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Original Article

Novel augmentation ileocystoplasty technique to manage non-compliant bladders in the presence of obstructed megaureters: The "fez procedure"

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Abbreviations & Acronyms
99mTc-DTPA = technetium 99m-diethylene triamine pentaacetic acid
CIC = clean intermittent catheterization
GFR = glomerular filtration rate
UTIs = urinary tract infections
VCUG = voiding cystourethrography
VUR = vesicoureteral reflux

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Objectives: To show the efficacy and safety of a novel modification of Studer's neobladder, herein defined as the "fez procedure."

Methods: The medical records of 21 children (mean age 9.4 ± 1.3 years) who underwent the "fez procedure" at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, to manage refractory poorly-compliant bladders and concomitantly obstructed megaureters were retrospectively reviewed. The patients had been previously managed by either preliminary cutaneous ureterostomy (17 patients) or temporary nephrostomy (four patients) to improve and stabilize the renal functions. The "fez procedure" entailed augmentation ileocystoplasty and the use of an afferent tubularized ileal loop for direct ureteroileal anastomosis. The augmented bladder together with the tubularized loop were fashioned as a "fez" with its tassel. The outcome measures were changes in cystometric capacity, bladder compliance, glomerular filtration rate, serum creatinine, technetium 99m-diethylene triamine pentaacetic acid diuretic renography (T1/2), ureteral diameter, vesicoureteral reflux, febrile urinary tract infections, continence and complications.

Results: The mean study follow-up period was 52.5 ± 12.8 months. Means of changes of cystometric capacity (273.2 ± 60.9 mL) and bladder compliance (15.6 ± 4.2 mL/cm H_2O) were significant ($P < 0.0001$). Resolution of ureteral obstruction was documented with improved T1/2 and ureteral diameter ($P < 0.0001$, each) of all patients. The initially improved renal functions after ureterostomies or nephrostomies were maintained after "fez surgery," with non-significant changes in the improved glomerular filtration rate ($P = 0.22$) and serum creatinine ($P = 0.18$). None of the patients experienced ureteral restenosis, vesicoureteral reflux, febrile urinary tract infections, incontinence or significant complications.

Conclusions: The "fez procedure" represents a versatile and successful surgical option for these selected patients, as it offers improved bladder capacity/compliance, resolution of ureteral obstruction and vesicoureteral reflux, preservation of the renal function, control of urinary tract infections and urinary continence, and acceptable morbidity.

Key words: bladder augmentation, ileocystoplasty, neurogenic bladder, obstructed megaureters, pediatric, ureteral reimplantation.

Introduction

Augmentation cystoplasty was first applied in humans in 1889 by von Mikulicz, but it was later popularized by Couvelaire in the 1950s.[1,2] CIC contributed widely to the use of augmentation cystoplasty in the 1980s.[3] Ideally, the most important aim in the setting of augmentation cystoplasty is to create a low-pressure reservoir, while preserving the integrity of the upper urinary tract and improving incontinence.[4] Several tubular or detubularized bowel segments have been used successfully for bladder augmentation, including cecum, ascending colon and sigmoid colon. Yet, ileocystoplasty is the most preferred cystoplasty procedure.[4] Although the new pharmacotherapies, intravesical injections of botulinum toxin-A and neuromodulations, have led to a downward trend for augmentation cystoplasty over the past decade, this procedure remains a viable option for non-compliant bladders refractory to these treatments.[4]

Traditionally, obstructed megaureters have been treated by tailoring and reimplantation of the ureters into the bladder.[5] Ureteral reimplantation into the thickened trabeculated non-compliant bladder with friable mucosa imposes technical difficulty and increases the risk of postoperative

ureteral stricture.[6] Tailoring of megaureters might be complicated by stenosis at the ureterovesical anastomosis when excisional tapering is carried out, or excessive bulk of tissue when plicated.[5] Likewise, ureterointestinal anastomosis using a non-refluxing technique could result in higher rates of anastomotic stricture than the direct anastomosis.[7]

