue conditioning become soften due to loss of alcohol
- Main properties:
    1. Viscous behavior: adapt to irritated tissue
    2. Elastic behavior: cushions under fracture and parafracture force

- Initial flow depend on:
  1. Time of loading
  2. Volume of material
  3. Load applied on seating
- Plastisine is added different % up to 58%

Implant

Nobel implant
Ti-unite- moderate rough thickened Ti O2 with high crystalline and phosphorus
Content: spark iodization, it builds on tradition of machined implant surfaces
Nobel has 4 implant system, Grade 1 pure Titanium
Nobel active= initial stability is good, ideal for aesthetic zone, taper, microthread
Nobel replace= taper, microthread
Nobel speedy= taper tip with parallel drill, all on 4, two type-NS internal replace, NS groovy external connection
Branemark= self cutting, parallel side, enternal hex connection

Two drilling protocol
1. Parallel
2. Tapered

Three connections:
1. Internal conical connection
2. Internal tri channel connection: easy of use, color coded, tactile feedback and stability
3. Internal brex connection: versatility, 6-12 position good for screw retain angle restoration

Ti-unit surface sturdy: start use at 2000 before Branemark implant was machined surface
1. Stable marginal bone levels after initial bone remodeling phase and over large term follow up of 10 years
   -Degidi and Piatelli: 10 years follow up -→ branemark immediate load, 1.9mm in 10 years
   -Ostman and Hellman: 10 years follow up, 20% implant immediate load and healed socket
2. High stability in critical phase healing compound with machined surface (Glauser and Hammerle)

Nobel Active:
- Minimal marginal bone remodeling→ Arnhart, 3 years study
- High success rate over 3 years > 95%

Zimmer
1. Taper screw vent: TSV- 11 years (2002)
   - TSV- MTX→ 1mm machine color
   - TSV- HA→ 1mm machine color
   - TSV-M→ .5 mahine color + 1.8mm MTX microgroove
   - TSV -T→ 1.8 mm coated collar + 1.8mm MTX microgroove
2. Taper- swiss plus "Advent"
   - Single stage- soft level implant with MTS surface
3. Trabecular metal implant:
   - Similar structure to cancellous bone, design to allow bone to grow in→ osseo incorporation

- Zimmer one piece

MTx→ microtextered titanium

- Non coated microtextured surface created by grit blasting in machined implant surface with HA particle follow by watching in non etching acid to remove blasting material.
- MTx surface shown increase bone opposition compare to machine surface (72% vs 38%)
    - Trisi and Todisco→ BIC compound MTx and machine in sinus graft
    - Todisco and Trisi→ compare 6 dental implant surface to → MTx has excellent BIC and osteoconductive capacity(implantation humor sinus and then section hole area)

Connection:

- Friction fit internal hex connection: torque to 30 Ncm
    - Lead in bevel and 1.5mm deep internal hex to decrease horizontal bone stress and distribute forces deep in implant and shield screw from load
    - Eliminate abutment micromovent and decrease screw loosing

Bimon etal, chun→ FEA→ show decrease stress on bone.

<u>Atlantis abutment</u>

1. Titanium- milled from solid titanium alloy blanks, titanium alloy TI 6 AL 4 V (grade 5)
   Gold shaded titanium → thin coating titanium nitride
2. Zirconia→ milled from Y-TZP blanks, 5 shade
   Use CAD and CAM abutment design (software VAD→ virtual abutment design)

Advantage:

1. Provide optimal support and retention for first restoration'
2. Promote soft tissue management
3. Cost (no gold)
4. Can be anatomical contour for good emergence profile and margin design

Publication:

1. Excellent aesthetic → Ganz, Kois and Kan
2. Decrease chairtime → adams
3. Cost effection and simplify tx procedures
4. Accuracy of fabrication
5. Optimum fit between A and I

   IA interface was perfectly sealed compare with replace select→ Sumi and Wennerburg, precise adaptation in SEM and radiograph compare with stock abutment→ Apicelle and Ferarri.
6. Allow direct fabrication of casting in duplicate which result in smaller marginal gab and better retention compare with indirect technique using stone or epoxy resin→ Ganz and Weiner 2006

7. Minimize soft tissue changes from removing and replacing abutment→ Albretsson,Abrahmson.

Abutment: abutment implant interface

1. External connection: Butt joint
2. Internal connection: in slip fit, 2. Friction fit (beveled joint)

External connection: Branemark
- hex of 1.2mm long use in hybrid
-Disadvantage:
1. 40% screw loosening (Jemt, Becker and Becker)→ single tooth implant
2. Rotational misfit

Internal connection:
-First use with core vent system by Gerald NiZnick
-1.7mm IC with 0.5mm wider internal bevel
Advantage:
1. Decrease vertical height of platform for restorative component
2. Distribute lateral load deep within implant
3. Shielded abutment screw

Types:
NB→ morse taper 12^0 - 3.8mm length of IC/I
Zimmer→ friction fit internal hex – 1.5mm length of IC/I eliminate movement
Strauman→ mourse taper 8^0 syn octa cross fit- 2mm of IC/I
3I→ 6 point hex of 12 point double hex -4mm of IC/I
NB→ internal conical “hexagonal con”→ NA and NR conical
→internal tri channel → internal trilobe – easy repositioning→ replace select
→external connection→ 6-12 positions→ N branemark Nobel speedy

System provide platform switching→ 3 I, astra, strauman bone level, nobel active and replace IC
Norton, 1997, COIR→ compare strength of IC (astra, biconical) and EC (butt jont, BN)
-IC need double force to fatigue sample (3 point bending) 1315 vs 645 N mm
Conclusion:
1. IC has higher failure force than EC
2. Seating of restoration component, screw loosening, abutment microgap lesser with IC
3. Bacterial microleakage was marginally lesser in IC

Abutment Selection:
-Material “Plastic , Ti, gold, ceramic(Zr or Al)- use (healing , temp, final)
-Mode of retention (screw, cement) manufacture (stock-custom)
-Baldassori, 2012→ 3 Zr system of microleakage→ atlantis has less than nobel
-Angle >15^0→ use custom abutment rather than prefab→ Giglio
-Deep implant use multiunitt abutment or custom abutment and preferable screw retain
-Shallow implant use ceramic abutment to mask subgingival color

-Restoration space→ <6mm screw retain

Cleaning cement:

- Placeing margin above or 1mm below gingival (2 and 3mm shows sign cement left
    - Linkevicus (2012, CoIR)→ deeper margin→ greater non detectable cement and radiograph shouldn't be consider as reliable method to detect cement.
- Use copy abutment, venting crown, decrease luting agent

Premier Cement: Non eugonol- temporary resin cement

- Radiopaque material easy to detect
- Provide excellent retention and good marginal seal
- Retrievability and easy to clear
- Low salability

Feature: working time→ 1.5m, setting 5 minutes
Film thickness→ 15μm

Implant Literature

???????????

Nanometre Surface Configuration:

- Electropolished surface (main ca-p or TiO_2)
- Few animal study exist to study importance of nanometre structure with a lot of unknown

Conclusion: direct correlation between BIC and surface roughness

- No consistent differentiation of roughness in literature
- Surface microroughness is surface nanoroughness even if it is not intended
  N.B. Astra implant surface
- TiO blast, osseospeed is first chemically modified titanium surface to nanoseal
- Microroughened Ti surface with fluoride → ↑ BIC and ↑ bone formation
- Has microthread → stress distribution and ↓ stress ratio

Clinical Study

- 5 years comparative analysis of systematic review of RCT (Esposito, 2005)
  - 6 implant compared shows no significant difference in regard of success rate and MBL with patients rather than per implant basics (AstraTioblast grade 3, BN turned G1, ITI SLA grade 4)
- Jokstad and Wennnerberg, 2003:
  - No significant difference between implants compared

Primary Stability: Elias, Brazil, 2012

- Prerequisite for OI (Branemark, 1977, Albrektsson, 1980) especially for early or immediate loading
- Insertion torque fuse to predict implant survival and estimate healing time (Walker, 2011)
- Primary stability assure high resistance to micro movement which is important for successful OI and movement shouldn't exceed 150μm (SZ Mukler, 1998) and lead to a reduction in patient treatment time
- Minimum or maximum value of primary stability is not determined
  - Immediate load with insertion torque 'IT' of > 40 N cm → 100% success rate (Degidi &Piatelli, 2005)
  - 92.5% success rate of immediate compare with 100% rate of delayed (Degidi &Piatelli, 2005)
  - Primary stability must be enough to avoid implant mobility but not induce bone injury
  - 9.8 μ increase in IT → ↓ implant loss by 20% (Ottoni et al, 2005)
  - Raccuzzo et al (2009) suggest a torque of at least:
    1-30 Ncm for single immediate load and 20 Ncm for multiple implant
- Primary stability of immediate loading in post Mx is difficult because:
  1. Thin cortical bone
  2. Low density and trabecular bone
  3. Inadequate height
- Factors affect implant stability

1. Surgical technique: use tool one size smaller than diameter of implant (Hermann, 2005)
2. Bone quality and density: (Alghamadi, 2011) cortical thickness
3. Implant design:
   -↑ length and diameter → primary stability
   -shape = taper "conical" required more insertion tongue than straight "cylindrical"
   Surface treatment → anodized and acid etch > machine

Immediate, Early, Conventional Loading (Esposito, et al)

- Primary stability and lack of micromovement are pre-requisite for successful OI implant "Albrektson and Branemark"
- Presence of movement lead to soft tissue encapsulation and causing factor to minimize that, it has been recommended by Branemark to keep implant load free for 3-4 months in Mn and 6-8 months in Mx
- Immediate (within 1 week), early (1 week to 2 months), conventional (> 2 months)
- Immediate implants can be successful for selected patient with high primary stability

Socket Preservation "Scott Froum"

- Proper management of extraction site prevent need of advance ridge augmentation at implant placement and maximize esthetic and function (ideal position implant)
- Normal healing of post-extraction healing as resorption and maximum in horizontal dimension of buccal ridge
- 5 Stages of Healing in Human Extraction Site:
  - Stage 1 – clot forms
  - Stage 2 – replace clot by granulation tissue in 4-5 days
  - Stage 3 – replace granulated tissue by CT , 14-16 days (CT has fibreblast , collagen and ground substance)
  - Stage 4 – calcification take place at base of socket, start at 7 days, takes 6 weeks to fill socket
  - Stage 5 – epithelium closure completed 24-35 days, at 8 weeks → slow osteogenic activity and by 16 weeks → bone fill is completely
- 50% of loss of ridge width with average of 3.6mm is in horizontal within 6 months
- .9mm loss of ridge height (Iasella, et al)
- Iasella use allograft with collagen membrane and found that less width loss of 1.6mm and 2.2mm in height
- use graft in socket work as scaffold and promote new bone formation but it does not prevent bone remodelling of socket → Arauja and Lindhe
- Material used, autogenous, allogenous, xenograft and alloplast
- Iasella → using membrane ↓ gingival tissue thickness compared with no membrane due to less blood supply to crest
- Buccal thickness is important to assess (>2mm – no difference)

Ridge Preservation Technique for Implant Therapy (Darby and Buser, 2009)

- Ridge preservation is effective to limit H and V ridge alteration
- No evidence to support superiority of one technique over other

  N.B. Bioguide → resorbable contain collagen from porcine origin

Bioss → xenograft derived from mineral portion of bovine bone

Puros → allograft part outer mineralized bone → cortical or cancellous, scaffold

Biomend → absorbed collagen membrane – fully resorp by 8 weeks → collagen type I from bovine

CollaTape → collagen type I, ridge preservation, repair Schniedeian membrane → resorp in 2 weeks

CollaPlug → extraction site of 4 wall defect and biopsy site

Peri-implant Disease

-Darby, et al

Peri-implant Disease

1. Mucositis: apparent inflammatory changes restrict to peri-implant mucosa → revisable
2. Peri-implantitis: clinically and radiographically evident of loss of bony support for implant together with inflammatory reaction of peri-implant mucosa
    - Implant should be in function if it loose before loading, it considers apical peri-implantitis "contamination of epithelial rest of malassez than remaining in bone after extraction

Etiopathology

1. Epithelium fiber run parallel not perpendicular like tooth, low vascularization, higher rate of collagen fibre to fibroblast (ratio of 4 in tooth and 109 in implant)
2. Implant design → poor alignment of components? → more plaque accumulation
3. Use non-nobel component attach to implant → corrosion
4. Microbial infection → negative anaerobes spread from adjacent current periodontal disease
5. Excessive mechanical stress, occlusal load, poor implant distribution, cantilever, poor quality bone

Signs and Symptoms of Peri-Implantitis

1. Color change
2. Bleeding in probing
3. ↑ probing depth (25 grams, >5mm pocket)
4. Suppuration
5. Peri-implant radiolucency
6. Progressive loss of bone height (IMP shoulder to bone crest)

Treatment depends on if it is:

- Mucositis → "no bone loss", OHI, remove plaque and calculus, MW (3Tx/15day), check contour and occlusion
- Peri-implantitis → treatment depends on amount of bone loss and aesthetic impact
    a. Incipient bone loss – like mucositis + abutment decontamination and AB
    b. Advance bone loss – surgical debridement of affected tissue and implant surface + bone regeneration
    *Horizontal BL <3mm → apical replacement flap →decontaminate implant + GBR + AB (7-10 days)
    *Severe bone loss for strategic implant → decontaminate implant + GBR + AB (7-10 days)
    ** Decontamination: 40% citric acid 30-60 seconds' , chlorhexidine 2%, hydrogen peroxide, air abrasion, laser

N.B. use plastic rigid probe because metal can abrade implant surface

Peri-Implant Pocket

- < 3 mm
  - No plaque
    No BOP
    - No treatment
  - Plaque + BOP
    - Use plastic scaler
      OHI + scaling
- > 3 mm
  - No loss of bone component
    with Base Line
    - No BOP or Plaque
      - No treatment
    - Plaque + BOP
      - OHI + Debridement
        Surgical Resection
  - Loss of bone
    - Mild
      *OHI
      *debridement
      *local and systemic AB
      *GBR
    - Moderate
    - Severe
      Possible
      trephining

Biology of Bone to Implant

"Philip Boyne"

- What ever protocol used to prepare osteotomy → some bone necrosis will occur
- Branemark define osseointegration as "direct structural and functional connection between ordered, living bone and surface of implant"
- GPT define osseointegration as two words as "direct apparent attachment or connection of osseos tissue to inert alloplastic material without interfering of CT"

A. Implant place on healed ridge
- Implant placed on osteotomy will have direct bone contact and stabilized implant
- Blood from osteotomy site coat implant and fill space
- Blood will coagulate > clot organization → pre-osseos matrix and bone formation

B. Implant in extraction site:

- except apical part of the implant,most of implant not connect bone

- clot fill space, 4-6 weeks to fill socket with cancelluos bone

- cancellous or woven bone take more time to remodel with lamellar bone

Bone Necrosis

- About 1 mm of cortical bone adjacent to osteotomy site undergoes post-surgical necrosis inspite of careful surgical procedure (Roberts, 1988)
- Phase development: 3 phase to develop BI interface
  1. Stabilization phase → calluses form and adhere to implant
  2. Strength phase → lamellar stronger bone form due to osteoclast resorp non-vital bone and restore it with lamellar bone
  3. Durability phase → extensive remodelling and additional strength develop

**Remodelling rate: human cortical bone up to 10% per year
Trabecular bone: up to 20-30% per year
Highest remodelling is at 1 mm of bone implant interface

<u>Ectodermal Dysplasia</u>

(Pigno, JPD, 1996)

- It is hereditary X-linked disorder characterized by abnormal development of certain tissue of ectodermal origin
- It is syndrome exhibits at least 2 of the following features:
  1. Trichodysplasia – abnormal hair
  2. Onchodysplasi – abnormal nail
  3. Dyshidrosis – abnormal or missing sweat glands (avoid patient covering in surgery room)
  4. Hypo or oligodontin – missing dentition (alveolar bone defect)
- Fixed:
  - FPD with rigid connection should be avoided because growth (not cross midline)
  - Crown: larger pulp and shorter crown may be concern
  - Ortho, composite and RPD is common treatment
- Removable:
  - CD retention and stability is compromised because underdevelopment
  - OD is good option to prepare bone and get support
  - Deliver one denture at time, start with most retention (Till and Marques)
  - Periodic recall for relining and future replacing
- Implant:
  - 95% success rate (Smith and Ekstrand)
  - Jaw growth
    -Mn is safe (symphysis), Mx anterior is dangerous, at growth time
    -Maximum jaw growth 15 years for girls and 16 years for boys → Leckholm

