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Photoselective vaporization of the prostate using GreenLight 120-W lithium triborate laser to treat symptomatic benign prostatic hyperplasia: A single-centre prospective study

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Abstract

Objective: We evaluated the safety and efficacy of photoselective vaporization of the prostate (PVP) using GreenLight 120-W lithium triborate (LBO) laser to treat symptomatic small-to-medium sized benign prostatic hyperplasia (BPH).

Methods: This prospective non-controlled observational study included symptomatic BPH men ≥50 years with international prostate symptom score (IPSS) ≥14, prostate volume (PV) ≤80 cc and maximum flow rate (Q-max) ≤15 mL/s. PVP was performed using the GreenLight 120-W LBO laser machine. Patients were assessed at baseline and postoperatively at discharge, 2 weeks, and 3, 6 and 12 months. We measured changes in IPSS, PV, PSA, Q-max, post-void residual (PVR), hemoglobin (Hb), serum sodium (Na+) and reported complications. Statistical significance was $p < 0.05$.

Results: The study included 103 men with mean age of 67 (±standard deviation)±9.7 years. Thirty patients were on indwelling urethral catheters for refractory urinary retention and 12 on ongoing anticoagulants. The mean baseline IPSS, PV, PSA, Q-max and PVR parameters significantly improved at follow-up ($p < 0.001$; each). Mean measurements at baseline versus at six months were: IPSS 25.6 ± 4.2 vs. 7.4±2.3; PV 44.6 ± 9.2 vs. 21.6 ± 6.3 cc (51.6% reduction); Q-max 5.8 ± 3.4 vs. 20.4 ± 4.8 mL/s; PVR 110 ± 40 vs. 35 ± 9 cc. Mean baseline Hb and serum Na+ declined non-significantly ($p > 0.05$) at discharge and at 2 weeks. No patient needed a blood transfusion. Secondary procedures were needed in 2 patients for urethral and bladder neck strictures. The re-treatment rate for residual adenoma was 0.97%.

Conclusion: PVP using the GreenLight 120-W LBO laser to treat small-to-medium sized symptomatic BPH demonstrated significant improvements in efficacy parameters and high safety profile within 12 months of follow-up. The procedure entails good hemostasis with minimal blood loss even in patients receiving ongoing anticoagulants.

Introduction

Benign prostatic hyperplasia (BPH) affects many aging men. Transurethral resection of the prostate (TURP) has been the gold standard for symptomatic BPH with outstanding long-term efficacy, yet with a range of minor-to-major complications.[1] Over the last decade, photoselective vaporization of the prostate (PVP) using GreenLight laser (American Medical Systems, Minnetonka, MN), with documented safety and efficacy, has been accepted as an alternative to TURP.[2-16] The GreenLight laser is generated by passing neodymium:yttrium aluminum garnet (Nd:YAG) laser through a frequency-doubling crystal, reducing its wavelength from 1064 nm to 532 nm. The 80-W laser system uses potassium-titanyl-phosphate (KTP) crystal, while the newer high performance system (HPS) device uses lithium triborate (LBO) crystal for frequency-doubling to generate higher 120-W laser, resulting in a speedy and more efficient vaporization.[16,17]

While several studies have reported on PVP using GreenLight 80-W KTP laser,[2-11] reports on PVP with higher power GreenLight HPS 120-W LBO laser are scarce[12-16] or involve multicentre studies.[16] The objective of the current single-centre study was to prospectively evaluate the safety and clinical efficacy of GreenLight HPS 120-W LBO laser PVP to treat symptomatic small-to-medium sized BPH.

Methods

This prospective non-controlled observational study was conducted at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, between March 2008 and March 2010. The study was approved by the ethics committee and written informed consent was obtained from each patient.