In 1989, Studer *et al.* reported their first 3 years of experience of orthotopic ileal neobladder replacement, with an ileal loop chimney for direct ureteroileal anastomosis to prevent vesicoureteral reflux.[8] The more recent study by Studer *et al.* reporting on orthotopic neobladder in 482 patients with 20 years of experience showed the durable efficacy of using the ileal loop chimney for direct ureteroileal anastomosis with less than a 3% anastomotic stricture rate.[9]

To our knowledge, based on a literature search, Studer's technique was described primarily for orthotopic neobladder replacement of the urinary bladder after cystectomy.[8,9] We report our experience with a new indication and modification of Studer's technique (fez procedure), which entails augmentation ileocystoplasty, and using an afferent isoperistaltic tubularized ileal loop for direct ureteroileal anastomosis. The procedures were carried out for the management of a particular exceptional group of children having refractory neurogenic or non-neurogenic poorly-compliant bladders, and concomitantly obstructed megaureters. The aim of the present study was to show the efficacy and safety of this modified technique; in the domains of bladder function, ureteral obstruction, renal functions, VUR, febrile UTIs, continence and complications.

Methods

Setting

We carried out an ethics committee-approved retrospective review and analysis of data of 21 children who underwent our modified fez procedure at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, between March 2004 and June 2011.

Inclusion/previous management and exclusion criteria

The children had been previously presented during their early lives with neurogenic bladder as a result of myelodysplasia (17 children), or posterior urethral valve bladder (four children). All children were incontinent to urine, whereas 15 patients had recurrent febrile UTIs. Six patients showed grade 4–5 VUR at their initial VCUG. The children were initially refractory to anticholinergics, botulinum toxin-A intravesical injections, CIC and/or antibiotics suppression; with progressive decline of renal functions. Ureteral obstruction was suspected from ultrasonography and 99mTc-DTPA diuretic renography with evidence of hydroureteronephrosis and prolonged T1/2. Ureteral obstruction was further proved by failure of renal function to respond to an initial 2 to 4-week period of urethral catheterization; followed by improvement of renal function and elimination of obstruction at 99mTc-DTPA diuretic renography after an additional 2 to 4-week period of nephrostomy catheterization. Patients with documented ureteral obstruction (18 bilateral and three unilateral; total 39 megaureters) were further managed with cutaneous ureterostomies, or continued on the nephrostomies, awaiting their growth. At the time of fez surgery, 17 children had preliminary cutaneous ureterostomies, whereas four children were on temporary nephrostomies. The mean age at ureterostomy(ies) was 2.5 years (range 7 months to 4 years), and the children underwent the fez procedure after 3–9 years after ureterostomy(ies). Patients who responded favorably to the initial 2–4 weeks of urethral catheterization were offered other alternatives (e.g. anticholinergics and CIC, or vesicostomy), and were not included in the current study. Children with GFR <30 mL/min or serum creatinine >2 mg/dL were not offered the fez surgery.

Fez procedure

The native bladder was widely incised sagittally down to the level of the interureteric ridge. The ureter(s) were dissected, tortuosities were corrected, and the ureteral stenotic segment and extra length were trimmed. As a modification of Studer's procedure, a 25 to 40-cm ileal segment, at least 15 cm from the ileocecal valve, was isolated with its segmental blood supply, and the ileal continuity was re-established.[8,9] The selected segment was detubularized by opening its antimesenteric border, keeping the proximal 5 cm of the segment as an afferent isoperistaltic tubularized loop. The detubularized segment was constructed as a U- or W-shaped patch (Fig. 1). The ileal patch was sutured with absorbable sutures to the wide-opened native bladder to prevent the hourglass deformity, and to configure the bladder in a spherical shape (Figs 2,3). The ileal patch with

