



Original Article

The role of photovaporization of the prostate in small volume benign prostatic hyperplasia and review of the literature

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Abstract *Objective:* Our objective was to characterize the safety and efficacy of the 180 W XPS-GreenLight laser in men with lower urinary tract symptoms secondary to a small volume benign prostatic hyperplasia (BPH).

Methods: A retrospective analysis was performed for all patients who underwent 180 W XPS-laser photoselective vaporization of the prostate (PVP) vaporization of the prostate between 2012 and 2016 at two-tertiary medical centers. Data collection included baseline comorbidities, disease-specific quality of life scores, maximum urinary flow rate (Q_{max}), postvoid residual (PVR), complications, prostate volume and prostate-specific antigen (PSA). The secondary endpoints were the incidence of intraoperative and postoperative adverse events. Complications were stratified using the Clavien-Dindo grading system up to 90 days after surgery.

Results: Mean age of men was 67.8 years old, with a mean body mass index of 29.7 kg/m². Mean prostate volume as measured by transrectal ultrasound was 29 mL. Anticoagulation use was 47% and urinary retention with catheter at time of surgery was 17%. Mean hospital stay and catheter time were 0.5 days. Median follow-up time was 6 months with the longest duration of follow-up being 22.5 months (interquartile range, 3–22.5 months). The International Prostate Symptom Score improved from 22.8 ± 7.0 at baseline to 10.7 ± 7.4 ($p < 0.01$) and 6.3 ± 4.4 ($p < 0.01$) at 1 and 6 months, respectively. The Q_{max} improved from 7.70 ± 4.46 mL/s at baseline to 17.25 ± 9.30 mL/s ($p < 0.01$) and 19.14 ± 7.19 mL/s ($p < 0.001$) at 1 and 6 months, respectively, while the PVR improved from 216.0 ± 271.0 mL preoperatively to 32.8 ± 45.3 mL ($p < 0.01$) and 26.2 ± 46.0 mL ($p < 0.01$) at 1 and 6 months,

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respectively. The PSA dropped from 1.97 ± 1.76 ng/mL preoperatively to 0.71 ± 0.61 ng/mL ($p < 0.01$) and 0.74 ± 0.63 ng/mL at 1 and 6 months, respectively. No patient had a bladder neck contracture postoperatively and no capsular perforations were noted intraoperatively.

Conclusion: The 180 W GreenLight XPS system is safe and effective for men with small volume BPH. PVP produced improvements in symptomatic and clinical parameters without any safety concern. It represents a safe surgical option in this under studied population.

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1. Introduction

Benign prostatic hyperplasia (BPH) is a common condition that affects the male aging population and can lead to lower urinary tract symptoms (LUTS) or bladder outlet obstructions (BOO) [1]. The size of the prostate is a significant factor to consider when evaluating different treatment options used to ameliorate symptoms related to BOO [2]. The first line of treatment for patients with LUTS secondary to BPH is medical therapy [2–4]. With intolerance or failure of medication, the next tool in the arsenal against BPH is surgery. Most of the available data on surgical BPH patients are with larger prostates [5–9]. Most urologists believe the larger the prostate the greater the LUTS [10]. Most studies suggest greater volume prostates cause more symptoms. Consequently, men with smaller prostates are rarely included in clinical studies or reported on larger case series. This may lead to treating a patient with medication even when surgery is indicated due to the paucity of literature on this cohort and the lack of clinical evidence suggesting benefit for this group. However, delaying surgical intervention can be very detrimental to the patient leading to bladder decompression and ultimately decreasing the effectiveness of surgery [7,11].

Photoselective vaporization of the prostate (PVP) using the GreenLight XPS-180 W system has demonstrated efficacy and durability in the literature [12], given BPH surgery has been heavily studied relating to patients with larger prostates [5,8,12,13]. Despite PVP having a high safety profile resulting in a decreased convalescence period, shorter length of stay in the hospital and a reduction in catheterization time in large prostates, a high reoperation rate due to bladder neck contractures (BNCs) has been reported in the literature [14]. BNCs and capsular perforations are of concern in these patients due to high energy delivered to the tissue creating scarring of the bladder neck [6,15]. There have only been a few studies evaluating the efficacy of BPH surgery in patients with small volume prostates [16–18]. However, due to the paucity of literature addressing the 180 W PVP in small prostates [16–18], it remains unclear the effectiveness of 180 W PVP for this cohort of patients. We sought to assess the safety and efficacy of the 180 W XPS-GreenLight laser in patients with a BPH volume ≤ 40 mL.