Symptomatic BPH men ≥50 years with international prostate symptom score (IPSS) ≥14, transrectal ultrasound (TRUS) measured prostate volume (PV) ≤80 cc and maximum flow rate (Q-max) ≤15 mL/s were included. Patients with neuro-

logical disorders, urethral stricture, bladder calculi, bladder or prostate cancer, previous prostate or urethral surgery were excluded. Men having indwelling urinary catheters for refractory urinary retention or receiving ongoing anticoagulant medications were not excluded.

We adopted the technique originally developed by Malek and colleagues[18,19] and modified by Muir and colleagues[20] to perform PVP using GreenLight HPS 120-W laser system. While the patients were under either general or regional anesthesia, PVP was performed through a 23-Fr continuous-flow laser endoscope. The solution of 0.9% sodium chloride served as irrigation medium.

Patients were assessed at baseline and postoperatively at discharge, two weeks, and three, six and 12 months. The measured efficacy outcomes were changes in IPSS, TRUS determined PV, prostate-specific antigen (PSA), Q-max and ultrasound determined post-void residual urine (PVR). The safety profile was assessed by changes in hemoglobin (Hb) and serum sodium (Na+), as well as any reported adverse effects or complications.

Statistical analysis was performed using SPSS 16.0 software (SPSS, Inc., Chicago, IL). Results were presented as mean ± standard deviation (SD), number of cases or percentage (%). Nonparametric analysis of variance test was used for testing continuous data. A two-sided p value <0.05 was considered statistically significant.

Results

The study included 103 men with a mean (±SD) age of 67.9 ± 9.7 years (range: 52-97) and mean baseline PV of 44.6 ± 9.2 cc (range: 24-67) (Table 1). A total of 30 patients had history of refractory urinary retention and were on indwelling urethral catheters, while 12 patients were on ongoing anticoagulant medications. The mean operative time was 39 ± 25 minutes, while the mean catheterization time and mean hospital stay were 28.5 ± 13.5 hours and 38.5 ± 14.5 hours, respectively.

All patients completed the three-month follow-up. A total of 101 patients completed the six-month follow-up, including 72 patients without preoperative indwelling catheters. A total of 92 patients completed 12 months of follow-up, including 67 patients without preoperative indwelling catheters. In comparison to the baseline (Table 2), significant improvements of efficacy outcome parameters of IPSS, PV, PSA, Q-max and PVR were evident in early and/or subsequent follow-up assessments ($p < 0.001$, each). The mean IPSS significantly decreased from 25.6 ± 4.2 to 7.4 ± 2.3, while the mean Q-max significantly increased from 5.8 ± 3.4 mL/s to 20.4 ± 4.8 mL/s at baseline and six months post-treatment, respectively. The mean baseline PV level decreased by 51.6% at six months (44.6 ± 9.2 cc vs. 21.6 ± 6.3 cc, respectively), while the mean baseline PSA demonstrated a 48.6% reduction at three months. Significant improvements in all efficacy parameters were maintained in the 12-month follow-up assessment (Table 2).

Considering the safety outcomes parameters, the declines in Hb and serum Na+ were non-significant ($p > 0.05$, each) at discharge and at 2 weeks compared to baseline. None of the patients sustained significant bleeding requiring blood transfusion and none demonstrated transurethral resection (TUR) syndrome. Transient urge incontinence was documented in 4 patients (3.9%), while 29 patients (28.2%) suffered transient burning sensation upon micturition (dysuria). Re-catheterization (3-7 days) for transient retention was required in three patients (2.9%). Secondary surgical procedures were needed in 3 patients (2.9%); re-treatment for residual adenoma (1 patient, 0.97%), endoscopic holmium laser treatment of bladder neck contracture (1 patient, 0.97%) and endoscopic treatment of urethral stricture (1 patient, 0.97%).