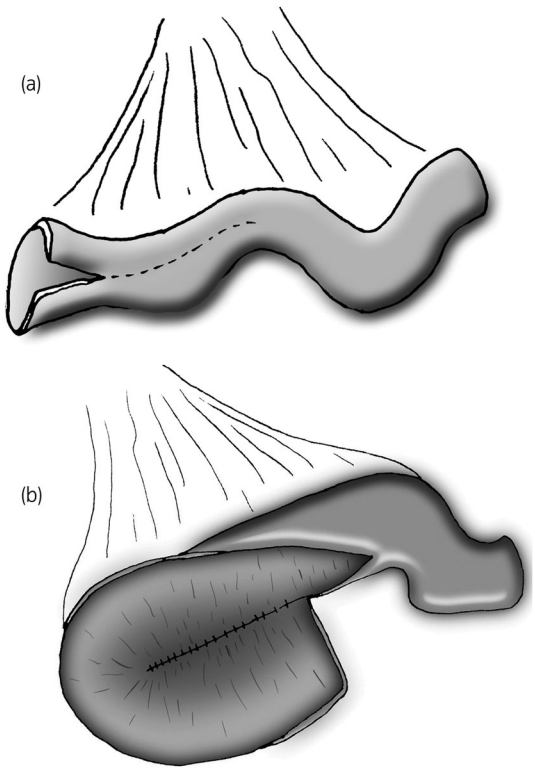

Fig. 1 (a) The selected segment was detubularized by opening its antimesenteric border, keeping the proximal 5 cm of the segment as an afferent isoperistaltic tubularized loop. (b) The detubularized segment was constructed as a U- or W-shaped patch.

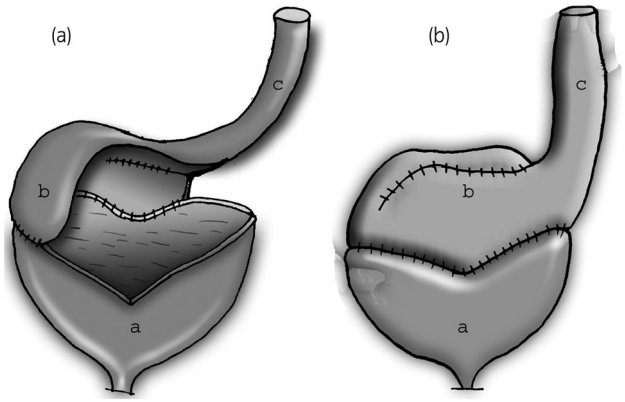

Fig. 2 (a) The ileal patch was sutured with absorbable sutures to the wide-opened bladder. (b) The ileal patch with its loop was finally fashioned as a "fez" with its tassel. a, Native bladder; b, ileal patch; and c, tubularized ileal loop. The Mitrofanoff channel is not shown here for simplification.

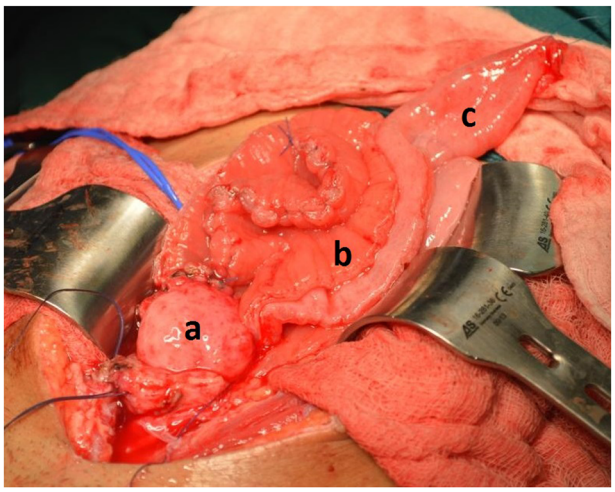

Fig. 3 Operative photography showing (a) the opened native bladder, (b) the ileal patch and (c) the tubularized ileal loop.

its tubularized loop, when sutured to the bladder, was finally fashioned as a "fez" with its tassel (Fig. 2). The tubularized loop was directly anastomosed to the non-tailored ureter(s); as end-to-end with the right ureter and end-to-side with the left ureter in bilateral megaureters, or end-to-end in unilateral disease (Fig. 4). The ureteroileal anastomoses were stented, a suprapubic catheter was brought out of the native bladder and perivesical drains were secured. A concomitant Mitrofanoff catheterizable channel using the appendix was carried out in 16 patients to facilitate CIC. No concomitant bladder neck surgery was carried out in the reported patients. Ureteral stents were removed after 2–3 weeks, whereas cystography was carried out 4 weeks after surgery, and the suprapubic catheters were removed if there was no extravasation.