- Cronin, et al:
  - Implant place after age of 15 in girls and 18 for boys provide most predictable prognosis
  - Complication of placement is growing palate
    1. Implant submergence because jaw growth and infraocclusion
    2. Implant exposure because bone resorption with growth
    3. Bone movement because jaw growth
    4. Limitation of growth because implant connected at midline by rigid preothesis

N.B. implanat should be used only if:

1. Growth is completed and hand and wrist X-Ray → no space
2. All teeth ar fully erupted

Yap and Klineberg, IJP, 2009:

- Implant placed in patients younger than 18 years have high chances of failure

- Osteopenia – thinning of bone mass

    *Test: DEXA C – dual energy X-Ray absorption

    *T. Scan: -1 to -2.5

- Osteoporosis – fragile bone density characterized by loss of bone mass caused by deficiency in Ca, Vitamin D, Mg and minerals

    *T. Scan ≤ -2.5

<u>Hybrid Implant Prosthesis</u>

(Drago, JP, 2011)

- Zarb and jansson stated that framework for fixed could be:
  1. Bulk will be metal and teeth with acrylic is minimum
  2. Bulk will be acrylic resin and metal will be the minimum
- Requirement for metal framework:
  1. Provide passive fit
  2. Bulk for strength
  3. Adequate access for oral hygiene
  4. Miminum metal display on Facial and Occlusal
  5. Allow good retention for acrylic
- 1.5mm is minimum for resin to resist fracture
- Ortorp and Jemt, 10 year study → low prosthetic complication
- Zarb and Schmitt → up to 9 years → high prosthetic complication → old study, no complications
- Staab & Stewart: compare Designs ‘L,I.U. Elliptical cross section’
  - Implant framework should be rigid o support prosthesis
  - I-beam design proposed deflect less and experience less stress
  - Elliptical shape deflect highest and L experience highest stress
  - Design of study use worse scenario, thinnest metal framework

Treatment Plans Reflected to Key Implant Positions and Implant Number

(Carl Misch, Chapter 8)

- The primary cause of complication in implant dentistry are reflected to biomechanics (e.g. early loading failure)
- Misch develop treatment plan sequence to decrease risk of biomechanical overload:
  1. Prosthetic design
  2. Patient force factors
  3. Bone density in the edentulous site
  4. Key implant position and number
  5. Implant site
  6. Available bone in the edentulous site
  7. Implant design

Abutment Option:

- As a general rule, implant-supported prosthesis independent from natural adjacent teeth are designed whenever possible:
  1. This concept reduced the risk of decay on the natural tooth margin next to adjacent pontic or abutment
     - Incidence of decay on a tooth splinted in FPD as a general rule → 22% with 10 years
     - Incidence of decay on individual crown → < 1% with 10 years
  2. Endodontics related factor "15% of patient within 10 years"
     - When an implant joined to natural tooth
       - An increased risk of abutment screw loosening
       - Implant marginal bone loss
       - Unretained restoration
       - Unequal distribution of the forces

Key implant position

Four general guide line to determine key implant position

1. No cantilevers
2. No three adjacent pontics
3. Canine-molar rule
4. Arch dynamic

1. No cantilever

- Cantilevers on the prosthesis: should be reduced and preferably eliminated → terminal abutments are key position
- Cantilevers are force magnifiers to the implant, abutment screws, cement or prosthesis screws and implant, bone interference
- Length of cantilevers is directly related to the amount of natural forces placed on the abutment
  - 25lb forces in long axis of implant → 25lb implant system

- 25lb force in 10 mm cantilevers → 250 lb forces in implant system

- Cantilever restoration on multiple implants may be compared with class 1 lever
- Cantilever is magnify forces to all abutment
- When cantilever is only a solution it is considered:
  1. Parafunctional forces
  2. Crown height
  3. masticatory dynamic
  4. Implant location
  5. AP spread
- When forces are low and bone density is favorable → cantilevers are extended 2.5 times the AP distance "AP spread → from distal implant to mild anteriorly"

2. No three adjacent pontics:
   - 3 adjacent pontics are contraindication on implant because:
     1. They are contraindication in natural teeth
     2. All pontic spans flex under load →
        a. a greater risk of porcelain fracture
        b. Uncemented prosthesis
        c. abutment screw loosening

-Span of pontics in ideal treatment plan should be limited size of two PM (13.5-16mm)
-2 pontics should be consider to replace molar
-missing tooth span is often related to the missing number of root in the Mn and number of buccal root in Mx.
-Start with 2 terminal abutment and then a pier or intermediary abutment to maintain no more than 2 pontics

<u>3. Canine and first molar sites</u>

- 3 adjacent teeth are missing (canine, PM, lateral)→ key implant position is canine and PM

why canine should be replaced be:

1. Magnitude of bite force is increased in canine region
2. Lateral exertion movement of Mn

-First molar is also a key implant position when 3 adjacent post tooth are missing why:
-forces are double to molar region
-when one implant replaces a molar→implant should be at least 5mm in diameter

<u>4. Key arch position</u>

-Arch divided to 5 segments

1. 2 central + 2 Lateral
2. Right Canine
3. Right PM and M
4. Left Canine
5. Left PM and M

-key implant position needs to be situated within each segment.

Implant Number:

- Number of implant in a treatment plan should barely used a minimum number
- All in 4 implant→ no safely factor of one implant fail.

- Additional implant

   A. Reduced cantilever height
   B. Reduced number of pontics
   C. More abutment → greater retention
   D. Reduced rest of screw loosening or uncemented prosthesis

-The decision on the number of implant in treatment plan begins with the implant in the ideal key positions, additional implant are most often required and primarily related to the patient force factors or to bone density in the edentulous site.

-The number of implants to replace all of Mn teeth range from 5-9 which at least four between the mental foramen when fears then 6 implant are used → cantilever must be design in fix prosthesis as result of Mn flexure.

-Cantilever in Mn should be in only one posterior quadrant to increase A.P distance and reduce force to implant.

- 4 implant in the Mn → cantilever at less risk because dynamic of arch, increased range A.P distance and favorable bone density.

-When 7 or more implant used for Mn → two separate restoration with no posterior cantilever→ permit Mn flexure and torsion.

-Greater number of implant in Mx to compensate for less bone density, more unfavorable biomechanics of premaxilla→ 7-10 implant.

<u>Splint or Not:</u>

- Advantage:
    1. Increased functional area of support
    2. ↑ AP speed to resist lateral force
    3. Increase cement retention
    4. Decrease risk of abutment screw loosing
    5. Decrease risk of marginal bone loss
    6. Decrease risk of implant component fracture--→ entire system benefits
- Disadvantage:
    1. Difficult to maintain a good hygiene
    2. Difficult to repair a single unit porcelain fracture.

<u>Sullivan study</u>: 4mm single implant replacing molar had implant body fracture in14% of the cases , multiple implant splinted together had 1% implant body fracture
<u>*Blash*i:</u> single tooth replace molar had 48% screw loosing over a 3 years period when two implant were splinted together to replace molar incidence of screw loosing was reduced to 8% over same period.
Full arch Mn implant prosthesis→ Mn flexes distal to the foramen on opening and has torsion on biting → don’t splint molar in other side ‘ Author openioin”

Platform Switching

- It is larger diameter implant restored by a narrowed abutment.
- It is developed accidentally in mid 1980.
- Concept based on BW re-established result of micro movement of implant abutment interface (IAI) horizontally (1mm)
- This concept will decreased bone loss around implant
- Advantages:
  1. Wide and more resistance area of CT around IAI (Beckker 2007 , Journal of Clinic perio)
  2. Better distribution of loading stressed IAI (Canullo, 2010, Clinic of oral implant research)
  3. Preserve peri implant soft and hard tissue (Canullo and Rasperini, 2007, IJOMI)
     - -bone resorption is .78 ± .36mm compared to 1.7mm were stander flush implant abutment interface
     - -soft tissue is 0.25 mm.

  - It can be used when implants distance is <3 mm (Xavier, International Journal of Perio & Resto dentistry.2009)
     - 41 pairs of implant with less than 3mm interimplant distance
     - 0.62mm vertical bone loss, 0.60mm horizontal bone loss
     - Bone above inter implant line is 0.24mm

- B.W. around platform switched implant is located more coronally than B.W. around nor platform switched implant (Becker , JCP 2007)

Factors Affecting Peri-Implant Marginal Bone

The Factors is (Hermann, 2007, Implant dentistry)

1. Biological width
- Bone remodelling will occur until B.W established.
- It is not only vertical but also horizontal(1.5m) study by Tarnow JP, 2007
2. Platform switching
- Beside previous advantage it also decrease bacterial contamination of transmission of bacteria into bone by moving micro gap away from bone to decrease pumping effect which is when loud increase at IAI.
- This phenomenon by Ericson is called **distance sleeve** associated infiltrated correction tissue (Ericson, 1995, J.Clin Perico)
3. Implant design at Cervical region : Nanoroughness, fine threads and insertion depth:
- Micro and macrorough titanium surface extend to implant neck facilitate OI along entire length of implant
- Fine threads in cervical region result in load transmitted to bone and formation of trabecular bone
4. Abutment design and avoidance of micro-lesion;
- Platform switching design
- By placing final abutment, micromovement will occur and apical migration of epithelium attachment around implant neck lead to more resorption (Abrahamsson,1997, J. Clin . Perico)
- Cochrane: epithelium & fibroblast attached to or adhere to rough and smooth surface

Crown contour over Implant (Huan Su, Int J of Perio& Resto, 2010)

Ideal implant placement

1. Apicocoronal : 2-4 mm apical from FGM
2. FL: 2mm from facial bone
3. MD: 2mm from tooth & 3mm between implant

Over contour: cause apical migration of tissue
Under contour: cause coronal migration of tissue

Implant abutment Crown Contour

1. Critical contour: 1mm apical to gingival margin
2. Subcritical contour: below to critical zone provide running room

Facial profit of critical contour will affect

1. G. Zenith
2. labial G. margin level

Affects of crown Contour

1. Gingival margin:
- Critical: Convex – recession, fat or concave- migration
2. Interdental papillae
- Critical &subcritical: convex squeeze papillae 0.5 to 1 mm

- High of papillae in implant is 3.4 mm ‘ Salama”

3. G. architecture it affect by contour
4. Aveolar process by overcontour subcritical facial contour- It can give support to gingival
5. Gingival color: dark color due to lack of G. support can be overcome by overcontour of subcritical zone
6. Gingival texture: can’t be changed by charge contour

<u>Clinical Methods for Evaluation Implant Framework Fit</u>

(by Kan et.al. JPD, 1990)

- Purpose: to discuss passive fit and to review clinical methods to check fit
- Ill-fitting implant framework may cause:
1. Mechanical failure (loosening screw, fracture of component)
2. Biological complication: adverse tissue reaction, pain, tenderness, marginal bone loss and loss of integration)
- Distortion can occur in 3d and it might introduce b.c
1. Implant alignment
2. Impression techniques
3. Material used
4. Framework design and configuration
5. Clinician and technician experience.

- KAL techniques and precise disc prosthesis system in which the cement medium may decrease strain produce in bone around implant.
- Acceptable level of fit (all is empirical)
    - Branamark (1983) was first to define passive fit and he proposed and it should exist within 10 µm to enable bone remodelling under occlossal force.
    - In 1991, **<u>Jemt</u>** define passive misfit are level didn't cause any long term clinical complications & suggest miss fit < 150 µm were acceptable
- It was proposed in acceptable misfit exist when greater than ½ turn was needed for gold screw after seating resistance was encounter

<u>Factors affecting framework fit</u>

- Clel-land et al demonstrate marginal gap up to 500µm for two implant framework when screw tighten 10 Ncm is not detectable by explorer

<u>Methods for evaluation misfit</u>

1. Alternative finger pressure; <u>Henry</u> suggest alternative pressure on terminal abutment. Adell et al suggest alternative finger pressure with observation of saliva movement. Becking and saliva movement help to detect misfit
2. Direct vision and tactile sensation
   - using explorer depend on tip of explorer (new is 60 µm), clinical experience margin , if it is sub or supragingival

3. Radiograph: perpendicular to implant abutment junction, overlapping is problem

4. One screw test:

- **Jemt** suggest one screw test

- Tan et al: 1 screw was tighten at one terminal abutment and discrepancies observe on other abutment

- It detect vertical discrepancy but not in Z axis direction in a ''bottoming out phenomenon''

5. Screw resistance tests

– 1991, **Jemt** based on his experienced of acceptable misfit up to 150 µm which is ½ distance between Nobel gold screw thread

- Gold screw are tighten one by one starting from midline until initial resistance between screw and framework is encountered. A maximum of ½ turn is allow to complete screw and 10-15 Ncm
- Misfit consider of your need more than ½ turn to achieve desired screw
- Flag technique by Rochette: tape placed around of screw driver

6. Disclosing media and other material: fitchecker, pIp, disclosing wax

- Lack of quantitative guideline for misfit and to achieve possible fit is emotional reasons rather than evidence based science.

Comparison of strain procedure in bone simulation between conventional cast and Resin luted implant framework (by Lelland, IJOMI 1997)

- It has been suggested more passive fit between framework and abutment maybe created by luting framework to abutment intraorally
- KAL (kulzer abutment luting technique used to improve fit and reduced strain and bone around implant.

Implant Surface Texture

Influence of Surface Characteristics on bone integration of titanium implants. A histological study in Peige (by Buser, J. Biomedical Material Research,1991)

- Morphometric analysis of 6 different surface placed in tibia and femur
- All implant has same shape and diameter and measure bone at 3 and 6 weeks

1. Type E: electropolished = bone contact= 20 – 25 %
2. Type SMP: sandblast with medium grit (.12 - .25 μm) and acid pickling HF/HNO3 = 20-25%
3. Type SL: sandblast with large grit (.25 - .50μm) = 30-40%
4. Type SLA:sandblast with large grit and acid etch under Hch/H2 SO4 = 50-60%
5. Type TPS = Titanium plasma spray = 30 – 40%
6. Type HA = plasma sprayed = 60-70%

- Conclusion: increase bone to implant contact is related to surface roughness.
- HA coated revealed sign amount of resorption (3 – 6 weeks)

Enhanced bone apposition to a chemically modified SLA Titanium surface (by Buser, J Dent Res, 2004)

- The most important surface properties is topography, chemistry, surface change and wettability
- Compare SLA and modified SLA (rinse under N2 protection and stored on isotonic Sodiun Chloride solution) – hydrophilic surface
- High bone to implant contact for modified SLA in 2 weeks (49- v.s 29% and 4 weeks (81 vs 66%)
- Modified SLA enhance bone apposition in early stage of bone regeneration

Review Surface Treatment of Titanium dental implants for rapid osseointegra (by Guechennee, Dental Material, 2007)

- Chemical composition of the surface of implants
    - Commercially pure titanium common use and has 4 degree of purity based on content of Oxygen, Carbon and Iron content
- Grade 4 Commercialy pure titanium is common used (stronger)
- Ti alloy are compose of Ti6AL4V (grade 5 ti alloy) has greater yield strength and fatigue
- Hydrophilicity of surface is an important contact for Ti implant range from O^o(hydrophilic) to 140% hydrophobic
- Hydrophilic SLA surface has higher bone to implant contact than regular SLA

Surface roughness of implants:

- Roughness divide into 3 scale – macro-micro and nano size topographies
- Macroporous surface give surface roughness > 10μm
- Microporous surface give surface 1- 10μm
- Nanotopography absorb protein leading to adhesion of osteoblast
- Ideal surface should be covered under hemispherical pits of 1.5 ‘depth’ x 4μm ‘width’

Ca phosphorus (HA) act as osseoconductive which make matrix for tissue to attach.

- Plasma spray technique – HA ceramic particles are injected into plasma at high temperature and project to surface if titanium.
- Disadvantages:possible delamination of coating from implant.

Albrektsson and Wennerberg,2004 classify roughness value to 4 group smooth <.5µm, minimum rough .5-1µm, moderate 1-2µ and rough >2µm

Dental implant surfaces (by Ballo)

- describe preparing of each implant surface
- SLA active – SLA implant rinse in Nitrogen atmosphere and store in saline solution to reduced amount of carbon and improve hydrophilicity

3 I Implant

Osseotite implant: tapered certain external hex, platform..'