Table 1. Baseline demographics and characteristics of the study population

	Baseline: Mean ± SD (range)
Age (year)	67.9 ± 9.7 (52–97)
IPSS (point)	25.6 ± 4.2 (17–33)
PV (cc)	44.6 ± 9.2 (24–67)
PSA (ng/mL)	3.5 ± 0.9 (0.8–4.9)
Q-max (mL/s)*	5.8 ± 3.4 (2–13)
PVR*	110 ± 40 (20–165)
Hb (g/dL)	13.2 ± 2.0 (7.5–16.2)
Na+ (meq/L)	137 ± 5.3 (129–149)

IPSS: International Prostate Symptom Score; PV: prostate volume; PSA: prostate-specific antigen; Q-max: maximum flow rate; PVR: post-void residual urine; Hb: hemoglobin; Na+: serum sodium. *Analysis in 73 patients without preoperative indwelling catheters.

Discussion

GreenLight 80-W KTP laser PVP has gained increasing acceptance as demonstrating low morbidity, satisfactory efficacy outcomes and a relatively short learning curve. Ruszat and colleagues reported on 500 PVP procedures using 80-W KTP laser in symptomatic BPH patients with mean PV of 56.1 cc (range: 10-180) and mean follow-up of 30 months (maximum 60 months).[5] The mean operative time (66.4 minutes), mean catheterization time (1.8 days) and mean post-procedure hospitalization time (3.7 days) were documented. Despite the fact that 45% of patients were taking anticoagulant medications, no severe intra-operative complications were observed. Transient dysuria, that was mostly resolved within 4 to 6 weeks, was reported in 14.8% of patients. Three years following the procedure, the mean values for IPSS, quality of life score, Q-max and PVR were 8.0, 1.3, 18.4 mL/s and 28 mL, respectively. Urethral and bladder neck strictures were reported in 4.4% and 3.6% of patients, respectively. The re-treatment rate was 6.8% and attributed to insufficient first vaporization or re-growth of prostatic tissue.

Table 2. Changes in measured outcomes during follow-up versus baseline

	Baseline*	At discharge*	2 weeks*	3 months*	6 months* ‡	12 months* ‡‡
IPSS (point)	25.6±4.2 (17–33)	NA	13.8±2.0(9–17) $p < 0.001$	10.5±1.7(7–14) $p < 0.001$	7.4±2.3 (4–12) $p < 0.001$	8.5±3.1 (5–13) $p < 0.001$
PV (cc)	44.6±9.2 (24–67)	NA	NA	20.4±5.7 (10–35) $p < 0.001$	21.6±6.3 (12–27) $p < 0.001$	19.5±6.2 (10–28) $p < 0.001$
PSA (ng/mL)	3.5±0.9 (0.8–4.9)	NA	NA	1.8± 0.6 (0.6–3.2) $p < 0.001$	NA	1.9± 0.5 (0.4–3.3) $p < 0.001$
Q-max (mL/s)**	5.8±3.4 (2–13)	13.8±7.2 (4.9–26.3) $p < 0.001$	14.5±6.1 (6.7–23.1) $p < 0.001$	18.6± 5.1 (12.1–25.3) $p < 0.001$	20.4± 4.8 (14.3–28.2) $p < 0.001$	19.8± 4.6 (11.9–25.8) $p < 0.001$
PVR (cc)**	110±40 (20–165)	NA	NA	31±10 (15–65) $p < 0.001$	35±9 (20–60) $p < 0.001$	28±8 (15–55) $p < 0.001$
Hb (g/dL)	13.2±2.0 (7.5–16.2)	12.5±2.7 (7.3–15.9) p = NS	11.9±3.2 (7.2–17.3) p = NS	NA	NA	NA
Na+ (meq/L)	137±5.3 (129–149)	134.7±6.1 (121–141) p = NS	136.5±2.1 (122–140) p = NS	NA	NA	NA

IPSS: International Prostate Symptom Score; PV: prostate volume; PSA: prostate-specific antigen; Q-max: maximum flow rate; PVR: post-void residual urine; Hb: hemoglobin; Na+: serum sodium; NA: not applicable; NS: non-significant. **Analysis of 73 patients without preoperative indwelling catheters. *Mean ± standard deviation (range). ‡101 of 103 patients and 72 of 73 patients without preoperative indwelling catheters completed 6 months follow-up. ‡‡92 of 103 patients and 67 of 73 patients without preoperative indwelling catheters completed 12 months follow-up.