Follow up

Visits after fez surgery were typically scheduled at 3-month intervals for the first year; and every 6 months thereafter. Urine analysis, urine culture/sensitivity tests, serum creatinine and ultrasonography of kidney-ureter-bladder were carried out at each visit; whereas VCUG was carried out at the first 3-month visit. 99mTc-DTPA diuretic renography and urodynamic cystometry studies were carried out every 6 months for the first 2 years, and were then repeated annually.

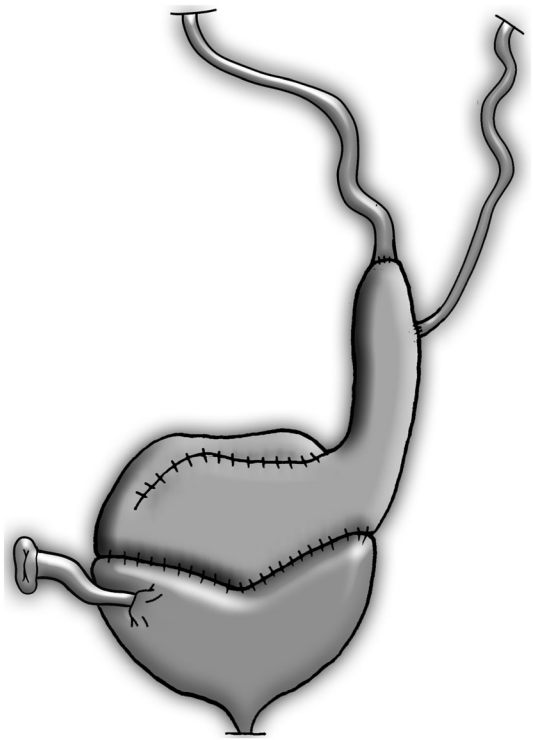

Fig. 4 The tubularized loop was directly anastomosed to the non-tailored ureter(s) as end-to-end with the right ureter and end-to-side with the left ureter in bilateral megaureters, or end-to-end in unilateral disease. The Mitrofanoff channel is shown. The catheters and drains are not shown.

Outcomes

The measured outcomes were changes in cystometric capacity and bladder compliance, degree of hydroureteronephrosis in ultrasonography, 99mTc-DTPA evidence of ureteral obstruction (T1/2), 99mTc-DTPA determined GFR, serum creatinine, documentation of reflux on VCUG and febrile UTIs episodes. Improvements of urinary incontinence, documented complications after surgery and length of hospital stay were also analyzed.

Statistical analysis

The Wilcoxon signed-rank test was carried out using GraphPad InStat version 3.06 for Windows (GraphPad Software, San Diego, CA, USA). Two-tailed $P < 0.05$ was considered significant.

Results

The present study included 21 children, 15 boys and six girls, with a mean age of 9.4 ± 1.3 years (range 6–12 years) at the time of fez surgery. The mean operative time was 301 ± 40 min (range 250–370 min).

The postoperative hospital stay varied between 15 and 33 days with a mean of 23.3 ± 5.8 days. The follow-up period after fez surgery ranged between 18 and 78 months, with a mean of 52.5 ± 12.8 months.

The mean ± SD of preoperative cystometric capacity (96.9 ± 21.4 mL) and bladder compliance (3.1 ± 1.2 mL/cm H_2O) showed significant improvements during follow up ($P < 0.0001$, each). After the fez surgery, the cystometric capacity mean change ± SD was 273.2 ± 60.9 mL (95% CI 245.5–301); whereas the bladder compliance mean change was 15.6 ± 4.2 mL/cm H_2O (95% CI 13.6–17.5); with a percentage change of 282% and 503%, respectively (Table 1).