- acid etch surface provide effective clot/ implant attachment aid in increase platelet activation and RBC agglomeration
- osteogenesis around implant:

1. Contact osteogenesis, direct migration of bone building cell through clot matrix to implant surface, bone is quickly form direct on implant surface

- Stronger clot connected to implant surface, high degree of contact osteogenesis

2. Distance osteogenesis: gradual process of bone healing inward from edge of osteotomy to implant, bone doesn't grow direct on implant surface

Park and Davis, COIR, 2000

- Osseotite yields 110% increase in platelet adhesion and 54% increase in RBC agglomeration in compare well machine surface

Bone Graft

Allograft

1. DFDBA → it is osteo-inductive due to available BMP
2. FDBA → osteo-conductive act as scaffold and need delay release of BMP as osteoclast decalcify bone & release protein

Study:

- **Wood, Robert, 2011, JP** → human histologic study compare healing after extraction with ridge preservation using DFDBA or FDBA
  - 40 patient of 20 in each group → graft taken from one patient and treatment based on mineralization
  - Result after = 14 weeks of biopsy taken from socket is:
    1. No significant difference in H or V alveolar ridge dimension or CT between 2 group
    2. Significant difference in vital bone of 14% more in DFDBA
    3. After = 19 weeks, residual growth of 9% in DFDBA and 25% in FDBA
- **Beck and Mealey, 2010, JP** → histological analysis and healing after ridge preservation using FDBA
  - 38 extraction and ridge preserve: 16 site heal for 14 weeks and 22 sites for 27 weeks
  - Result: 1. No significant difference between 3 or 6 months of healing between newborn (45%), residual graft (14%) and non-mineralized tissue (40%)
- **Wallace and Froum (2003, JP)** → systematic review: Mx sinus augmentation and survival of implant
  1. Average survival rate of 92% of lateral window and it is equal to ungrafted post Mx
  2. Rough surface implant has high survival rate in sinus compared with machine surface
  3. Implant survival rate is higher when membrane used in lateral window
- **Iasella et al (2003)** → non-molar extraction of 24 patient and use for ½ of them FDBA and collagen membrane, measure ridge dimension after 6 months
  - Result: 1. Ridge width change of extraction – 2.7mm and with graft – 1.2mm (1.6mm difference)
  - 2. Ridge high change of extraction – 0.9 mm and with graft + 1.3 mm (2.2mm difference)
- **Darby and Buser, 2009** → RP techniques for implant
  - Review: - ridge preservation are effective in limiting H and V ridge alteration
- No evidence to support superiority of one technique over other

Bone grafting material in implant dentistry (by Misch, ID,1993)

- Bone graft act on three different mechanism:

1. Osteogenesis: material able to form bone directly from osteoblast
2. Osteoinductive: material is able to induce transformation of UMC, Mesenchymal into osteoblast or chondroblast and enhance bone growth.

- It depends on specific protein such as bone morphogenic protein "BMP" located primarily in cortical bone

3. Osteoconduction: permit bone apposition from existing bone and required presence of bone or UMC. It is not produce bone

Type of Bone Grafting Material

1. Autogenous bone

- It is only osteogenic material available
- Common introoral site tuberosity,ramus, symphysis exostosis and tori
- Grafted bone heal in 3 phases:

Phase 1-osteogenesis form osteoid within 4 weeks
Phase 2 – osteoinduction – BMP and other protein release 2 weeks to 6 months (peak at 6 weeks)
Phase 3- osteoconduction – inorganic matrix – space filler
cortical plate – GTR

Graft bone can be:
- Trabecular bone: provide cell for osteogenesis
- Cortico trabecular: allow containing and adaptation to site
- Cortical: act as barrier to soft tissue invasion and provide most of BMP compare to trabecular bone and more resistance scaffold

2. Allografts: from same species but different genotype (e.g cadavers)
   - Advantage: availability, eliminate donor site, decrease anesthesia and surgery time, decrease blood loss, less complications
   - Disadvantage: medical condition of other, bone formation is slower and less in volume compare with autogenous graft.

- 3 main type: Frozen, freeze – dried and demineralized freeze dried bone (DFDB)
- Form bone by osteoinduction and osteoconduction

3. Alloplast: synthetic like ceramic, HA, "Tricalcium phosphate"
   - HA inorganic component of calcified tissue in human body and has Ca to ph ratio of 10:6
     a. Physical properly are surface area or form of product (block or partical, porosity (dense,macro and microporosity) and crystarility (crystalline or amorphous)
   - Greater porosity has greater resorption
   - Material used when long term matrix is desired
   - Resorption rate range between 6 to 36 months
   - Not use at implant osteotomy or in contact with implant since material can't grow to implant or attach to it.

Application:

- Five wall defect
  - At extraction socket - expected to fill with new bone
  - 40-60% of ridge resorption from buccal during first year after extraction
  - Socket can be fill by any material since it surround by bone
  - 4 to 6 months before implant placement
- 4 wall defect
  - Bony site lost one wall usually buccal
  - DFDB + Ca PO4(act as barrier of its has bulk)
  - 6 months healing before implant placement
- 2 – 3 wall defect
  - Autogenous bone graft needed due to large defect cover by DFDB and then by Ca PO4 + DFDB ± membrane
  - Resorbable membrane is prefer to prevent re entry and decrease risk of infection
  - Even the healing time is rapid with autogenous bone 6 m's before implant
- One wall defect
  - Defect of five missing wall
  - It needs autogenous block graft and corticotrabecular (symphysis)
  - Cortical bone place to act as barrier and produce BMP
  - Voids fill by any chipped part of graft + DFDB+Ca PO4
  - Membrane needed if no cortical bone to provide GTR

- Subantral augmentation

4. Technique described by Tatum in 1970 using autogenous bone
5. It is similar to 3 and 4 wall

Interdental bone and papillae

Vertical distance from the crest of bone to the height of the interproximal papilla between adjacent implant (Tarnow, J.P. 2003).

- The mean height of papillary tissue between adjacent implant was 3.4mm, with average of 1 to 7 mm.No two adjacent implant in aesthetic zone except two centrals.

The effect of inter-implant distance on the height of inter-implant bone crest (Tarnow, JP 2000)

- Crestal bone loss when inter-implant distance >3mm was 0.45mm
- Crestal bone loss when inter-implant distance ≤3mm 1.04mm due to lateral bone loss from adjacent implant overlap will result in increase in crestal bone loss "lateral bone loss around 1.4mm from D&M"
- Use implant with platform concept may favor lateral 'horizontal' biological width

The effect of the distance from the contact point to the crest of bone on presence or absence of the interproximal papillae (Tarnow, JP, 1992)

- When distance between base of contact to crest of bone was 5mm or less – 100% papilla present
- 6mm – 56% papilla present,
- 7mm or more – 27% papilla present

The interproximal height of bone: A guide post to aesthetic strategies of soft tissue in anterior replacement (Salama and Garber, Salama practical perio and aesthetic Dentistry)

CLASS	Restorative	Interproximal Limit	Vertical soft tissue Limit
1	Tooth – tooth	1mm	5mm
2	Tooth – pontic	n/a	6.5mm
3	Pontic – pontic	n/a	6mm
4	Tooth – implant	1.5mm	4.5mm
5	Implant – pontic	n/a	5.5mm
6	Implant – implant	3mm	3.5mm

- Soft tissue measure for most coronal interproximal bone

Outcome evaluation of early placed maxillary anterior single tooth implants using pink and white esthetic score (Belser, JP 2009)

PES/WES index for objective outcome assessment, score out of 10

PES	WES
1. Mesial papilla (0.1.2)	Tooth form (0.1.2)
2. Distal papilla	Outline/ volume
3. Curvature of facial mucosa	Color
4. Level of facial mucosa	Surface texture
5. Root convexity/soft tissue color and texture	Translucency/character

- The mean study of white and pink score is 7 to 8.

Evaluation of soft tissue around single tooth implant crowns the pink esthetic score by Furhauser, Oral implant R. 2005

- Objective score developed out of 7 variables and score out of 14
    - Mesial papilla
    - Soft tissue contour
    - Soft tissue color
    - Distal papilla
    - Alveolar process
    - Soft tissue texture
    - Level of tissue (major discrepancy >2mm – 0) (minor discrepancy 1-2mm – 1) (no discrepancy <1mm – 2)

DAHL appliance

-appliance use to open VDO by placing removable or fixed casting in anterior teeth which will lead to posterior opening which will allow for posterior overeruption and mild intrusion of the anterior teeth, creating anterior interocclusal space which may be desired for either orthodontics and restoration

Regeneration of gingival papillae after single implant treatment (by JEMT, 1997 IJPRD)

Index to assess gingival papillae

Index score 0	No papillae present
Index score 1	Less than half of papillae present
Index score 2	Half or more of papillae present but not to contact
Index score 3	Papillae fill all of interproximal space
Index score 4	Papillae fill hyperplastic and cover too much

<u>Contemporary Implant Dentistry</u>

Carl Misch

- Caries and endo are the most cause of failure in FPD
- 15% of abutment of FPD need RCT while non abutment just 3%
- Advantages of single tooth implant
  - High success rate (97% for 10 years)
  - Decrease risk of caries and endo of adjacent teeth compare with FPD
  - Improve ability to keep adjacent teeth clean
  - Maintain bone
  - Psychological

- Basal bone form dental skeletal structure and contain muscle attachment and begin to form before teeth form
- Alveolar bone form when Hertwing root sheat of tooth bud evolve
- Bone needs stimulates to maintain its form and density
- Robert et.al. report 4 % strain required to balance resorption and formation
- Carlsson et.al: after extraction and complete denture
  - 25% decrease in width and 4 mm in height in first year
    - Bone loss continue through the life
- Tallegen et. al: mandibular 4 times of maxillary bone

- Screw implant design is most clinically reported more than cylinder e.g. (Nobel, 3 I,Zimmer)

- V shaped thread has largest history of clinical use

- Most common outer thread diameter is 3.75 mm with .38mm thread depth and . 6 mm thread pitch (distance)

- Housefield unit start in mathematics and astrophysics

- Air = - 1000, water = o, bone = 1000, enamel 2500

- If you have an avilable bone with no proximal vital structure – use pan and supplement periapical if needed

- Radiographic sequence of implant

- Pre-treatment – post surgery – healing period if needed – 2nd stage surgery
- Post prosthetic – 1 year post op- every 2 years after 1st year

Misch prosthetic classification for implant
Fp1 – fixed prosthesis: replace only crown
FP2 – fixed prosthesis: replace crown and part of root, larger than normal
FP3 - fixed prosthesis: replace crown or gingiva

RP4 - overdenture support by implant
RP5 - overdenture support by implant & soft tissue

- Bite force is 9 min daily in eating and 20 min/day swallowing
- Force in each tooth 20 to 30 psi and maximum biting force 50 – 500 psi
- High force with implant which is 4 times higher than natural(no proprioception)
- **Bruxism**: horizontal,non functional grinding of teeth
- Maximum biting force of bruxer is greater than average
- **Clenching**: habit of generated constant force exerted from one occlusal surface to athor without lateral movement

- Ideal crown high space for fixed implant prosthesis range between 8 -12mm

- Ideal crown high space for removable implant prosthesis ≥12mm

- Ideal crown space for hybrid is 15mm

Bone density: Mn Anterior > Mx anterior>Mn posterior>Mx posterior
- Adell et. Al: 10% higher success – Mn anterior than Mx anterior
- Highest failure reported in post Mx since force magnitude is high and bone density is poor

Bone quality classification

- Linkow, 1970, 3 category

Classification I: ideal bone type, evenly space trabecullar with small cancellous
Classification II: large cancellous space
Classification III: large marrow space

- **In 1985, Lekholm and Zarb:**

Quality 1: homogenous compact bone
Quality 2: bone in which a thick layer of compact bone surrounds a core of dense trabecular bone
Quality 3: bone in which a thin layer of cortical bone surrounds a core of dense trabecular bone
Quality 4: bone characterized as a thin layer of cortical bone surrounding a core of low density trabecular bone of poor strength

Misch bone quality
D1 – dense cortical bone
D2 – dense and thick cortical bone on crest and coarse trabecular bone underneath
D3 – porous thin cortical bone on crest and fine trabecular bone underneath
D4 – no crestal cortical bone and trabecular bone form all volume of bone

CT determine bone density

- D1, >1250 HFU, D5<150 HFU

Bone density affect treatment plan:
-Decrease bone density – increase implant area (number, width, large, design, surface)

- Bone is strongest under compression force, 30% weaker to tensil forces and 65% weaker under shear forces
- 10 mm implant increase surface area of 30% over 7 mm length
- Goodacre, 2003, implant of ≤10mm has increase failure rate (10% failure)
- 4 reasons for higher failure of short implant;

1. High bite force
2. Bone density
3. Increase crown height
4. Implant design consideration for short implant

- Ideal implant length is 12mm or more
- Advantage of short implant:
    1. Less bone grafts (less time, less cost, less discomfort)
    2. Less surgical risk
    3. Surgical ease

For every .25mm increase in width – 5-8% increase in surface area
For every 1 mm increase in width – 30% increase in surface area

Advantages of wide implant

1. Improve average profile - facilitate oral hygiene
2. Decrease prosthetic complications (screw loosening..)

Implant size selection

- 2mm below CEJ of adjacent tooth
- 1.5mm from adjacent tooth
- 3mm from adjacent implant
- 4mm diameter minimum post Mx
- ➢ In esthetic based on size of tooth, MD and FP bone
- 1.5 – 2mm surgical error is maintain between implant and adjacent landmark
- Mx bone resorption toward midline and Mn resorpe facially

- ➢ In 1985, Misch and Judy classify avilable bone in width , height, length, angulation of bone

(A, B, B-W, C-W, C-H, D)

Implant width:

- Greater surface area – less stress transmitted to bone – improve implant prognosis
- For cylinder implant form of .25mm increase in diameter – 5-8% increase in surface area

- **Width of implant is more critical than height after minimum height obtain**
- Wider implant less likely to fracture; strength of material increase by power of 4

Implant height

- Height of implant affect surface area
- Cylinder root form of 3mm longer – 20-30% increase in surface area

Advantage of longer implant:

1. Improve initial stability
2. Improve overall bone implant interface
3. Greater resistance to rotational torque

Implant selection based on available bone:

- Height of avilable bone measure from crest of ridge and opposing land mark
- Width measure between facial and lingual plates
- Keep 1mm at least in both side (6mm is ideal)
- Bone length for one implant of 4 mm diameter – 7 mm (1.5mm from tooth)
- Bone angulation ideally perpendicular to plane of occlusion to place occlusal force parallel to long axis of implant

4 basic thread shapes

- V thread is compare to reverse buttress in inferior portion of thread face angel
- Buttress & square thread under load well transfer compressive forces to bone
- Anisotropy: refer how bone mechanical properties depends on direction to bone

Thread pitch: distance between adjacent thread

- Greater number of thread – greater surface area
- Thread number is most important for short implant
- ITI has 1.5mm between threads, 0.6mm for Zimmer and 3I.

V-shape and reverse buttress has same amount of BIC percent and similar Reverse torque value while square shape is highest
Shear force at bone is highest for V& reverse buttress and low for square

Bone lost in most system to first thread and then stop b.c. first thread change shear load created by crest module to compresssive load

Fatigue strength of titanium alloy is 4 times greater than grade 1 titanium and almost 2 times, greater than grade 4

Teeth move apically 8-28mm and implant up to 5μm

Teeth move horizontally 56 to 108 μm and implant 12- 66μm

Muhlemann found 2 type of tooth movement

- Initial movement: under light force as consequence of perio ligaments
- 2nd movement: under additional force is related to viscoelasticity of bone (up to 40µm)

Bis-phosphonate “Fosamax”

- Use to treat osteoporosis, metabolic bone cancer, Paget’s disease
- 2 group: nitrogen and non-nitrogen containing
- It is suppress or reduce bone resorption by osteoclast
- 10 years bone half- life of drug
- Main complications is osteonecrosis of bone
- Implant protocol

- Oral Bisph use >3 years old
    1. Drug holiday stop 3 months before and 3 months after
    2. CTx- telopeptides – marks monitor > 150 pg/ml before surgery
    3. Informed consent of possible osteonecrosis

Maxillofacial:

Chapter 3 - Cancer Chemotherapy

- Surgical and radiation are primary modes of treatment of most tumors.
- Radiation has advantage of localize morbidity to specific area of body.
- 50% of all cancer patient treatment with chemotherapy to prolong life.

Chemotherapy Effectiveness:

- Based on ability to destroy or slow growth of rapidly dividing cells.
- Chemotherapy are unable to distinguish between normal and malignant dividing cells and most affects:

    1. Cells in bone marrow.
    2. Cells lining oral cavity and GIT tract (high proliferation ratio)

- Goldic-Coldman Hypothesis: Chemotherapy fact to eradicate all tumor cells because drug resistance neoplastic cells originate from mutation and these drugs resistance can be inherited and propagated.