An important drawback of GreenLight 80-W KTP laser was sluggish vaporization and ineffective tissue ablation.[16,17,20,21] To enhance the vaporization capacity of GreenLight laser and to facilitate the rate of tissue ablation, the newer GreenLight HPS 120-W[16,17,20] and the latest GreenLight XPS 180-W laser systems[21] were developed, using LBO crystal rather than KTP crystal. The LBO crystal generates the same KTP 532-nm laser wavelength, but within a higher power setting of 120-W (HPS) or 180-W (XPS); this results in more effective and speedy ablation of the prostate and enables PVP in larger prostates. Although XPS 180-W PVP has a significantly higher vaporization rate and speed with a deeper hemostatic coagulation zone than the HPS 120-W PVP in dogs,[21] the XPS generator is novel and its clinical outcomes are not readily available. On the other hand, a report on 305 patients treated with GreenLight 120-W LBO laser was published by the International GreenLight User Group.[16] The study was conducted at 8 international centres and the patients were observed for a maximum of 11 months, with a mean follow-up of 4.2 months. It included 3 subgroup analyses involving men with urinary retention, ongoing anticoagulants, and PV >80 mL. Changes from baseline Q-max, PVR, IPSS and PV during follow-up were significant in all patients ($p < 0.001$) and the reported complication rates were low. Based on these findings, the authors concluded that PVP using GreenLight 120-W laser was safe and effective in all subgroups.[16]

In our prospective single-centre study on PVP, we used GreenLight 120-W LBO laser to treat moderately-to-severely symptomatic patients with small-to-medium sized BPH. Significant improvements ($p < 0.001$) of efficacy domains were evident in initial follow-up assessments and were sustained in subsequent assessments up to 12 months compared to baseline. Improvements were observed in patients with or without indwelling urethral catheters for refractor urinary retention. The IPSS demonstrated significant reduction ($p < 0.001$) of the baseline level during follow-up assessments. Similarly, Q-max and PVR significantly improved ($p < 0.001$ for each) in follow-up instances compared to baseline. Additionally, the 51.6% prostate volume reduction at six months compared to baseline and the 48.6% decrease of mean baseline PSA at three months clearly demonstrated the efficacious ablative effect of GreenLight 120-W LBO laser, which is comparable to that attained with standard TURP.[1] The immediate effective vaporization and debulking of prostatic tissue is attributable to the high 120W power generated by this device.[16] Although in our study we limited the inclusion criteria to small-medium sized prostates ≤80 cc, successful outcomes in larger prostates have been reported. Woo and colleagues studied PVP using 120-W GreenLight laser in 2 groups of patients with PV ≥80 or <80 mL.[16] They reported significant improvements over baseline for all parameters measured ($p < 0.001$) in both groups. Yet, change in PV was significantly different between groups favouring prostates ≥80 mL.[16] The low re-treatment rate (0.97%) for residual adenoma tissue in our series, as compared to the 6.8% rate reported with 80-W KTP laser,[5] further elucidates the effective ablative capacity of this laser system.

Our findings further illustrated the safety of GreenLight 120-W LBO laser PVP with non-significant changes ($p > 0.05$) of Hb and serum Na+. Since this laser wavelength is effectively absorbed by Hb, simultaneous tissue vaporization and coagulation ensue,[6,16] which result in good instantaneous hemostasis. Satisfactory hemostasis was achieved in our patients throughout the procedure and was maintained postoperatively even in patients receiving ongoing anticoagulant medications. Consequently, none of