Improvement of hydroureteronephrosis was evident on ultrasonography of all patients; although none of them had complete resolution. Likewise, resolution of ureteral obstruction was documented at follow-up 99mTc-DTPA diuretic renography studies of all patients, and none of them experienced reobstruction of the ureters (Table 1). The improved renal function, previously documented with the preliminary cutaneous ureterostomies or nephrostomy catheters, were maintained after fez surgery (Table 1) with non-significant changes of the improved GFR ($P = 0.22$) and serum creatinine ($P = 0.18$).

Continence between CIC was observed in all patients; although two patients required anticholinergics to achieve continence. None of our patients showed VUR after fez surgery, and febrile UTIs episodes were also resolved in all children. No significant intraoperative or postoperative complications, such as significant bleeding necessitating blood transfusion, wound dehiscence, sepsis or anastomosis leaks, were reported. However, Mitrofanoff stomal stenosis was seen in one patient and was successfully revised.

Discussion

Augmentation cystoplasty has been advocated as a sufficient procedure to resolve refluxing megaureters in neurogenic bladder, with no necessity to carry out ureteral reimplantation.[10,11] However, in obstructed megaureters, the decision of surgical intervention is more complex. As long as renal functions are not significantly jeopardized and UTIs are not a major concern, the basic management is antibiotic suppression with close observation, and no surgery should be carried out. If surgery is warranted, repair is typically carried out between 1 and 2 years-of-age, as earlier surgical intervention is fraught with higher complication rates.[12] Surgery usually entails reimplanting the plicated or tapered ureter into the bladder. Plication usually results in a bulky ureter, whereas tapering can lead to anastomotic stricture.[5] Furthermore, the thick non-pliable bladder might encumber the reimplantation of the ureter, and increases the risk of postoperative ureteral stricture.[6]

Nevertheless, different procedures were described to implant the ureters into bowel segments used for orthotopic neobladders; including both antireflux and direct anastomosis procedures.[7,13–15] The benefits of antireflux techniques have been overestimated despite the higher rates of stricture formation; and direct ureteroileal anastomosis seems to be more rational than antireflux techniques for non dilated ureters. Hassan *et al.* compared the outcomes of the Le Duc antireflux technique versus direct anastomosis for ureteral implantation in the setting of orthotopic Y-ileal neobladder.[13] Unilateral ureteroileal anastomotic stricture was encountered in 9.7% of Le Duc patients compared with none of the direct anastomosis patients. Additionally, antirefluxing techniques did not guarantee the non-existence of reflux, particularly with preoperatively dilated ureters.[13] Similarly, Shigemura compared the direct ureteroileal anastomosis using the Wallace method versus Le Duc ureteroileal anastomosis in modified Studer's orthotopic neobladder reconstruction, and they concluded that direct ureteroileal anastomosis was a simple technique minimizing the incidence of anastomotic stenosis.[14] Furthermore, Waidelich *et al.* reported on 15 patients with direct ureteroileal anastomosis using Studer's technique, and confirmed the postoperative absence of vesicoureteral reflux.[15]

The present series included a particularly complex group of 21 children who had presented in their early lives with refractory poorly-compliant bladders, of neurogenic or non-neurogenic origin and documented obstructed megaureters; with or without VUR. The patients were incontinent to urine, showed progressive deterioration of renal functions and 15 of them experienced repeated episodes of febrile UTIs. The patients were refractory to less invasive managements with anticholinergics, botulinum toxin-A intravesical injections, CIC and/or antibiotics suppression; thus necessitating the preliminary management of cutaneous ureterostomies in 17 patients and temporary nephrostomies in four patients. Fez surgery was applied to those children who showed improvements of renal function and resolution of obstruction after cutaneous ureterostomies or, alternatively, after the nephrostomies.

Studer's procedure was basically designed as an ileal neobladder to replace the bladder after cystectomy procedures.[8,9] We described our new modification of Studer's procedure using an ileal patch in continuity with an afferent

Table 1 Pre- and post-fez surgery studies of bladder and renal functions.