Bone Marrow Transplantation:

- Multiple chemotherapy in combination with total body transplantation.
- Autogenic or allogenic marrow IV transfused into suppressed marrow and marrow function is restored.
- Aim of Treatment: To achieve maximum anticancer effect without limitation imposed by marrow toxicity.
- Tongue is first and most sensitive Intraoral site to be affected.

Cancer Chemotherapy Agents
It can be divided to:

1. Cell Cycle Specific: acts in rapid growth tumor (e.g. leukemia) in specific biomolecules
2. Cell Cycle Non-Specific Drugs: acts on DNA regardless cell division cycle.

Empirical Methods of Grouping:

1. Alkylating Agents: e.g. cyclophosphamide – non-specific, inhibit DNA synthesis
2. Anti-metabolites
3. Anti-tumor antibiotics: bleomycin – G2 phase specific – inhibit DNA repair
4. Plants Alkaloids
5. Hormones and Miscellaneous: androgen, estrogen, adrenocorticosteroids

Oral Manifestations and Complications:

1. Mucositis: most common, Treatment: palliative, analgesics
2. Xerostomia: less severe than radiation, 50% ↓ of minor salivary secretion.
3. Oral Hemorrhage: due to thrombocytopenia (platelet <60,000 per C^2)
   Normal – 150,000 - 400,000
4. Infection: bacterial (gram negative aerobes), viral (herpes), fungal

Chapter 4: Radiation Therapy of Head and Neck Tumors

- It is therapeutic use of ionizing radiation
  1. Electromagnetic "protons" or
  2. Particular Electron (negative) or Proton (positive) or Neutron (no charge)
- Primary effect of radiation occurs in Nucleus since it is 100-1000 times more sensitive to radiation than Cytoplasm.
- **Fractionation:** delivered in a series of treatment or fractionstoatl
  e.g. in US – Conventional fractionation consists of total dose 6500 – 7200 centigray (CGY) in daily fraction of 180 – 200 CGY fractions given from Monday to Friday over 7 weeks.

  Advantages:
  1. Allow regular re-oxygenation of tumor during treatment (tumor cell has less oxygen and less sensitivity to radiation, more oxygen = more sensitive)
  2. Affects more cells in radiosensitive phase of cell cycles.
  3. Normal cell recovery from sublethal damage than tumor cells
  4. Experienced works

- **Hyper-fractionation:** compare to conventional fractionation by ↑ total dose, total numbers of fraction and number of fraction per day while ↓ dose per fraction and maintain time (overall) (e.g. 120 CGY twice daily) at least 6 hours between fraction.

- **Accelerated Fractionation:** ↓ overall treatment time, slight ↓ in dose per fraction while ↑ number of fraction per day and keep overall dose or slight decreased.

Dosimetry:

- Evaluate amount of energy absorbed by tissue subjected to radiation.
- Standard unit is "Gray" energy absorption of 1 joule per KG of tissue
- It replaced rad → 1 rad = 1 centigray

Indications and Uses:

- Radiation and/or surgery based on location or extent of tumor.
- Maximum dose of delivery based on tolerance of adjacent normal tissue.
- Positioning Stent: to optimize delivery while ↓ morbidity
- Shielding: Cerrobend alloy help to ↓ radiation exposure to normal tissue
- Cerrobend alloy → low fusing alloy composed of 50% bismuth, 26.7% lead

— Shield help to receive unilateral dose of radiation.

Radiation Effects:

1. Mucositis – first sign appear 2-3 weeks after therapy stent
2. Taste and Olfaction – taste bud atrophy at 1000 CGY
3. Edema and Trismus – reduce mouth opening 10-15 mml
4. Diet – 20-30 pounds weight loss
5. Salivary Gland
    - Change volume, viscosity, pH and constitute
    - Change predispose patient to caries and perio-disertion
    - If major salivary gland in field of radiation → output ↓ from 86% to 93%
    - Destructive radiation has not been defined
6. Bone: 1.8 times dense than soft tissue, absorb large dose
    - MN more than MX since it is denser and has less blood supply
7. Periodontum
    - Fiber disoriented and PDI thicker, also get less cellularity and vascularity
    - Pre-extraction treatment of perio involve teeth is most important factor
    - Avoid perio-surgery especially in Mn when dose > 5500 CGY
8. Oral flora change

Dental Management:

- Majority of patients who develop ORN are those with teeth prior to radiation.
- Aggressive extraction philosophy should be considered for teeth in field of radiation and teeth has advanced caries, periapical infection and significant perio disease.
- Molar with furcation involvement must be extracted if it is in radiation field and radiation dose of >5500 CGY.
- Almost all ONR occurs in Mn, caution taken for pre-radiation extraction in maxilla due to development of ONR.
- Moderate aggressive philosophy of extraction should be followed.

Dental Maintenance:

- Fluoride, mouth wash, follow-up
- Endo treatment and crown amputation to give an access to clean instead of extraction after radiation.

ONR

- Defined as: exposure of bone within radiation, treatment volume of 3 months or longer
- Treatment: if less than 5500 CGY → conservative therapy or surgery and hyperbaric oxygen

Hyperbaric Oxygen:

- It stimulates neurovascular proliferation, enhance bactericidal activity of WBC, ↑ fibroblast proliferation and ↑ bone matrix.
- Hart and Mainus has first use it as 2 oxygen chambers for 2 hour per session.
- ORN defined by Marx "presence of expose bone in radiation field for 6M with or without pain".

- Marx Protocol:

  Stage I: 30 Hyperbaric Treatment (2.4 atmosphere, 100% O_2 for 90 minutes.

  Stage II: if no response after 30 treatment → surgery (primary closure) + 10 HBO

  Stage III: Non-response to Stage II, has fracture or fistula → IO resection + 10 HBO

  Stage IIIR: ten weeks after resection → grafts (bone) + 10 HBO

Prosthetic Management:

- Risk of development of ONR is minimal for edentulous prior to radiation and dental patient has higher risk.
- Silicon liner is less beneficiale than PMMA resin.
- Silicon has less wettability and not allow denture to slide easily ever dry.

Mucosa

- High risk of tissue abrasion, poor adjustability, high fungal infection and rapid deterioration of silicon liners.
- For those are edentulous before radiation, wait 3 to 12 months to place denture (to allow healing of soft tissue).
- Those are being edentulous before radiation and don't have enough experience with denture are more at risk.
- Making new denture use conventional procedures, avoid any overextension mainly in mylohyoid space (no saliva → no retention)
- Consider reducing VDO for:
  1. To ↓ closing forces to supporting mucosa
  2. To ↑ interocclusal space for trismus patient to easy entrous bolus.

Occlusion: assumption been to use non-anatomic occlusal scheme to ↓ horizontal stresses.

Implant

- Success based on anatomical site, dose to site and use of HBO.
- Less risk to place implant in MN if dose < 5500 CGY and use of HBO.
- Irradiation to existing implant (p.105)
  - Cause back scatters and lead to more dose in tissue around implant.
  - Dose ↑about 15% at 1mm from implant.
  - Granstom: remove abutments & superstructure prior to radiation and barry implants before radiation and re-open it and use it after radiation.

Chapter 5: Acquired Defects of the Mn

- Lateral margin of tongue and floor of mouth are most common site of SSC.
- Oral cancer is 6^{th} most common tumor and 4^{th} common cancer in men.
- Carcinoma account about 96% of all oral cancers and 4% sarcomas.
- Most common oral cancer is SSC , 9 out of 10 patient
- Tongue is most common site for oral cancer (53% of tongue cancer in anterior 2/3)

- Predisposing factors:
  - Age – most etiological factord of age > 40 years.
  - Immune system – viruses – tobacco and alcohol
- Leukoplakia (white patches) and erythroplakia is precancerous lesions.

Classification and Staging: T4N3M1

- T_0 -- primary tumor (Treatment, T"1to 4', 1 → ≤ 2cm, 2 → 2-4cm, 3 → > 4cm, 4 → invade adjacent) – carcinoma in situ
- N_1 -- regional lymph node involvement (N_0 – not palpable, N_1 – ≤ 3cm , N_2 – 3-6cm, N_3 – >6cm)
- M -- distant metastasis (M_x – not accessible, M_0 – no distant metastasis, M_1 - ___)

Treatment

- Delay implant placement for 6-12 months to allow graft to vascularized
- NB: Stress Shielding – disuse atrophy of Mn bone due to shield stress produced by physiological forces when large rigid reconstruction plate used.
- Bone graft (radial or fibula) and split-thickness skin graft are used for reconstruction.
- Advantage of Skin Graft: depth of sulcus doesn't change after surgery.
- Graft must be thin (0,o125 to 0.015 inch) to avoid hair follicle
- <u>Tongue bulk and integrity are most important factors for dental stability.</u>

Dysphagia - difficulty in swallowing, should be assisted carefully.
- patient should be examine before surgery to determine early factors.

Frontal Plane Rotation - Mn rotate around occlusal contact on un-resected site.
- Palatal guidance prosthesis used to maintain contact on un-resected site due to Mn deflection.

Chapter 6: Hard Palatal Defects

- Retention of key teeth is important and mainly Mx canine.
- Resection should made as distant as possible from tooth adjacent to resection. Next distal tooth should be extracted and cut through distal portion of socket to preserve bone.
- Sinus and salivary gland cancer (pleomorphic adenoma) are common.

Prosthetic Rehabilitation

- Prior to surgery examination is essential and collect all records (mouth catsts)
- It falls in 3 phases:
  1. Surgical Obturation: to restore and maintain oral function.
     - Place at time of surgery or thereafter.
     - Modify in basic interval to accommodate soft tissue healing.
  2. Interim Obturation: to provide patient with comfortable and functional obturation
     - Timing depends on patient function and needs, place 2-6 weeks post-surgery.
  3. Definitve Obturation: 3-6 months post-surgery when complete healing and tissue is stable.

Surgical Obturation 2 Types:

A. Immediate Surgical Obturation (at time of surgery)

Advantage:

1. Act as matrix to maintain surgical packing
2. ↓ oral contamination of wound
3. Speak more effective
4. Deglutition
5. Psychological
6. ↓ period of hospitalization and cost

- It is fabricated on cast pre-surgical, use clasp or ligation to hold it.
- Left in place for at least 6 days post-surgically.
- Obturator should be short of skin graft mucosal junction.
- As soon as surgical packing removed, extension to defect by viscogel or coecomfort
- Holes placed in interproximal area to allow ligature wires.
- Establish normal contour of palate on cast.
- No posterior occlusion on defect site, anterior teeth placed for esthetic.
- Surgical obturator should look like record base.
- Existing denture can be used by cutting border and posterior teeth.
- If pterygoid hamulus is removed, the function of tensor veli palatini, buccinators and superior constrictor muscle are compromised.
- Soft lining material should be change totally every 2 weeks to allow soft tissue contraction.
- For edentulous patient, immediate surgical obturator should be fixed to bone.

B. Delayed Surgical Obturator

- Placed 6-10 days post-surgically if patient is edentulous and defect is extensive.
- Relining material use to fill defect.

Interim Obturation

- Between immediate and definitive obturator at time of tissue healing.
- It is improve retention and stability by add post teeth in occlusion.

Definitive Obturation

- 3-4 months after surgery.
- Time depends on size of defect, prognosis of tumor, remaining teeth.
- Dimensional change will continue for 1 year.
- Degree of extension into defect depends on retention, support and stability.
- Hollow obturator ↓ weight 7-33% and ↓ occlusal forces
- Engage skin graft and scar band at skin graft mucosal junction will improve retention significantly (if it contract → create undercut superiorly)

Chapter 7: Speech and Velopharyngeal Function

- Kantner and West divide speech to 5 components:
  1. Respiration: volume and air pressure
  2. Phonation: first level controlling air in "vocal folds"
  3. Resonation: pharynx (3 muscles), oral and nasal cavity act as chambers
  4. Articulation: lip, tongue, cheeks, teeth and palate modify sound
  5. Neurologic Integration: CNS and PNS
- Lawson add audition (hearing)
- Primary function of vocal folds to protect lungs and lower respiratory tract from inhalation of any matter.
- Resonance and articulation are most affected by MF prosthesis.

Velopharyngeal (VP)

- Deficiency might result from congenital (cleft), developmental, neurologic defects or surgical resection.
- Velopharyngeal deficiencies classify to palatal insufficiency and palatal incompetency.

<u>Palatal Insufficiency:</u> refers to patients with inadequate length of hard or soft palate to affect VP closure but with normal movement of remaining structure (patient with congenital, developmental or surgical defect fall in this category).
<u>Palatal Incompetence:</u> refers to patient with abnormal VP structure but intact mechanism is unable to affect VP closure (e.g. Neurological diseases)

- VP mechanism coordinate valve by several muscle group
  - At rest: soft palate drop downward allow opening of naso and oropharynx which allow air flow.
  - At deglutition and some speech form: VP closure is required, middle 1/3 of soft palate arcs up and backward to contract posterior pharyngeal wall at or above palate plane level. Also, lateral pharyngeal wall move medially and posterior pharyngeal wall move anteriorly to meet soft palate

Methods to test VP function:

- Use video fluoroscopy, nasal endoscopy and oral-nasal airflow recording technique

Anatomy:

- Levator veli palatin: palatal elevation
- Tensor veli palatin: little function on soft palate but primary function is dilation of the eustachians tube

Prosthetics:
Obturator (to close) use to establish oral-nasal partition

- Immediate surgical obturator
  - Mainly to support surgical packing
  - Plan in it cast presurgically
- Delayed surgical obturation
  - Smaller defect of posterior or lateral borderof soft palate

- Definition obturation
  - Movemet of residual VP complex during function gave excellent prognosis to achieve good speech
  - Level of optimum obturator placement in nasopharynx determine by position of movement of residual VP mechanism
  - Guide line for obturator placement:
    - Located in nasopharynx at level of VP closure
    - Inferior margin of obturator: not extend below lower level of muscle activity
    - Superior margin of obturator: not extend above level of muscle activity
    - Inferior entention: at on entention of hard palate to post pharyngeal wall

Palatal left prosthesis: displace soft palate superior and poterior to assist soft palate to affect closure with peripheral pharyngeal tissue

Meatal obturator: control nasal air flow by entention in nasopharynx

<u>Fixed Prosthodontics Mock Board Answers</u>

Esthetic, Fixed and Material

Most important factor to achieve esthetic (Preston,1985) is color, form, surface texture

Copper (Cu) is responsible for heat to softer/harden gold alloy

Anneling: make gold crown soft by immediate cooling

Bench cooling – make it harder (Craig,2001, p.404)

48 hours take to generate slumy water from discarded cast (Rudel,narrow, JPD 1970) – Terra Alba

4 stages of setting reaction of dental stones (Craig")

Fluid – plastic – friable- carrvable

"Kelly syndrome,1972 features combination syndrome"

a. Destruction change in hard and soft tissue of palate with maxillary CD & Mn unstable Kennedy Cl I
b. Extrusion of Mn anterior and alveolar process
c. Loss of Mn posterior bone
d. Papillary hyperplasia
e. Atrophic pemaxillar and hypertrophy of tuberosity lead to reverse occlusal plane

Delayed passive eryption – junctional epith remains along convexity of anatomical crown but it doesn't migrate apically

Turner and Missirillain Classification 1984

Classification	Loss of vertical	Available space
I	L	S
II	N	S
III	N	N

Tooth preparation design:

- recommended TOC is 10 – 20^{o}
- OC dimension of molar is 4mm, IC diameter is 3 mm PM's and anterior
- ratio of OC/FL is .4
- axial grooves or boxes needed in molar to augment resistance form due to shorter OC dimension, less favourable, OC/FL ratio and greater tape

Goodacre, JPD, 2011

- to enhance resistance form when lack resistance is decrease TOC of cervical portion of pep axial wall (1.5mm) to 8^o (Proussaefs, Goodacre, JPD, 2004)

Schallhern 1957: find that 95% of subject AHA fall within 5 mm for KHA error produce by decrease of 5mm from KHA produce 2mm of occlusal error in Mn 2nd molar (A-P)

- (AHA is Beyron point = 13mm anterior)

A-P spread is distance between horizontal line through center of most anterior implant to posterior edge of most posterior implant "Bronsky"

Functionally generated path technique to stimulate jaw movement in static record (Panky Mann,19600)

Niswonge (1934) use Jaw relator to determine V.D.