our patients required blood transfusion. The minimal risk of bleeding with laser PVP in our study, as well as in previous studies,[13-16] is a clear advantage over standard TURP which requires blood transfusion in 2% (range: 0-9).[1] Working with saline as an irrigant for laser PVP is an additional advantage over standard TURP, eliminating TUR syndrome. Dilutional hyponatremia occurs when the traditional solution of 1.5% glycine is absorbed through blood vessels during TURP and may result in the unique, although rare (0.8%), complication of TUR syndrome.[1,22] In our series, urethral stricture (0.97%) and bladder neck contracture (0.97%) were less observed than the 4.4% and 3.6% of patients, respectively, previously reported with the 80-W KTP laser.[5] Notably, transient burning micturition or dysuria was a common complaint following PVP; 28.2% of our patients reported this condition. We believe that undue coagulation to ensure hemostasis might cause dysuria. The high safety profile of this procedure was translated into short catheterization time and short hospital stay in our patients. With the safety and efficacy profile of PVP in our study, PVP using GreenLight 120-W laser should be considered an alternative to standard TURP, particularly in patients on ongoing anticoagulants.

Although the current prospective study was powered with an adequate number of patients from a single centre, the study was limited by its observational, non-controlled design. A randomized controlled trial with long-term follow-up should provide better evidence in this regard.

Conclusion

GreenLight 120-W laser PVP to treat symptomatic small-to-medium sized BPH demonstrated significant improvements in efficacy parameters and high safety profile within 12 months. The procedure entails good hemostasis with minimal blood loss, even in patients receiving ongoing anticoagulants.

Competing interests: None declared.

This paper has been peer-reviewed.