2. Patients and methods

2.1. Patient population

After obtaining institutional review board (IRB) approval at Weill Cornell Medicine, we conducted a retrospective analysis on prospectively collected data of patients treated with GreenLight PVP for BOO using the XPS-180 W system (Boston Scientific, Boston, MA, USA). Only patients with small volume prostates size (<40 mL) were included. PVP were performed at a two-tertiary medical center between 2012 and 2016. Patients with a history of prostate cancer, radiation therapy and chronic retention were excluded from the analysis. All treatment indications were in accordance with both American and Canadian clinical practice guidelines. Patients were stratified according to treatment indication.

2.2. Surgical technique

As previously described, patients underwent 180 W GreenLight XPS PVP procedure [19,20]. Preoperatively, all patients underwent a urinalysis and urine culture in order to rule out any active infections. All procedures were done under either general or spinal anesthesia. Valdivieso et al. [19] previously explained this procedure being performed similar to a transurethral resection of the prostate (TURP) with the prostatic cavity lined by capsular fibers. A 22 Fr silicone Foley catheter was inserted postoperatively with a 30 mL balloon postoperatively. This was then standardly removed 24 h following the procedure. Many patients were on anti-coagulants prior to surgery. The decision to continue use was made on a case by case basis with the overseeing cardiologist or internist. Anticoagulant use is more of an issue postoperatively (initial 30 days) rather than intraoperatively. For most of our patients, anticoagulants were withheld 5–7 days preoperatively and resumed within initial days postoperatively depending on status. A single dose of an oral antibiotic was given to patients upon catheter removal.

2.3. Covariates

The following parameters were collected preoperatively: Patients' age, body mass index (BMI), comorbidity status,

and antithrombotic therapy use. Additionally, urinary retention history as well as BPH medication use was also recorded. Prostate volume was measured using transrectal ultrasonography. Operative characteristics included: Median lobe, operative time (min), lasing time (min), energy use (kJ) and energy density (kJ/g).

2.4. Endpoints

International Prostate Symptom Score (IPSS), maximum flow rate ($Q_{\max}$), postvoid residual volume (PVR) and quality of life (QoL) score were all included as primary endpoints. Furthermore, percentage of prostate-specific antigen (PSA) reduction was also calculated. The secondary endpoints were the incidence intraoperatively and post-operatively adverse events. Complications were stratified using the Clavien-Dindo grading system up to 90 days after surgery [21,22].

2.5. Statistical analyses

For categorical variables, descriptive statistics included frequencies and proportions. Continuous variables reported means, medians and interquartile ranges. We utilized the Mann–Whitney test and the Chi-square test to infer statistical significance in differences in medians and proportions, respectively. All statistical tests were performed using SPSS Version 21 (IBM Corp., Armonk, NY, USA) with $p < 0.05$ considered statistically significant.

3. Results

A total of 58 males were included in this study. Patient preoperative characteristics are summarized in Table 1. Median follow-up time was 6 months (interquartile range, 3–22.5 months). Median age and prostate volume were 68 years and 33 mL, respectively. High-risk patients, defined as chronic catheter use (17%), antithrombotic therapy (47%) or American Society of Anesthesiology score equal to 3 (28%), represented 68% of the study population. Additionally, 50% of patients were on dual therapy (alpha blockers and 5 alpha-reductase inhibitors). Ten percent of patients had median lobe at surgery. Median baseline IPSS and QoL were 22 and 4, respectively.

Operative characteristics are described in Table 2. Median operative and lasing time were 45 min and 21 min, respectively. Median energy used and energy density were 127 kJ and 4.2 kJ/g, respectively. The majority of the patients were treated with one laser fiber (91%). All patients were discharged the day of the surgery, except for one patient. First voiding trial was recorded in five (9%) patients (Table 3).

Thirty days postoperatively adverse events are shown in Table 3. Within 30 days after surgery, 27.6% ($n = 16$) of patients had a postoperative adverse event. All adverse events were Grades I and II according to Clavien classification. Thereby, three (5.2%) patients had urinary tract infections (UTIs) Grade II after surgery. Grades I and II irritative symptoms were reported in 5.2% and 0% of patients, respectively. BNC was not recorded in this patient population.

Table 1 Descriptive characteristics of 58 patients treated with XPS GreenLight for small prostate size (prostate volume ≤ 40 mL).