Gothic arch tracing to determine C.R position:

- Needle point tracing describe by Hesse 1987 then Gysi 1910 and it was extra oral incisal tracer
- Hardy and Pleasure develop Cobalt balancer " Myers, CR record 1982, JPD"

Arbitrary axis point:

Beyron's point "we use it"- 13mm anterior to the posterior margin of the tragus of the ear, on a line drawn from the center of the tragus to the outer canthus of the eye
Gysi point – 10 mm anterior to the posterior margin of the tragus of the ear, on a line drawn from the center of the tragus to the outer canthus of the eye
Bergstrom point – 11mm anterior to posterior margin of tragus on line parallel and 7mm below Frankfort horizontal plane
Tetruck and Luncheon: 13mm anterior to posterior margin from base of tragus to outer canthus

***Bennett* angle**: medial movement of balancing condyle measure from sagittal plane (view in horizontal plane)
***Fischer* angle**: different between balancing condylar path and protusive condylar path (view in sagittal plane)

Advantage of perio ligament

1. Withstanding force exerted
2. Send an overload signal to change muscle activity
3. Induce open reflex respond

Splinting abutment teeth is indicated when perio support is reduced and stress on abutment is high (Petridis, IJP, 2001)

Posterior limit of Mn position determine by muscle ‘ Lateral Pterygoid’

Border position of Mn establish by ligaments not muscle (Atmood, 1968, JPD)

Most common complications in prosthesis (Goodacre, 2003, JPD)

1. FPD (27%) – 18% caries,11% endo, 7% loss retention
2. RBFPD (26%) – 21% debonding,18% discoloration,7% caries
3. Single crown (11%) – 3% need RCT, 3%, veneer fracture,2% loss retention
4. Post and core (10%) – 5% post loosening,3% root fracture, 2% caries
5. All ceramics (8%) – 7% crown fracture,2% loss retention,1% need RCT

Airborne particle abrasion of fiber post significantly improve bond strenght between post and luting resin cement (Choi,JPG,2010)

Fiber post has 2 types

1. Fiber reinforce resin
2. Fiber reinforce epoxy – carbon post

Components of composite resin

1. Organic polymer matrix: Bis-GMA,UDMA
2. Inorganic filler: silicone oxide or glass – increase resistance and translucency
3. Coupling agent e.g. Silane
4. Initiator: accelerator system: Campherquinone, lucirin
5. Inhibitor: hydroquinone, hydroxytolone

Most important to check of Cl II Div I after delivery of FPD is envelop of function (Jensen,JPD,1990)

Lithium disilicate: (Duarte, ceramic system,2010) – can be etch hydrofluoric acid (10%)

- require shorter etching time (20sec)
- can be silanted to create bi-functional layer

Mechanism to bond metal to porcelain (Naylor,1992)

- compression bonding
- mechanical retention
- chemical bonding
- Van der walls forces

<u>Spherical theory</u> – sphere exist with 4 inches radius (8 inches diameter =20 cm) with center in glabella in equal distance from occlusal surface of posterior teeth and center of condylar.

No evidence exist to show amalgam is direct hazard to patient health (Robert, OP Dent, 2009)

Sleep Disorders Classification:
1) Central sleep apnea syndrome
2) Sleep related hypoventilation syndrome
3) Sleep related hypoventilation secondary to existing medical condition (pulmonary, Neuro)
4) Obstructive Sleep Apnea
5) Unspecific other sleep related breath disorder

Apnea-Hypopnea index is use to quantify sleep disorder

5- 15 mild
5 - 3 moderate
> 30 severe
Apnea: Cessation of breath for 10 second

30 – 40% of Lat pterygoid muscle attach to disc " okeson"

Ayad, Rosenstiel (JPD, 1997) found that:
- Panavia provide greater retention regardless bur use
- Up to 55% ↑ retention for Zn Phosph with carbide bur (12 fluted flushing)
- No sign differ in retention for GIC & Panavia with any bur

Mechanism to compensate for casting shrinkage (Shillingburg)
1) Wax pattern expansion: for heating of investment
2) Thermal pattern expansion: heating is burnout to 1200°F (650°C)
3) Hygroscopic pattern expansion: Immerse in water (hollenbback) >38°, 100°C, 1.2 – 2.2%
4) Setting expansion: Growth of crystal - .4%

10 mm Condyle track distance from starting center positive produce most consistence & valid reading (Dr. Scoll. Charg, JPPD, 2004)

Cross study use Diagnosis Cast to measure occlusal discrepancy:
- 92% of supra-eruption of unopposed teeth occlusal common in Mx discrepancy
- Active eruption, perio growth, & relation occur are 3 type of supra-eruption
- Active eruption, had associate with attachment loss
- Perio growth had invasive associate with attachment loss
  (perio growth is supraeruption with bone & attachment
  Active growth is supraeruption of tooth without bone or attachment
  (Craddock, JP, 2007)

Low FMA (<20) has (Dipiettro, JPD, 1476)

1. Short clinical crown
2.↑ biting force
3. less zone of attachment gauge
4. Broad flat parallel fault

Enamel: 96% Inorganic, 4% organic (by weight) By volume 88% organic
Dentin: 70% inorganic, 30% organic
Ceramic: 45-50% inorganic, 50-55% organic

According to Gysi, average progressive shift "Benette" is 15° (range 5-35°)

Immediate side shift is 86% with average 1-4mm (Zarb, 1497)

Study by Balkenhol (JPD, 2008) of resin material in interim FPD:

- Marginal discrepancy ↑ with time (10min → .2 , 60min →.5 mm)
- Wait at least 30minutes after temperature fabrication & then trim it & (most change 30min)
- No significant relation between width of gab & shrinkage

- Best flame direction is oblique in soldering (Stackhouse, JPD, 1467)

- ↑ intercondylar distances with:
  1) Mx teeth grooves & ridges orient more mesial "small angle between MT & LT"
  2) MX teeth groves & ridges orient more distal "small angle between MT & LT by **Huffman, 1989**

Weibull Modulus: To measure flaw distribution for brittle material & that to measure strength (e.g. ceramic)

- Low WM → high variation in measure strength & weakness material (Kelly, JPD, 1989)

Caries management in prosth patient: CAMBRA PROTOCOL (Featherstorm, 2010, JP)

- For patient with gingival recession & other risk for caries, fluoride varnish in root surface 3 times annually.
- Brush twice /daily with fluoride dental tooth paste (>600 ppm)
- Xylitol gum twice daily for 15 minutes with 7 – 10gm total dose
- Rinse once daily for 7 consecutive day a month with 10 mL of 12% chlorhexidine for 1 minute before sleep and at least 1 hour after brushing with fluoridated paste & remove prosthesis "to avoid F^- & chlorh $^+$ competing each other.

Ozkar (JP, 2010), clinical success of Zr in dental prosthesis

- No framework fracture
- Up to 26% of chipping of veneering porcelain
- 2nd caries at margin of abutment (.9% at 3years, 21.7% at 5 years due use Cercon

Pjetrsson and Lang, "COIR, 2004), Complication of FPD

- Pulpal necrosis "32.7%" > caries "9.1% > tooth fracture 2.9% → biological
- Lack retention "16.1%" most technical complicate
- Estimate survical rate is 81.8 %, success 63% after 10% FPD with cantilever

Leucite ″up to 45%" → flexural & compressive stronger, ↑ CT contraction "craig"

Add violent stain in yellow chronu PFM will "Rosenstail"

- ↓ Chroma &↓ value.

Tjan & Miller (JPD, 1989) show:

High smile line: show band of gingival tissue in full smile
Average smile line: 75-100 of Mx teeth & Interproximal gingiva only
Low smile line: <75 of Anterior teeth exposed

Perr, compare lab process & autopolymerized relining resin "JPD, 2002"
-Hardness value greater for lab process
-Hardness value increase for lab process after 1 week water immersion
-Up to 1 year, water sorption is the same

According to ADA Spec:

- ❖ 25 = gypsum product produce fine detail of 50μm
- ❖ 19 = impression product produce fine detail of 20μm

Williamson (JPD, 1983) show:

Canine guidance & latent dis-occlusion produce ↓ in EMG activity of temporal & masseter muscle when eliminate post contact.

- 1 sivert = 1 gray = 1 John 1 Kg = 100 rem ünit of absorp radiation

- CTE of porcelain should be slightly smaller (.5 -1 & 10-6) than metal
  e.g. CTE of porcelain much smaller → cracks in ceramic surface
- Devitrification: loss of glass "form new oxide bond due to overfire"
- Vitrifiction: formation of glass

Golden Proportion "Roberson", 2002, student book"

- Based on apparent size not in actual size
- Each tooth is 60% size of Mesial Tooth to it
- Ideal proportion of central is 75 – 80% width to hight ratio

Gold base alloy "type III "shrink 1.48, base metal 2.3% :"Philip"

Subtractive Color System:

- 3 primary hue of subtractive color Mx is cyan, magenta & yellow
- 3 primary hue of subtractive mix are 2nd hue of addictive system
- 3 primary hue of subtractive mix together → black

Additive color → Red, green, blue (RGB)
Mx Additive color combined → white

3 walls control ISS is

- Rear and superior wall in WS and medial wall in NW side

Silver in dental gold solder has:

1. Decrease melting range
2. Increase adherence
3. Increase flow of solder

- Copper: increase hardness, strength

Minimum fineness in soldering is 580 ‘Shillengberg”

Passivation: change from chemically active to less active state leads to corrosion resistance and inability to oxide “Philip’

Atropine is parasympatholytics

Highest bond strenght for PVS adhesion is 48h before (Dixion,RPD,1999)

Horizontal determinal of occlusal morphology

1. Increase distance from rotating condylar
2. Increase distance from midsagittal plane
3. Increase lateral translator movement
4. Increase intercondylar distance ‘– small angle in Mn (move distal in Mn)& Smaller angle in Mx (move mesial in Mx)

Freedom in centric (by Schylar, 1963) is lateral and AP movement in centric rather than locked centric for patient comfort and decrease bruxism and occlusal trauma.

long centric “Dawson” in posture close, lower incisors shouldn’t strike in incline before closure

Add surfactant to PVS will:’ shillingburg,p.299’

- To material : decrease void up to 55% and less accurate cast which will be up to 33% softer
- At pouring stage: decrease void up to 86%

Scavenger add to PVS to decrease H2 product – pour after 15-30minutes
IF no scavenger add – pour <15mm or >24 h

Feldspathic porcelain

1. Feldspar (64% - 69%) – silicon dioxide – matrix and give translucency
2. Quartz silicon oxide – matrix form of porcelain when firing
3. Kaolin clay – binder of porcelain before firing, easy manipulation
4. Opacifier – TO2,Sno2.Zno2
5. Color: Indium- yellow, tin _ pink

Jagger and Harisson “1994”found
- Opposing enamel were produce by polyshed porcelain was less than glazed and unglazed aluminum porcelain

Giordayn et al found that flexture strength of polyshed and overglazed is better than self-glazed

50% of new alloy should be added in casting to old alloy
Re-use it a lot will produce voids casting but not affect strength

Sterographic use to program TMJ articulator

Zach and Cohen (1965) about pulp respond to heat
- Increase temperature more than 6.6 degree celcius (20F) will cause 60% of pulp destroy
- Increase temp below 10F – pulp recover

Rosenstiel (p.461) – recommended disinfectant by impression material.
- Irreversible hydrocolloid – chlorine compound or iodophores
- Polyethy – chlorine compound
- PVS – chlorine compound or idiophores , 2% glutarldehyde
- Material move from mouth,rinse,dry, then disinfect

By Shillingburg at Disocclusion ‘by Hobo et al”
- Recommended space at working is .5mm
- Recommended space at non working is 1mm
- Recommended space at protrusive is 1.1mm

3 basic ceramic layer damage mode
(Lawn and Thompson,JDR,2002)
1. Core cracks: initiate from top outside surface
2. Quasi cracks: when max shear stress exceed ½ yield strength
3. Radial cracks: initiated from starting flaw inner ceramic surface
    - Occur at low load and spread aver large distance
    - Priming mode of failure of all ceramic and most common

Proussaefs and goodacre (JPD,2004) have done
- Ivorin teeth of 2.5mm OC diameter with 20% TOC, compare box, isthmus, groove and 8 degree taper
- Decrease TOC from 20 – 8degree at cervical 1.5 mm of axial wall will increase significant resistance form and use other method doesn’t affect resistance form

COTE of PFM are critical and it should be match within 4%

Parker (1988) limiting tape of tooth prep depends on

1. Height /base ratio of prep
2. Tape of perp

Phillips Classify porosities in Nobel metal:

1. Solidification defect
   - Localized shrinkage
   - Micro porosity
   - Incomplete filling
2. Trapped gas
   - Pinhole porosity
   - Gas inclusion
   - Subsurface porosity
3. Residual air

Pesun (JP,1997) 7 theory behind intrusion of tooth in implant tooth FPD:

1. Disuse atrophy:PDL fiber not used
2. Differential energy dissipation:tooth relieve in high stress
3. Mn flexure: between Mn flexure and framework rigidity – push tooth laterally
4. FPD flexure
5. Impaired rebound memory continuous remodelling of PDL to be away from force
6. Debris impaction and micro jamming – get under bridge
7. Ratchet effect- precision are not allow tooth to return after force eliminate

Fererra ,minimal reduction is .5mm for veneer to avoid overcontour or esthetic problem and avoid dentin exposure

Raigrodski (JPD,2004) for all ceramic FPD

-connector of at least $9mm^2$

<u>Eccles and jerkins classify erosion crown</u>

- Grade 0 – no involvement
- Grade 1 – loss surface texture, no dentin involvement
- Grade 2 - <1/3 of surface, dentin involvement
- Grade 3 - >1/3 of surface ,dentin involvement

Panoramic radiograph has 15-20% magnification in vertical height

4 zones in torch use in casting alloy are “shilliburg”

1. Oxidizing zone “outer”
2. Reducing zone “ hottest,blue, use in casting
3. Combustion zone “green”
4. Mixing zone “gas’

Ph of Zn phosphate at initial mix is 2 then increase to 6 at applying porcelain it shrink and reduce porosity due to evaporation liquid binders and dense porcelain “Campell,JPD,95)

- 30-50% volume and 6-8% linear shrinkage

NB; Naylor said 10-15%shrinkage

6 possible bond failure in metal ceramic (metal- metal oxide – porcelain)

- Teeth set-up

1. incisors too long - F like V
2. Incisors too palatal- T like D

<u>ERA allow rotational and vertical resiliancy of 0.4mm</u>

<u>Loctors allow rotational ‘8degree’ and vertical resistancy of 0.2mm</u>

(blue-1.5Ib, pink-3Ib, clear- 5Ib)

- Zone of caries
  1. Surface zone
  2. Body zone
  3. Dark zone
  4. Translucent zone

Vita Color System:
A → red – brown
B → red – yellow
C → Grey
D → Red – Gray

- *Lucia coined the term mutually protected occlusion*
- *D. Amice coined term of canine guidance*
- *Stuart: Panlograph*
- *MC Collum: First to find THA*

Removable Prosthodontics Mock Board Answers

A randomized clinical trial of a basic RPD (Kapur part 1 1994, 1997, JPD)
Part 1: 134 patient with Kennedy class I or II with either I bar or circumferential retainer.

- 5 year success rate is 71.3% for circumferential & 76.6% for bar
- No significant difference between two design in term of success rate, maintainace effect on abutment teeth.
- Well constructed RPD with either design supported by favoranle abutment or regular recall after satisfactory treatment.

Part 2: 118 patient with class I or II Kennedy (RpI OR distal rest and circumferential clasp)

- No difference in masticating performance
- Conclusion from many articles:
  - Use RPD change qualitative or quantitation plaque
  - If basic principle of RPD follow (rigid MC, simple design, proper basic adaptation) perio health of remaining dentition can be maintained.
  - Regular recall and prostho maintenance are essential for long term prognosis.
  - RPD doesn't cause adverse perio reaction
  - No ideal RPD design

- Masticating efficiency ability of complete denture wearer is less than 1/6 or 30% of natural dention (Kapar, 1964, JPD)

- Use neuromuscular perception to determine VDO by Lytle (JPD, 1964) by using central being device or open it beyond VDO and reduce it until patient feel comfortable.