	Pre-op mean ± SD (range)	Post-op mean ± SD (range)	Change mean ± SD (95% CI of change)	% Change	*P*
Cystometric capacity (mL)†	96.9 ± 21.4 (62–135)	370.1 ± 79.2 (221–458)	273.2 ± 60.9 (245.5 to 301)	282%	0.0001
Bladder compliance (mL/cm H_2O)†	3.1 ± 1.2 (1.1–5.2)	18.7 ± 5.2 (10.2–31.4)	15.6 ± 4.2 (13.6 to 17.5)	503%	0.0001
GFR (mL/min)†	62.0 ± 10.7 (45–77)	60.2 ± 11.5 (43–80)	−1.81 ± 5.1 (−4.14 to 0.52)	−2.9%	0.22
Serum creatinine (mg/dL)†	1.05 ± 0.4 (0.4–1.7)	1.16 ± 0.43 (0.42–1.84)	0.1 ± 0.27 (−0.01 to 0.23)	9.5%	0.18
T 1/2 (min)‡	27 ± 5.03 (24–41)	12.9 ± 2.4 (9–18)	−14.1 ± 5.7 (−16 to 12.3)	−52.2%	0.0001
Ureteral diameter (mm)‡	13.3 ± 4.8 (8–25)	6.1 ± 2.1 (5–14)	−7.26 ± 3.6 (−8.4 to −6.1)	−54.4%	0.0001

†Assessment before fez versus the latest post-fez follow-up. ‡Initial assessment (before nephrostomy/ureterostomy) versus latest post-fez follow-up.

isoperistaltic ileal loop for augmentation cystoplasty and direct ureteroileal anastomosis in this particular group of patients. The augmented bladder with its attached ileal loop, when distended, resembles the fez – a traditional Arabic hat – with its attached tassel; hence, we named this technique the "fez procedure."

Augmentation ileocystoplasty in our patients resulted in significant improvements of bladder function with a significant increase ($P < 0.0001$) of both bladder capacity (282%) and bladder compliance (503%). Additionally, the application of this procedure resolved the ureteral obstruction in all children with no restenosis formation. Furthermore, none of our patients demonstrated reflux; showing the efficacy of this simplified direct ureteral anastomosis to the tubularized ileal loop in the prevention of reflux. The improvements of bladder functions and the resolution of ureteral obstruction consequently maintained preserving the renal function – an ultimate goal – with continued improvement of GFR and serum creatinine after fez surgery. The procedure was also effective in controlling febrile UTIs episodes and incontinence in all children; although two patients required anticholinergics to achieve continence.

The safety of our procedure was observable, as none of the patients experienced significant intra- or postoperative complications; further highlighting the relative simplicity of this procedure. Stenosis of the Mitrofanoff stoma was seen in one patient, which required a secondary procedure and was successfully revised.

To our knowledge, this modification is novel, as we are not aware of any previous report describing a similar technique. Additionally, although controversy exists on the necessity of ureteral reimplantation to eliminate VUR in refractory patients undergoing augmentation ileocystoplasty for non-compliant bladders and refluxing ureters,[6,10,11] we believe that our procedure might also be studied in such patients as a potential simplified antireflux measure with a minimal stricture rate. The fez procedure could also have a potential to be studied in other conditions associated with contracted bladder and concomitant ureteral strictures, such as tuberculosis or schistosomiasis.

The retrospective design, and the limited number of patients were limitations of the present study. Of note, ureteral dilatation in children with neurogenic bladder is usually secondary to increased intravesical pressure, and improving bladder compliance will consequently improve the ureteral dilatation in the majority. Thus, our procedure was proposed only to manage an exceptional particular group of complex patients with evidence of refractory poorly-compliant bladders and proved concomitantly obstructed megaureters.

The fez procedure, entailing augmentation ileocystoplasty and direct ureteral anastomosis to an afferent tubularized ileal loop, was applied to this particularly complex group of children with refractory poorly-compliant bladders and concomitantly obstructed megaureters. The procedure proved to be a versatile and successful surgical option, with improvements of bladder capacity/compliance, resolution of ureteral obstruction and VUR, preservation of renal functions, controlling symptomatic UTIs and incontinence, and showing acceptable morbidity.

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Conflict of interest

None declared.

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