References

1. Ahyai SA, Gilling P, Kaplan SA, et al. Meta-analysis of functional outcomes and complications following transurethral procedures for lower urinary tract symptoms resulting from benign prostatic enlargement. *Eur Urol* 2010;58:384-97. http://dx.doi.org/10.1016/j.eururo.2010.06.005
2. Malek RS, Kuntzman RS, Barrett DM. Photoselective potassium-titanyl-phosphate laser vaporization of the benign obstructive prostate: observations on long-term outcomes. *J Urol* 2005;174:1344-8. http://dx.doi.org/10.1097/01.ju.0000173913.41401.67
3. Hai MA. Photoselective vaporization of prostate: five-year outcomes of entire clinic patient population. *Urology* 2009;73:807-10. http://dx.doi.org/10.1016/j.urology.2008.08.502
4. Hamann MF, Naumann CM, Seif C, et al. Functional outcome following photoselective vaporization of the prostate (PVP): urodynamic findings within 12 months follow-up. *Eur Urol* 2008;54:902-10. http://dx.doi.org/10.1016/j.eururo.2008.05.003
5. Ruszat R, Seitz M, Wyler SF, et al. GreenLight laser vaporization of the prostate: single-center experience and long-term results after 500 procedures. *Eur Urol* 2008;54:893-901. http://dx.doi.org/10.1016/j.eururo.2008.04.053
6. de la Rosette J, Alivizatos G. Lasers for the treatment of bladder outlet obstruction: are they challenging conventional treatment modalities? *Eur Urol* 2006;50:418-20. http://dx.doi.org/10.1016/j.eururo.2006.04.013
7. Bachmann A, Ruszat R, Wyler S, et al. Photoselective vaporization of the prostate: the Basel experience after 108 procedures. *Eur Urol* 2005;47:798-804. http://dx.doi.org/10.1016/j.eururo.2005.02.003
8. Bachmann A, Schurch L, Ruszat R, et al. Photoselective vaporisation (PVP) versus transurethral resection of the prostate (TURP): a prospective bi-center study of perioperative morbidity and early functional outcome. *Eur Urol* 2005;48:965-72. http://dx.doi.org/10.1016/j.eururo.2005.07.001
9. Reich O, Bachmann A, Shneede P, et al. Experimental comparison of high-power (80W) potassiumtitanyl phosphate laser vaporization and transurethral resection of the prostate. *J Urol* 2004;171:2502-4. http://dx.doi.org/10.1097/01.ju.0000128803.04158.76
10. Te AE, Malloy TR, Stein BS, et al. Photoselective vaporization of the prostate for the treatment of benign prostatic hyperplasia: 12-month results from the first United States multicenter prospective trial. *J Urol* 2004;172:1404-8. http://dx.doi.org/10.1097/01.ju.0000139541.68542.f6
11. Hai MA, Malek RS. Photoselective vaporisation of the prostate: initial experience with a new 80W KTP laser for the treatment of benign prostatic hyperplasia. *J Endourol* 2003;17:93-6. http://dx.doi.org/10.1089/08927790360587414
12. Heinrich E, Wendt-Nordahl G, Honeck P, et al. 120W lithium triborate laser for photoselective vaporization of the prostate: comparison with 80W potassium-titanyl-phosphate laser in an ex-vivo model. *J Endourol* 2010;24:75-9. http://dx.doi.org/10.1089/end.2009.0051
13. Woo HH, Hossack TA. Photoselective vaporization for prostatic obstruction with the 120-W lithium triborate laser: 1-year clinical outcomes. *Int J Urol* 2011;18:162-5. http://dx.doi.org/10.1111/j.1442-2042.2010.02686.x
14. Al-Ansari A, Younes N, Sampige VP, et al. GreenLight HPS 120-W laser vaporization versus transurethral resection of the prostate for treatment of benign prostatic hyperplasia: a randomized clinical trial with midterm follow-up. *Eur Urol* 2010;58:349-55. http://dx.doi.org/10.1016/j.eururo.2010.05.026
15. Ruszat R, Seitz M, Wyler SF, et al. Prospective single-centre comparison of 120-W diode-pumped solid-state high-intensity system laser vaporization of the prostate and 200-W high-intensive diode laser ablation of the prostate for treating benign prostatic hyperplasia. *BJU Int* 2009;104:820-5. http://dx.doi.org/10.1111/j.1464-410X.2009.08452.x
16. Woo H, Reich O, Bachmann A, et al. Outcome of GreenLight HPS 120-W laser therapy in specific patient populations: those in retention, on anticoagulants, and with large prostates (≥80 ml). *Eur Urol Suppl* 2008;7:378-83. http://dx.doi.org/10.1016/j.eursup.2008.01.016
17. Geavlete P. Is classical transurethral resection of the prostate, the gold standard endoscopic treatment for benign prostate hyperplasia, in real danger of being replaced? *Eur Urol* 2010;58:356-9. http://dx.doi.org/10.1016/j.eururo.2010.06.001
18. Malek RS, Barrett DM, Kuntzman RS. High power potassium-titanyl-phosphate (KTP/532) laser vaporization prostatectomy: 24 hours later. *Urology* 1998;51:254. http://dx.doi.org/10.1016/S0090-4295(97)00613-4
19. Malek RS, Kuntzman RS, Barrett DM: High power potassium-titanyl-phosphate laser vaporization prostatectomy. *J Urol* 2000;163:1730. http://dx.doi.org/10.1016/S0022-5347(05)67530-1
20. Muir G, Sancha FG, Bachmann A, et al. Techniques and training with GreenLight HPS 120-W laser therapy of the prostate: position paper. *Eur Urol Suppl* 2008;7:370-7. http://dx.doi.org/10.1016/j.eursup.2008.01.012
21. Malek RS, Kang HW, Peng YS, et al. Photoselective vaporization prostatectomy: experience with a novel 180 w 532 nm lithium triborate laser and fiber delivery system in living dogs. *J Urol* 2011;185:712-8. http://dx.doi.org/10.1016/j.juro.2010.09.076
22. Reich O, Gratzke C, Bachmann A, et al. Morbidity, mortality and early outcome of transurethral resection of the prostate: a prospective multicenter evaluation of 10,654 patients. *J Urol* 2008;180:246-9. http://dx.doi.org/10.1016/j.juro.2008.03.058

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