Occlusal Rest:

- Floor of rest seat incline slight downward from guide plan
- 1/3 to ½ width MD of abutment
- ½ BL width at cusp tip to cusp tip
- Outline should be triangle in form
  (Stewart, p 47)

Golden proportion and dimention in face:

1. Vertical line from lateral margin of nose at smile was same as Mx intercanine widths at canine tips
2. Mn incisors width equal to width of eyes
3. Mx canine width equal to width between outer canthus of eye (Levin, 1978, JPD)
   $\frac{\text{Bizygomatic}}{16}$ = central incision, $\frac{\text{bizyg}}{3.3}$ = 6 anterior

Posselt in 90% of population MIP # CD

Occlusion with 10 pairs of teeth up to 2nd pm a shorter dental arch for 45 yrs Old is more beneficial than molar extension with RPD (Elias, JOR, 1498)

According to Keltjen (1997, JOR), the 2 independent variable affect fit of RPD clasp
- age of RPD
- opposing dentation

Aras (IJP, 2004) compares SDA and distal extension RPD for 1 year
- Occlusal force and amount of occlusal contact area of post-canine teeth are major factor in determine masticatory function.
- Patient adapt to restore to SDA
- Patient with SDA and then restore with distal extension RPD will not change masticatory function.
- There is correlation between pm/m pairs and masticatory performance

A clinical investigation of fit of RPD clasp (Dunham, JPD, 2006)
1. 76% of rest didn't contact intended surface
2. 7% of rest contact only at periphery of rest
3. Suprabulge surface of tooth can support framework ' a 2 or 3 suprabulge contact to provide $\geq 180^0$ encirclement'
4. No different between tissue or teeth bone.

- Muscle attach to pteygoid humulus is tensor veli palatine and it open Eustachian tube
- Muscle form 1/3 of palate and responsible of palatal movement is levator veli palate and it is responsible for palatoparyngeal closure.

Gag reflex due to stimulation of nerves.
1. Trigeminal (V) 2. glossopharyngeal (IX) 3. Vagus (X)

Type of block out in RPD is "SPA"
- Shaped blockout convey certain information from master cast to refractory cast like retentive tip, position of reciprocation arm, position of internal finish line and tissue stop
- Parallel blockout: under survey line, block anything cause interfering between RPD metal framework during seating.
- Arbitrary blockout: help duplicate without tearing of impression and make it ease to duplicate, blockin area not related to design e.g. undercut in front of anterior teeth (McCracken, RPD)

Contact of soft palate to posterior pharyngeal wall is (Ananda Krishna, JP, 10)
- Male: at a point above palatal plane
- Female: at or below palatal plan

Most important complication for OD with inadequate internal space is

1. Physiologically inappropriate contour
2. Weak prosthesis (min. 2 mm for resin)
3. Aesthetic compromise
4. Encroachment into inter occlusal space

Minor space for implant supported OD attachment
Location= 8.5mm V and 9mm, H
Bar = 13-14 mm V

Ahuja and Cagna (JPD, 2010) classify vertical restoration space
Class I - ≥15mm
Class II- 12-14 mm
Class III- 9-11mm
Class IV-< 9mm (difficult to use attachment)

Advantage of RPI concept by Krol in 1973:

- I bar move in mesiobuccal direction under masticatory load which disengage undercut and decrease torque on teeth
- Rest, proximal plate and I bar prevent migration of teeth
- N.B: In krashovile design (1963) provide physiological relief for proximal plate when pressure exerted on denture base.

-14.07 pound to release upper denture (Jacobson)

Five stage to represent mono-polymer mix (Philip, 1996)
Sandy- stringy- dough like- stiff- elastic and rubbery

- 7% volumetric shrinkage
- 1% linear shrinkage
- 21% monomer shrinkage
- 3% for light cure resin

-SDA satisfy most criteria, decision to replace missing teeth should based on

1. Position of missing teeth
2. Age of patient (>45 y, does not need restore with RPD)
3. Number of occluding pair
4. Occlusal forces.

-Inflammatory papillary hyperplasias

- Reactive tissue growth develop beneath denture due to poor oral hygiene, denture overuse& ill fitting denture.
- Usually asymptomatic at hard palate, 20% incidence
- Treatment in minor case by removal of denture and advance by surgery.

-Aramany classification of obturators is,
- Class I midline resection
- Class II semilateral resection
- Class III central resection
- Class IV lateral ant-post resection “teeth on straight line”
- Class V posterior resection (bilateral post)
- Class VI anterior resection (Kennedy class IV)

-Function of guide plane surface:
1. Provide one path of insertion and removable for denture.
2. Provide stabilization against horizontal rotation
3. Decrease food entrabment between teeth & prosthesis

-By Naylor:
- Low fusing porcelain in < 870^{0}c / high fusing bt1315- 1370^{0}c
- Kaolin add to increase stabilized during porcelain build-up
- During firing molten metal oxide contact with cold water to form uncrystalline powder.

-McNamara Line relate A.P relation of mx and mn to cranial base (Dowson)

SDA provide (by Witter, JDR, 2001)
- Have similar vertical overlap & occlusal were like complete dental arch
- More interdental spacing in pre region and more anterior in contact
- Can provide long term occlusal stability
- Meet requirement for functional occlusion

-Room temp vulcanizing silicone elastomers are most common MF prosthesis since:
1. Good aesthetic
2. Ease of coloring
3. Thin margin possible
4. Adhesive compatibility
5. Ease manipulation

-Edge strength and color stability is most important function
(Montgomery, JP, 2010)

Dipietro (JPD, 1977) is study of occlusion as related to FMP angle found.

Angle	%	Occlusion	
13.24	17.9	Disocclusion	Immediate disocclusion upon excursion
16.27	19.6	Delayed	Contact up to 1mm (at first molar) follow by disocclusion
20.30	8.9	Progressive	Contact from 1-2mm
20.40	53.6	Group function	Beyond 2mm end to end contact of buccal cusp.

Sequence in RPD survey.

1. Vertical overlap of max. ant. teeth by use mount diagnosis cast in case of maxillary palatal plate
2. Path of insertion
3. Identify undercut
4. Transfer survey line
5. Tripode
6. Framework design

McCraken: guide plan, retentive, interface, aesthetic

Function of indirect retainer "McCruken"

1. Resist dislodgement of distal extension base from tissue
2. Resist anterior posterior tilt in principle abutament
3. Stable against horizontal movement (contact of minor connection)
4. Stable anterior teeth against rigid movement
5. Indicate for reliening
6. Act as auxillary rest to support margin connection to facilitated stress distribution

<u>Okason for TMJ ligaments: "P II"</u>

- Ligament is passive restraining device to limit and restrict border movement
    - 3 functional ligament support TMJ:
        1. Collateral ligament "M and L discal" restrict movement of disc from condyle
        2. Capsular ligament "Between Temporal bone and condyle' : resist medial, lateral, inferior force to dislocate articular surface.
        3. TML: has 2 part
            a. Outer oblique portion: limit extensive mouth opening
            b. Inner horizontal portion: limit post movement of condyle and disc
    - 2 accessory ligament:
        1. Sphenomandibular ligament "from spine to lingula - no sign effect on movement
        2. Stylomandibular ligament "from styloid to ramus' : limit excess in protrusion movement.

Mc Garry (JP, 1999) PDI classification based on:

1. Residual ridge morphology of maxillary arch
2. Mn muscle attachment
3. Jaw relationship
4. Mn height in "pan"
5. Interarch space
6. Tongue anataomy
7. Need for pre prosthetic surgery
8. Modifying variable(psycho, TMD..)

-Disinfectant and polyether:

Craig: Immerse up to 18 hours without loss of surface quality and accuracy
Philip: immerse more than 10 minutes is susceptible to change in dimention

-Combination clasp design in ww retention and cast reciprocal clasp
indication: aesthetic and depth of undercut (Appelgale, 1965)

Soft conditional material

-Viscogel: Powder: PEMA liquid: glycolate and ethanol
Indication:
1-Tissue conditioning material for abuse tissue and after surgery
2-Temporary soft liner
3- Functional impression

-Technique:

-mix for 30 seconds , wait 2-3 minutes after mix

-mouth should be moisture
-guide patient to CR
-remain for 2 minutes
-functional jaw movement for 2 minutes
-wait 7-8 minutes
-check, add if needed, remove excess “hot knife, sharp instrument”
-change material or add when necessary but not more than 8 weeks.
- as functional impression put it for 24-48 hours, make cast

Starcke et al (“1973, JPD), 15 to 45 minutes for functional impression- if left more than 60 minutes_> ccuracy of reproducing detain diminish and border will stump

Wilson (1966) conditioning materail allow more equal distribution of stress and permit tissue to back normal

-Coc-soft: temporary lining for denture, last for 3 months
-Coc-comfort: tissue conditioning and functional impression, obturators
-Hydrocast: tissue conditioning and functional impression “doesn’t contain MMA”
-Lynal: tissue conditioning and functional impression “PEMA and alcohol”

-Fully adjustable articulator :
Stuart gnatholator. D5A. Dentatus.Stuart

-By placing acrylic resin provisional in pressure pot during polymerization will:
- increase transverse strength and decrease porosity “ more dense”
-doesn’t affect hardness
-water + pressure is like pressure (water doesn’t produce sign effect)
(Donovan, JPD 1985)

-Indication for Lingual plate:
1. Class I with expected loss of some of anterior teeth
2. High frenum attachment 3. Class I severe resorption 4. Stabilize perio weak teeth

- lingual bar: need at least 8mm between FGM and movable floor of mouth
- sublingual bar: shallow vestibule place inferior & post. Also due to axial alignment of teeth
- cingulum bar: when there is excessive undercut of alveolar area lingually
- labial bar: lingually incline teeth.

-Osteonecrosis associated with:

1. Systemic medication
2. Trauma
3. Radiation
4. Chemical toxicity

-Prognosis of resected mandibular depends on "Bumer, 1996"

1. extent and location of resection
2. Mobility and bulky tongue "most importance"
3. Mn deviation" more lateral force"

-Structure found in retromolar pad: "5"

1. Buccinators muscle
2. Superior constrictor muscle
3. Ptygomandibular raphea
4. Temporalis muscle
5. Glandular tissue

-*Boucher* said denture extention distal ½ to 2/3 of retromolar pad to avoid soreness and limitation of muscle at function
-To determine distal extent of lingual flange

Tonge Innervation
Anterior 2/3- taste 7th facial nerve'Chorda typanai"
Sensation trigeminal (lingual)
Post 1/3- all by glossopharyngeal "ninth"

-Primary supporting area: "Zarb"
Mx- post ridge crest & horizontal hard palate
Mn- retromolar pad and buccal shelf

Monson curve: curve of occlusion lie on surface of sphere 8 inches in diameter with center in glabella

Antimonson: "Pleasure curve": antimonson except 2nd molar

Undercut for clasp is:
Co-cr=,01", gold=,015", ww=,02"

-**4** stage of mitosis “PMAT”

1. Prophase
2. Metaphase
3. Anaphase
4. Telaphase

Exentration: removal of entire organ
Evisceration: removal of visceral content e.g lensed sclera and remove eyeball
Enucleation: removal content of viscera from cavity

75% of fovea platini post and 25% on the vibrating line (Chen, 1985)

Dipetro (JPD, 1961) Significant of FMA to prosthesis (average 25+5)
High FMA - decrease biting force, high palatal vault, prone to tongue thrust , hyperdivergent

-Flexibility of RPD clasp affected by:

1. Length and taper “from origin”
2. Diameter
3. Material
4. Cross sectional form

Anodontia: missing all teeth
Hypodontia: missing ≤ 6 teeth
Oligodontia: missing > 6 teeth “8% incident”

-Denture bearing area for Mx ($22.96cm^2$), for Mn is $12.25cm^2$ and perioligaments is $45cm^2$ (Zarb)
-Preradiation extraction should be at least 21 days before radiation
- Surgery through socket of tooth in tumore resection to maintain bone

-5 component of speech

1. Respiration
2. Phonation
3. Resonation
4. Articulation
5. Neurologic integration

-Function and position of clasp assembly:
- Supportive: occlusal rest seat
- Stabilization: proximal plate “from marginal ridge to junction between middle and gingival 1/3
- Stabilization : reciprocal clasp “ middle 1/3 of teeth”
- Retention: at Gingival 1/3

-beading line function
1. Ensure intimate tissue contact of MC with palatal tissue
1. Prevent food trap and dislodge RPD
2. Transfer MC to investment cast
3. Provide a visible internal finish line for casting

-Tissue stop: for acrylic retention" prevent distortion of framework during packing"
-Finish line:
- Junction between minor and major connector
- Should be ≤ 90 for undercut
- Locate 2mm medial from imaginary line connect lingual surface of missing teeth to provide natural palatal contour.

-Guide to CR, formed AP with right component interference
1. MT- inner incline of right palatal maxillary cusp with inner incline of mandibular buccal cusp
2. LT- inner incline of left buccal maxillary cusp with outer incline of mandibular buccal cusp
3. LT- outer incline of left lingual maxillary cusp with inner incline of mandibular buccal cusp

Lundeen & Gibbs found the maximuim lateral "Bennett" movement found in 90% of people when chewing is 1mm.

Content of acrylic material (Craig p502)

Liguid	Powder
Monomer MMA	Polymer PMMA
Inhibitor "hydroquine"	Initiator " benzoyl proxide"
Accelerator "tetracyanine"	Pigments
Cross linking agent	Dyes and opacifier
Plasticizer	Plasticizer

-**Balkwill angle** "average of 26": angle between bonwill angle and occlusal plane (incisor and DB cusp of Mn 2nd molar)

Neil's lateral throat form:
70% Class I (8mm-12mm)- place mirror or finger- move tongue- minumim movement
25% Class II (4mm-6mm) – between Class I and Class II
5% Class III- < 4mm

Contraindication for lingual bar:
1. Shallow vestibule
2. Severe tissue undercut
3. Mn tori
4. Excessive buccal or lingual tilt

ORN:

- Bumer: expose bone for > 3months
- Marx: expose bone for > 6 months
- Common in Mn due to less blood supply
- Leave 2 cm surface margin and mid-radical resection on teeth

-Craniofacial implant “Roumanas, IJP, 2002” high success rate
-Auricular (45%) > orbital (53%)> nasal (87%)

-Torus palatines incidence is 20%
-Torus Mn incidence 10%

-Cone theory: tooth consider as pair of cones sheering base. It introduced by James H. Prothero “1916” and he also stated tip of retention arm should passed under are base
-RpI name and design by Krol,1973
- RPA by Eliasor 1983
-RpI concept but not name by Kratchovill, 1963

-Denture tooth look wider and lighter if move anteriorly
-Denture tooth look darker if move posteriorly

-Ticonium RPD is Ni-Cr with beryllium
-Vitallium RPD is Cr-Co with difficult to adjust

-Mandibular Nerve

- Main trunk-meningeal branch
  -medial ptygoid nerve   -temporal tympani
  -tensor veli palate
- Anterior division- masseter-temporal
  - Lateral ptygoid branch -buccal nerve
- Posterior division: -Auroculotemporal nerve
  -lingual
  -IAN
  -branch to mylohyoid and anterior digastric

Alter cast: by definition is alter relation between teeth and tissue
Hindle: alter cast: aim to load tissue more than teeth
Krachovill & Leopold: alter cast: aim to load tissue and teeth simultaneous

-Wright “1966” Classify tongue to

1. Normal:
   - Completely fill floor of mouth
   - Tip of tongue rest on or just lingual side of lower anterior teeth
   - Lateral border rest over ridge or just above occlusal surface of teeth
2. Retracted “33%”: tongue is restruded back

- Hegman balancer “1920”. Nonadjustable articulator based in spherical theory
-Mucostatic impression technique by Page
-Mucocompression technique by Carol John
- Functional technique by Tryde and Jensen
-30^0 teeth by Turner and Pilkinton
-33^0 teeth by Gysi

-Condylar disc is thinner medially and posteriorly
Appelgale “1960” Classify RPD to:

I. All remaining teeth anterior to bilateral edentulous ridge
II. All remaining teeth is anterior to unilateral edentulous ridge
III. Teeth anterior and posterior can bear acclusal load
IV. Edentulous space lie anterior to teeth and cross midline
V. Teeth anterior and posterior where anterior teeth can’t provide any support
VI. Teeth anterior and posterior where teeth bear complete occlusal load , unilateral RPD

-Kivovics”2007” regarding adjustment of CD is
Mx Labial vestibule “41” > tubersely (21) > hamular notch (12%)
Mn Retromylohyoid “17” > lingual sulcus “14”

-For abutment prep on RPD
Proximal plate>high of contour> occlusal rest

- Always first because if you did it later> rest well be smaller

-Epoxy resin is more expensive and shrink more and not compatible with rubber base or hydrocolloid “advantage: high resistance to abrasion”

-At least 6mm between FGM and Mx major connector which provide best tissue response “Bissada,JP,1974- 5-6mm from palate plate”
-Any minor connector should cross FGM at 90^0 to decrease plaque
-Minimum of 5mm between minor connector to decrease plaque
-major connector should extend to distal extension for 2/3 length of edentulous ridge lenght.

-Carey and Craig found
- articulating paper indicate area of contact between teeth
- mark area doesn’t represent load contact in mark

-Vig and Brundo found Mx incisor display in response
Male- 1.41mm
Female- 3.4 mm

-Whisle sibilant connected by change palatal contour to partially block air flow “Narrow bicuspid to give space to tongue”

-Oral health impact profile investigate effect of prosthesis therapy on life

-Space of donders " area between dorsum of tongue and palate"

-Cleft palate- failure of Mx and median nasal process

-McCracken, RPD and occlusion

Bilateral simultaneous contact of posterior teeth in C.R
Mx Class I or complete denture- balanced contact (protrusive, N, NW)
Mn Class I- working side contact only
Mx and Mn Class II- only working side contact
Class IV- contact in C.R to prevent super eryption of opposing teeth
-In excursive- yes to enhance incisal function
-no to eliminate force in mx anterior

-Weinberg (JPD, 1961) if 3rd point of reference change:

- Raise it 16mm to height will decrease HCG from 40^0 to 31^0
- ↓ cusp height of 0.2mm in 2nd molar
- It well change condylar inclination relation to occlusal plane

-Crum and Rooney (JPD,1978) alveolar bone loss related to overdenture

- 2 group (mx and mn CD and mx and mn OD with canine as conical OD abutment
- Bone loss in Mx (.8 vs 1.7mm) and in Mn (.6 vs 5.2mm)

-Most common palatal tumor is
Epidermoid "SCC" > Salivary> Mesenchymal> Metastatic

-↑ ICD> move groove in Mx molar distal , acute angle between MT and LT

Tooth development: 4 stages from dental lamina

1. Bud: no clear arrangement of cell
2. Cap: enamel organ, dental papilla 'dentin,pulp' and dental follicle "PDC,cementum,alveolar bone'
3. Bell: histo and morpho defferntiation stages
4. Crown or maturation: enamel " inner enamel epith", dentin and pulp from D papille
   Dental follicle> PDL, cementum, alveolar bone, gingiva

-Wrought wire "McCracken"

- When heated> physical properties and microstructure alter
- Tensile strength is 25% less than cast alloy from which is made
- WW has smaller cross section than cast > for retention
- WW has minimum yield strength of 60,000 PSI is required for retention to use

-Dentinogenic (sex, age, personality) by Frush & Fisher
-Swing lock introduce by simmons
-Lang use leafe gauge to determine C.R
-Gold is 2x flexible as CR-CO clasp

Nelson (2007) implant success rate is less in patient with tumor history

-Methamethical formula use to represent hanau quilt interrelation is,
Thielemann's formula "1938" CG.IG=CH.CC.OP
' CG-condylar guidance, IC- incisal guidance, CH= cusp hight, CC- compensating curve, OP- occlusal plane'

-Possett's envelop: is 3D represent Mn motion in H, S and F planes

-Potassium nitrate is common desensitizing agent.

-Lack post teeth contact is straight protrusive in B.O can be solved by

1. Raise posterior plane occlusion
2. Increase prominence of A.P compensating curve
3. Increase cusp height toward posterior

"Jordan, 1978, "arrangement of anatomical teeth in B.O"

Advantage of lingualized occlusion by Becker "1997"

1. Enhance aesthetic
2. Allow posterior teeth placement at ridge crest
3. Balanced occlusion can be achieved
4. Vertical force can be centralized on mn teeth
5. Good food penetration

<u>Classification of articulator based on GPT (2005)</u>

- Class I- accept single static registration, only vertical movement " hinge"
- Class II- permit H and V movement but not relate motion to TMJ (monsos mx-mn instrument"
- Class III- simulate condylar pathways by using average or mechanical equipment
  -allow orientation of cast to joint
  -may be arcon or non arcon
- Class IV- accept 3D dynamic registration
  -allow orientation of cast to TMJ
  -replicate all mn movement

-CD patient has 25% masticatory efficiency of dentate patient "Zarb"
Masticatory load: natural (44IB, 20kg) and CD=(16 IB, 98kg)

Indication for Swing lock RPD "Stuart"

1. Loss of strategic abutment
2. Remaining teeth to mobile
3. Poor position of strategic teeth
4. Stabilization of MF prosthetic
5. Few remaining teeth

Advantage: inexpansion compared to fixed
Disadvantage: aesthetic, tip teeth for distal extension RPD

-Pterygomandibular raphe attach to pterygoid humular of medial pterygoid palate
-Retention of Mx Obturator can come from “ Desjurdins, JPD,78”

1. Residual soft palate
2. Residual hard palate
3. lateral scar tissue
4. Highly of lateral wall ‘not medial’

-Use hyperbaric O2 prior to implant placement will restore radiated tissue to 75.80% of their former healing potential (Marx,DCNA,98)
-1mm is minimum thickening of rest seat at thinnest part (stuart)
-Viscosity is most important factor to produce impression and die with minimum bubbles and maximum detail.

-Ring clasp ”McCracken”

- Indication: can’t approach undercut by other mean
- Shape: rest seat “ideal 2”, supporting strut or MC to stabilize and decrease flexibility of clasp.

-Non rigid connector in fixed “shillingburg”

- In middle of abutment to isolate force to that segment
- Break stress since each tooth have different movement

-Position:

- Keyway in distal of pier due to mesial direction of force and movement of teeth
  -any force will seat key in keyway
- If connector placed in mesial of pier> unsealing > mobility of canine or failure of retainer

-PalatoPharyngeal insufficiency is when some or all of anatomic structure of soft palate is missing
-PV incompetency: Neuromuscular defect which impaired function
-For rotational paths RPD, pioneer is King, Krol and Garner
-Enter bolus exit balance: Prince
-AHA used in ear piece face bone is Beyrons point
-A.P spread and recommended cantilever

- English> 1.5x
- Branemark> 2.3 pm’s
- Zarb and schenett> 20mm
- Taylor and Bergman> 20mm (5-6 abutment), 15mm(4 abutment)
- Rangert> 15-20mm (MN) > 10mm (MX)

-3 months is maximum time for RCT tooth with temporary crown
- .15mm mandibular flexion
-Soft palate muscle innervated by pharyngeal plexus (vagus nerve)
-Nesbitt- circumferential clasp, Roachet> bar
Neopla- balancing ram

45 F- means:

4. Tooth form classification (square, taper,…

5.Proportion tooth length to width and labial surface “large straight”

F. width of anterior teeth on curve

-Articulator Classification by GPT 2005

Class I

- Simple holding instrument
- Subdivision A- vertical motion “vesticulator”
- Subdivision B- vertical motion as joint related “hinge action”

Class II

- Allow V and H but it didn’t oriented to TMJ
- Subdivision A- eccentric motion unrelated to patient
- Subdivision B- eccentric motion based on monson spherical theory
- Subdivision C-eccentric motion based on engraving methods

Class III

- Simulate condylar pathways accept facebow, arcon or nanarcon
- Subdivision A: accept static protrusion record
- Subdivision B: accept static lateral record

Class IV

- Accept 3D dynamic record and facebow
- Subdivision A: condylar path formed by patient engraving (stereograph, Denar-combi)
- Subdivision B: condylar path formed by inserts e.g. pantograph D5A

Celenza Classification

Class I- simple holding

Class II- allow H and V but not related to TMJ

A. Motion unrelated to P.A
B. Motion based on chew
C. Motion based on patient

Class III--→ Class IV like GPT

Weinberg Classification

- Arbitrary: Monson
- Positional: stunberg tripod
- Semi adjustable: hanan H
- Fully adjustable: kinescope

-sequence of setting D5A PIPRVOT

Some Mn movement ranged

HCG	37^0	Aull
PCG	7.5^0	Lundeen, Gibbs, Gysi '15^0' Hobo ' 12.8^0 '
IMLT	.75mm	Lundeen
Curve of eminence	__3/4 inch____	Dull
ICD	110	Dull

AWN: Rihani "JPD, 1980" Classify articulator to:

- Non adjustable AR: accept 1 or 2 of facebow , CR, protrusion
- Semi adjustable AR: accept 3 record
- Fully adjustable AR: accept facebow, CR, protrusion, lateral, intercondylar record

-Snow-facebone
-Bennett- ISS
-Monson- spherical theory
-Avery brothers- anti monsoon reverse curve of wilson
-Pleasure- anti monson except 2nd molar balance
-Hall- conical theory

Weinberg- Hanan model H errors

- Approximal error at 2nd molar cups height

1. Anatomical average of hing ax axis- 0. 2 mm BS, 0.2mm WS
2. Arbitrary anterior point of reference - 0.2mm BS
3. Straight condylar path- o.2mm, 0.2mm
4. No fischer angle- 0.1 at BS
5. Lack working condylar motion- 0 , 0.8mm at WS

Implant Mock Board Article

Which hard tissue augmentation technique are most successfully in furnishing bony support for implant (Aghaloo and Moy, Ijomi,07)

- Long term success survival of implant place in Maxillary sinus graft regardless of material appear to be similar or better than implant placed using conventional protocol with no graft
- Implant survival rate on Maxillary sinus is well documented
- Implant survival rate on ridge augmented site is poor documented except of GBR technique

Accuracy of implant impression: Asystematic review (Lee, JPD, 2008)

- More studies reported greater accuracy when using direct open tray impression with splinted.
- For 4 or more implant, direct open tray give high accuracy
- Polyether and PVS are recommended material

Indication for conventional loading "weber, Ijomi, 2009"

1. Inadequate primary stability
2. Compromised implant site
3. Parafunctional is present
4. extensive augmentation or sinus lift

Advantage of immediate placement

1. Fewer surgical procedure
2. Less time
3. Improve esthetic
4. Psychological effect

Early implant placement (4 – 8 week)

- Concept is based on unavoidable bundle bone resorption (2 -3 mm) in height within 4 to 8 weeks regardless of implant placement lead to lack control of final position of soft tissue
- Solution: early placement of implant with GBR technique at 6-8 weeks (Weber and Buser, IJ PRO, 2008

No significant difference between fixed splinted or non-splinted cemented restoration regarding bone less in post maxillae.

- (by Vigolo and Zaccaria, IJOMI, 2006)

Zirconium vs. titanium in color change: " Ronald Jung", IJPR, 2007

- Mucosa thickness is crucial factor in color change
- In thin mucosa, Z. will show least color change
- In 2 and 3 mm thickness,Zirconium didn't induce color change

Zirconium abutment:

- Low tendency to bacterial plaque
- .5mm is minimum thickness
- Difficult to mask white color
- Decrease abutment strength follow cyclic load (Nakamura, IJP, 2010

<u>Single non-splinted restoration transfer significantly less load to implant and supported structure than splinted (Nissan, JOR,2010)</u>

Osteotomy temperature shouldn't exceed 39^{o}C and if it exceed 43^{o}C will lead to alkaline phosphate broke down

47^{o}C for 1 minute is critical to osteocytes (by Hobo, Chider, osseointegration and occlossal rehabilitation'

<u>Clinical significant of attached gingival</u>

1. Prevent spread of inflammation to deep tissue (less vascular)
2. Prevent recession of marginal gingiva
3. Prevent excess movement of FG
4. Resist damage from brushing

Non- surgical treatment of apical periodontitist decrease success rate 0 – 9% (Stogen, IE, 1997)

Most complication of splinting implant and tooth is:

- Intrusion of abutment tooth (5.2%) by Lang et.al (2004, OIR)

Indication for flapless approach in implant:

1. 2.5 – 3mm soft tissue thickness
2. Adequate residual bone width
3. Adequate bone height
4. Adequate primary implant stability

After surgical crown lengthening wait at least

- 3 months and possible 6 months for esthetically implant case (Hempton, JADA., 2000)

<u>**Limited amount of micro motion up to 150 μm doesn't seem to interfere with successful osseointegration. (by Szmukler;Salama, J. Biomed medical Res, 1998)**</u>

According to Cochrane review (ITI consensus 2003)

- **Conventional** Loading, loading greater than 2 months from implant placement
- **Early loading**: loading between 1 week and 2 months from implant placement
- **Immediate loading**: loading earlier than 1 week from implant placement (Weber, Ijomi,2009, p 180-183)

Light transmission (translucency) Zirconium was significantly lower than lithium disilicate glass

Complication of implant cantilever

- Screw loosening
- Porcelain fracture
- Loss of retention of prosthesis
- No significant bone loss

(by Ageltte (OIR,2009)

Advantages of cement retain restoration:

1. Passive fit
2. Better esthetic
3. Stable occlusal contact

Disadvantages

1. Retraceability
2. Clean cement

CIE*L*a*b: a – green=/magenta color

Most reliable methods to measure primary stability is insertion technique (30-35 Ncm by Ohonis,Ijomi,2005)(hbkirk, COIR,2006)

Improve quantity of bone by:

1. Cortical plate expansion
2. Sinus augmentation
3. Destruction osteogenesis

No significant difference in marginal bone loss are related to implant or attachment type between implant retaining or supporting OD (Cehreli,Ijomi)

Goodacre (2003),most common implant complication

- 33% loss retention of OD retentive mechanism
- 25% implant loss in irradiated area
- 24% hemorrhage at implant placement
- Least common is implant fracture (1%)

Llekholm and Zarb (1985)

a. Bone quality
    1. Homogenous compact bone
    2. Thick layer of cortical surround dense trabecular bone
    3. Thin layer of cortical surround dense trabecular bone
    4. Thin layer of cortical surround low density of trabecular bone
b. Bone quantity
    A. Most of alveolar bone present
    B. Moderate ridge resorption

C. Advance ridge resorption (only basal bone present)
D. Some resorption of basal bone
E. extreme resorption of basal bone

In microscopic level implant bone interface " Kasemo,JPD,1983)

- Collagen – chondrotic sulfate – Ti oxide – Titanium
- Permanent cessation of blood flow and bone necrosis of bone heated $\geq 60^0$
- At 47^oC for 1 minute start sensivity

Heat injury lead to CT formation 'adepos tissue' and failure of implant
(Erikson and Albertson,JPD,2004)

<u>56% buccal and 30% lingual bone resorption follow immediate implant placement (Boticelli:, 2004)</u>

Stanford (2010, IJOMI,) found

- No association between implant length or location of implant loss
- Implant loss mainly associate with adverse bone resorption and wider implant.

Tsolaki (JPO, 2009) outcome of implant in osteoporotic patient

- Lower osseointegration in osteoporotic bone (animal report)
- No data for contraindication of implant in osteoporotic patient
- Implant consideration due to lower bone volume and lack primary stability
  1. Reduce number of implant
  2. Longer healing time (50% longer than normal patient
  3. Under prepare site and use osteotome technique to compress tissue
  4. Penetrate cortical bone
  5. Root shape implant

- Osseoinduction,encourage UMC to become active osteoblast by BMP
- Appositional bone growth; position bone in pre-existing surface
- Osseoconduction; guide reparative growth of natural bone
- Osteogenesis: lining bone cell in graft contribute to bone remodeling

Study by Evian (2004, IJOMI) shows – there is significant difference in term implant survival between patient with or without perio disease regardless of its immediate (78%) or stage implant placement (81%)

Zarb (2008) shows implant with moderate rough (1- 2µm) has:

1. More bone fixation than turned implant
2. Elevate threshold of micromovement
3. More bone respond in compromised site

Disadvantage of replace Mn 2nd molar implant (Misch)

1. Provide <5% of total chewing efficiency
2. More common for check biting and occlusal interferes

3. Implant may place buccally in relation to maximum teeth
4. Difficult for oral hygiene
5. 10% highest biting force (stress in implant)
6.

<u>Raghavendra, &Taylor early wound healing around implant (IJOMI,2005)</u>

- Most critical time in healing is 2-3 week after implant placement since implant start to losse bone from mechanical stability “primary” provide by implant design and convert to 2nd stability (biological) by new bone formation
- Berlundhe “dog study show”
- At 4 days – osteoclast seen
- 7 days woven bone
- 2 weeks – new bone from parent bone

Following parameter affect temperature drill bone interface (Misch, 2008)

1. Drill speed and time
2. Drill diameter,sharpness and design
3. Temperature and quantity of irrigation
4. Depth of osteotomy and thickness of bone cortical

Study by Lang “JPD”,2003”)

- Preload contact force clumping together implant and implant abutment
- Optimum preload when tightening, torque is increase above initial contact force, preload increase to a point which is optimum preload
- Lowering co efficient of friction ‘type of metal,hardness” maybe sufficient to increase preload
- Result in pre load of 75% yield strength as recommend for screw

Autogenic graft: transplant from one site to another in same indivisual
Allogenic graft: between non-genetically related member of same species “DFDB”
Isogenic graft: between genetically related member of same species “DFDB”
Xenogenous graft between member of different species “Bioss,bovin’
Alloplastic: synthetic, non biologic material ‘HA’

<u>Safe age for implant placement “ by Conin, IJOMI,1994”</u>

- 15 years old girls
- 18 years old boys

<u>Platelet rich plasma (PRP) “by Marx’’</u>

- Growth factors found in platelets
- Obtain from autogenous blood using all separator
- Use to accelerate bone formation
- Result in more and denser bone

<u>Indication for use >2 implant to support mandibular OD “ Sadowsky,2001)</u>

1. Mn OD occlude against dental Mx
2. When implant <8mm lenght and <3.5mm height

3. When mucosa is sensitive, sharp mylohyoid bone, high retention need
4. High muscle attachment

Weber “ IJOMI,2007” – cement and screw has equal implant survival rate but restorative success differs; 83% screw retain and 93% cement retain

<u>Minimum 2mm space between implant and superior aspect of IAC “ Paterson”</u>

Titanium stabilize on B-phase by Valladum, Molybdenum and Niobirum

Kan JPD,1999 found that smoking is detrimental to success of implant in grafted sinuses regardless quantity of cigarettes consumed “65.3% vs. 82.7%

Goodace (2003)loss of implant single 3% ,FPD 10% , MN OD 4%, Mx OD 19%

Perimphtitis – grave anerobes and faculative is common

Torubinejad (JPD,2007) compare non surgical RCT, SCI, FPD:

- Replacement teeth with any of the above produce superior psychological effect In 6 years survival endo crown and implant is 97%, for FPP is 82%
- High quality study is needed

Brayant (IJOMI) answer 4 question

- Prosthesis success is 93% for cement and 83% for implant retain
- Implant ‘97%’ or implant-tooth ‘89%’-> support FPD doesn’t affect implant survival >5 years old
- No enough data support of type of abutment or restoration material effect outcome

McCracken”JP”,1999, Dental implant material;

- 4 grades of CPT and 2 titanium alloy “total of six”
- CPT – change related to oxygen content,iron
- Modules of elasticity increase from 1.2 ‘’G1’ to 1.4 to ‘G4’ & yield strength increase from 170 (G1) to 483 mpa ‘G4’
- Nobel Biocare use G1, 3I – G3, ITI – G4
- Titanium alloy is Ti-6AL-4V and Ti-6 AL-4 V extra low interstitial
- Titanium alloy is 60% stronger (860mpa v.s. 113mpa modules)

Iqbal and Kim (IJOMI,2007) found that – there is no statistically significant difference of non surgical RCT or implant or crown

Rosen et.al (IJOMI,1999), most important determine of implant survival rules is:

- Presence of at least 5mm of bone between crest of ridge and floor of sinus pre-operatively (96%)
- Presence of 4mm before internal sinus left well drop survival to 85.7%

Albrekstsson and Zarb (1986,IJOMI) gave criteria of success- annual radiographic vertical bone loss after first year is .2mm, ‘0.4- 0.6 in1st year’

How do smoking, diabetes and periodontitis affect outcome of implant (klokkevold,2007)

- Smoking effect implant success (11.7% for non-smokers) and survival rate (type 4 bone)
- History of periodontitis affect only success rate by 11.05% (more complications)
- No enough data for diabetes but type II adversely effects implant

Bakeen & winkler,(JOI,2001) effect of implant diameter, restoration and occlusal table

- Wider implant with wider B-L occlusal surface has more screw loosening
- For 2 regular implant width not effect screw loosening
- For single implant with narrow B-L wider to increase screw loosening

Lee (JPD,2005) effect of implant size and shape of implant:

- 7 mm implant had greatest failure when compare to all implant length
- Bone type and cortical bone engagement is more important than implant length
- Implant length- distance from implant platform to apex;

Moy :IJOMI”,2005” increase risk of implant failure with:

1. Diabetes 2.75x
2. Head and neck radiation 2.73%
3. Post-menopausal estrogen 2.55%
4. Increased age >16 years old- 2.245
5. Implant failure rate is 8.16% in Mx and 4.93 in Mn

According to FEA by Geramy and Morgano “JPD 2004”

1. Increase diameter from 3.75 to 5 mm – decrease MD and BL displacement by 50%
2. 2 implants or 5mm show similar BL displacement reduction

Board Examiners' Publications Review upto 2013

2. Steven Eeckert : 79 articles
   - Sagirkaya et al-> analysis of 55 articles about BIC 'bone-implant contact) in human
   - BIC in Mn (70%) Mx "56%" – anterior Mn (79%) > anterior Mx (74%)-post Mn (69%)- post Mx (36%)
   - Conventional load (75%) >unloaded (53%) > immediate load (58%)
   - Implant design & anatomical region affect BIC
     - Ranyruchagucent, 2013 – systemic review shows no effect of static load on implant
     - Wagenberg,2013 – 1-22 years follow up shows 90% has <1.5mm bone loss
     - Salinaj, 2012 –implant supported single crown review
       - implant survival is 96.8% and crown survival 94.5%
       - 12.7% of screw loosening
     - Balshe,2009 – retrospective study compare rough and smooth surface implant (>4000 imp)
       1. No different of survival rate between rough or smooth
       2. Location and implant length (≤10mm) associate with failure in smooth surface
     - Cehreli,2009 – meta analysis assist implant stability
       - High correlation between insertion tongue and RFA
     - Huh, 2009 – Zr abutment preparation increase temperature in implant but didn't reach critical level
     - Balshe,2008 – effect of smoking on smooth and rough surface "retro >4000mph " high failure rate of smooth surface with smokers but not rough

2. Jonathan P. Weins : 7 articles – occlusion

3. Robert Taft – 2 article – case report

4. Kent Knoernschild – 18 articles – review of single implant in esthetic zone – up to 47% fo IIP

5. Arthur Nimmo – 10 articles – Fernandez, 2013- compare plastic and metal implant impression coping
"for Strauman metal is more accurate & for Nobel "no difference"

6. Thomas Mcgarry – 21 articles
PDI -Classification

7. Donald Curtis – 22 articles
-Curtis , 2012 – managing dental erosion- assessment and management
- CAMBRA – with Featherstone
- Karo, 2007 – classification in system for IA microgap
    1. machined Ti abutment

2. premechained palladium abutment
3. plastic burnout cast with NiCr
4. plastic burnout cast with Co-Cr

No significant difference in vertical gab, horizontal there was a difference

8. Rhonda Jacob – 12 articles about maxilla-facial Prosth mainly
Bidra, 2012- for maxilla facial defect – no one class describe maxillectomy defect satisfy surgeon and prosthodontics need

9. Stephen Parel – 14 articles
- Bidra,Agar and parel,2012 – management of excessive gingival display
    - Pre-prosthetic surgical bone reduction to mid junction based on classification by Bidra and Agar

- Parel, 2011 – retrospective risk assessment for four tilted post - implant load Mx-FCD'
    - Common factor for Mx implant failure are opposing natural dentation, bruxer, lack bone density, distal implant site
    - Suggestive of add implant, delay loading for high risk patient

- Jensen et.al, 2011 – 2 articles talk about "all on 4 shelf"
    - osteoplasty describe as that "shelf" for adequate bone reduction
    - minimum of 20mm of interarch space for abutment, Ti bar and prosthetic restoration
    - 30^o angle of posterior implant for maxillary and mandibular
- Novum implant system " by Branomark, 1999" – consist of 3 implant between mental foramen and immediate fixed prosthesis denture

10. Malament - 19 articles
- Malament, 2010 – survival of dicore glass over 20 years
    - survival dicore influence by sex, tooth position and restoration luted to gold crown (molar, dentin core and men has more failure)
- Acid etch glass with cement show high success

11. Thomas Taylor – 41 articles
- ➢ Nazarova,2012 – RPH clasp
- Same as RPI but has horizontal retention and use when can't use RPI
- Cochran, 2011 – 5 years old prospective study of early loaded SLA implant
    - final abutment placed after 6 weeks in type I & II bone and 12 weeks in type IV
    - 98% of implant success rate after 5 years "very selected patient"
- ➢ Cochran,2011 – 5 years prospective of non-submerge TPS surface
- High success rate 92% of non-submerge implant
- ➢ Bidra,2009 – facial and dental midline
- Closest to midline of face at smile are midline of oral commisures >dental midline
- Closest midline of oral commissure are dental midline
- ➢ Ortegon,2009 – retention forces for implant
- Decrease retention of 30^o degrees divergent implant "ball attach"
- ➢ Karl, 2007 – screw access hole of screw retain FPD forms a weak point of ceramic layer

12. Carl Driscoll – 21 articles

- Banghani, 2012 – distribution of implant has significant effect on load distribution to palate when use locator. 4 implant when ≥ 16mm distance transfer load to palate within 8mm implant
- You, 2011 – denture cleansing significant decrease retention value of pink locator attach

    - NaOCl reduce significant relation value and Listerine is least effect (need more data)
    - Loss retention if soak in efferdent 49%, polident is 34%
- Varghese,2007 – retention value of head clip bar is unaffect by denture cleanser
- Habib, 2005 – Zinc phosphate cement had higher retention for CPC than panavia
- Butler,2004 – 1.23% of APF autoglaze surface procedure
- Driscoll,1991 – 4 material test show , increase temperature PMMA is highest and high active is lowest
- Driscoll,1990 – Bifid Mn canals distal to last molar

13. David Felton – 48 articles

- Cooper, 2008 – Mn 2 implant overdenture showed high success rate
- Felton – endo or implant

ABP Examination Questions Part 3 – Fixed

- What type of tooth wear patient has? How did you diagnose that?
- What is the different types of tooth waer that you are familiar with? What are the S&S of each?
- What is the caries risk for your patient? List the main criteria for that?
- How did you assist the VDO? Technique and literatures?
- How is the patient adabt to any increase in VDO?
- How did you perform the wax-up? Sequence?
- Why did you choose a D5A? what is the sequence of angle adjustments?
- What is the important of ISS? Literature and avarages?
- How is the rear wall adjustment effect on tooth morphology?
- What is your occlusal scheme?describe the progressive disocclusion?
- Different occlusal schemes?
- What type of provisionals technique that you did? Advantages and disadvantages?
- What type of implants did you use for this patient?
- What type of surface?
- How early can you load these implants? Any study?
- How is the implant have been placed?Did you place them?
- Why some implants were an immediate and the others were not?
- Any literatures to support such procedures?
- What is your philosophy for post and cores?What is the rule of third?
- What endo literature mention about the success rate for retreatment? Apical lesion and endo?
- Why cast post and cores for the premolars?
- What type of composite did you use with prefab post? What is the wear and leakage rate of those materials?
- What are the materials that you use for final restorations?
- Why all ceramic in anterior? What is the material?
- Why not in the posterior? Literatures?
- How is Lava restoration better than other All ceramic materials? Advantages?
- What is the main complications with Zirconia based restoration?
- Give me six explinations that has been mention in literatures that explain high chipping rate?
- Why did you use a deep chamfer for all your preparations?
- Do you splint implant-supported PFM crowns? Why not?
- What are the implant success criteria?
- How much bone do you lose around the implant in the first year? What about the following years?
- CAMBRA protocol? Why did you give pt nightguard?

ABP Examination Question Part 4 “CD”

- Whar type of impression technique that you follow?
- How did you perform your border molding?
- Describe the main structure and landmarks related to your border molding? How do you activate the superior constrictor muscle?
- What type of impression material did you use for your final impression? Why?
- Did you relief your tray?
- Who spoke about the selective pressure technique?
- Could you describe it for me?
- Your selective pressure technique differs from that of Boucher. Can you explain the difference?
- What are the primary stress bearing areas in the maxilla and in the mandible?
- How did you determine the VL?
- How do you imprint it?
- What are the anatomic structures that you could find underneath it?
- What is this area called?
- How do you imprint it?
- What is this area here?
- What is the importance of the PPS in the fabrication of the complete denture?
- How do you register the PPS?
- How spoke about the PPS in the literature?
- What technique do you use to locate the hamular notch in the mouth?
- What do you know about the vibrating line?
- Is it in front or behind the fovea palatinae? Any literature?
- What material did you use to do the border molding?
- Do you know the composition of molding compound?
- Did you use the same impression material for the mandibular complete denture?
- What consistency?
- What is this area called? (Buccal shelf)
- What are the primary stress bearing areas in the mandible?
- What muscle is attached here? (Pointing at the mylohyoid area)
- What is the pear shaped pad? Is it the same as the retromolar pad?
- What is the importance of this muscle when fabricating a mandibular CD?
- During the diagnostic exam, how do you check your patient’s mouth for cancer lesions?
- Why did you use modeling compound as a bite registration material? Any advantages? Any concerns?
- Would you be worried to have a space between the maxillary and mandibular wax rims following a bite registration record?
- What did Tallgren speak about?

- What did Atwood speak about?
- Do you know who came out with the classification of the tongue?
- Do you know what Niswonger spoke about?
- What type of occlusion did you provide the patient with? Describe it.
- Are you aware of any other type of occlusal pattern?
- Who spoke about lingualized occlusion? Describe it.
- Who spoke about neutrocentric occlusion? Describe it.
- Do you know what farmer’s teeth are?
- What are the signs of an open VDO?
- Would you be worried about an open VDO?
- What are the signs of a closed VDO?
- What esthetic criteria do you use to set your maxillary teeth?
- Do you know who spoke about the closest speaking space?
- Do you know what dentogenics and who spoke about it?
- Would you let your patient get involved in tooth selection? Any literature?
- Do you take protrusive records? What for? What material?
- What is the Bennett angle? What is the average?
- Anybody else spoke about this angle?
- What number did they found?
- What about Hanau?
- Do you know what the Hanao quint is? Its importance in CD?
- What factors could you change?
- Describe campers line. Why do you use it? Does it have anything to do with esthetics and function?
- How do you process your dentures?
- What are the steps that the acrylic goes thru after you mix the powder with the liquid?
- Composition of the liquid and powder. The initiator? The inhibitor?
- How long do you keep your denture in the curing tank?
- Any other techniques? What does the literature say about the different techniques?
- Would you be worried about the shrinking of acrylic?
- Anything you can do for acrylic to improve its esthetic?
- How did you place the implants? Did you use CBCT? How?
- What is the important vital structure that related to your surgical site?
- What is the implant diameter and length? How did you select them?
- Do you know the surface treatment of those implants? Literature about success rate and BIC?
- How did you pick-up your attachments?
- What is the pick-up material? What is other material can be used?
- What is your maitance protocol for such patient?

ABP Examination Questions Part 2 'Combination'

- Describe your RPD designs?
- What is the component of clasp?
- Why did you select lingual bar? Adv and disadv
- What are the classes for Lever? Explain them?
- Discuss your philosophy behind your clasp design?
- What is the difference between the clasp design of Kroll and Kratochvil?
- What metal did you use for the fixed partial denture? Discuss the components.
- Define high noble alloy.
- What does indium do to your metal?
- What type of ceramics did you use? What is the content?
- What does the Leucite do?
- How does bonding take place between the metal and the porcelain?
- What type of investment material did you use? Why?
- What is the difference between PBI and GBI? Are you aware of any other type of investment material?
- What alloy did you use for your metal framework?
- What is the difference between Vitallium and Ticonium?
- What does the Beryllium in Ticonium do?
- Which material has more strength?
- Did you do an altered cast technique? Why?
- Who spoke about the altered cast technique?
- How did you do your altered cast technique?
- What type of impression material did you use for your final impression for the complete denture?
- Is it the same material you used for the altered cast technique?
- Why did you use PVS for your impression of the FPD abutments?
- Any advantage(s) over other impression materials?
- How do you disinfect your final impression?
- Describe your teeth preparation? What type? Why? Any studies?
- How much reduction do you need?
- Who spoke about limited tapers?
- If your clinical crown is short what do you do?
- Other than crown lengthening, what can you do?
- Where do you place your grooves?
- If one of your abutments is tilted mesially, where would you place your grooves?
- What type of occlusal pattern did you provide the patient with?
- What cement did you use for your final cementation? Why?
- Why did you cement FPD temporarily?
- If the FPD has been in the patient's mouth for a week, will you do anything particular for that FPD prior to final cementation?
- Do you do that for all FPD's? Why not for PFM's?
- What is the split cast technique? How did you do it?

- Did you process your dentures yourself? How did you do it?
- What acrylic material did you use?
- What is its composition?
- What are the four stages that acrylic goes through after you mixed it?
- When do you know when is the best time for the trial pack?
- What if you go busy and you forgot to trial pack?
- What do you know about color?
- What type of pontic design did you use?
- Who described the modified ridge lap pontic?
- What are its advantages?
- What are its disadvantages in the posterior area?
- Could you describe any other types of pontics available?
- Since we still have time

  

  - What is the envelop of motion? Please draw them in three planes? Describe the points? Posselt's diagram?
  - What type of rotation your RPD will have?

Time out

GOOD LUCK