Variable	Value
Age, year	
Mean (median)	68 (68)
IQR	60–74
ASA score, n (%)	
I	9 (15%)
II	33 (57%)
III	16 (28%)
BMI, kg/m^2	
Mean (median)	26 (26)
IQR	24–29
Antithrombotic therapy use, n (%)	
No	31 (53%)
Yes	27 (47%)
Median lobe, n (%)	
No	52 (90%)
Yes	6 (10%)
5-ARI use, n (%)	
No	20 (34%)
Yes	38 (66%)
Alpha blockers use, n (%)	
No	13 (22%)
Yes	45 (78%)
Indwelling catheter, n (%)	
No	48 (83%)
Yes	10 (17%)
TRUS prostate volume, mL	
Mean (median)	31 (33)
IQR	27–37

ASA, American Society of Anesthesiology; IQR, interquartile range; TRUS, transrectal ultrasound; TURP, transurethral resection of the prostate; 5-ARI, 5 alpha-reductase inhibitors.

Table 4 depicts functional outcomes up to 6 months after surgery. IPSS score improved from 22 at baseline to 6 ($p < 0.001$) at 6 months. $Q_{\max}$ improved from 7 mL/s at baseline to 21 ($p < 0.001$) at 6 months. Similarly, PVR improved from 120 mL preoperatively to 15 mL ($p < 0.001$) at 6 months.

4. Discussion

This is the first report evaluating 180 W XPS in men with small volume prostates and BOO. Our study demonstrated durable results at 6 months postoperatively, albeit a shorter follow-up but no patients had intraoperative prostate capsular perforation or BNC. Because PVP is associated with minimal peri- and post-operative adverse events and has comparable functional outcomes, this technique has been known to be alternative for patients who are high-risk surgical candidates [23].

Our study demonstrated durable improvements in IPSS, $Q_{\max}$, PVR and QoL. These results have been corroborated in previous studies. In a study by Kim et al. [17], 120 W PVP showed a statistically significant improvement in functional scores (IPSS and QoL) and uroflowmetry parameters at

Table 2 Operative characteristics of 58 patients treated with XPS GreenLight for small prostate size (prostate volume ≤ 40 mL).

Variable	Value
Lasing time, min	
Mean (median)	21 (21)
IQR	15–24
Operative time, min	
Mean (median)	46 (45)
IQR	30–50
Energy use, kJ	
Mean (median)	150 (127)
IQR	99–184
Number of fibers, <i>n</i> (%)	
1	53 (91)
2	4 (7)
3+	1 (2)
Energy density, kJ/g	
Mean (median)	5 (4.2)
IQR	3.2–5.8
Hospital stay, day	
Mean (median)	0.5 (0)
IQR	0–1

IQR, interquartile range.

Table 3 Postoperative adverse events of patients treated with XPS GreenLight for small prostate size (prostate volume ≤ 40 mL).

Outcome	<i>n</i> (%)
Clavien-Dindo Grade I	
Hematuria	3 (5.2)
Irritative symptoms	3 (5.2)
Urinary incontinence	1 (1.7)
Clavien-Dindo Grade II	
Hematuria	0 (0)
urinary tract infection	3 (5.2)
Irritative symptoms	0 (0)
Urinary incontinence	1 (1.7)
Urinary retention	0 (0)
First voiding trial failure	5 (9)
Capsular perforation	0 (0)
Clavien-Dindo Grade III	
Bladder neck contraction	0 (0)
Clavien-Dindo Grade IV	0 (0)
Clavien-Dindo Grade V	0 (0)

12 months. Authors compared PVP to Holmium laser enucleation of the prostate (HoLEP) and found no difference in surgical outcomes. The Holmium laser was further studied in small volume BPH by Elshal et al. [18]. A total of 191 patients were included in this study with all patients having a prostate volume smaller than 40 mL. The procedure showed reduction in IPSS and QoL, as well as improvement in Q_{max} . BNC was reported in 6.2% of PVP patients and 2.1% in Holmium:YAG transurethral incision (Hol-TUIP). Capsule perforation only occurred in the PVP cohort at 0.7%. It was concluded that this procedure was

effective, safe and durable for patients with small prostates.

Furthermore, patients treated in our study with PVP 180 W GreenLight system had a low complication rate. Complications at both 30 and 180 days, postoperatively included UTIs (5.2%), irritative symptoms (5.2%), urinary incontinence (3.4%) failure of first voiding trial (9%), hematuria (5.2%) and the use of Hol-TUIP in men with prostates smaller than 40 mL found similar complication rates [18]. A total of 91 patients were included in the study. In the 120 W group, the most common complications were failure of first trial-of-void (TOV) (4.2%), recurrent/persistent LUTS (4.2%), operative bleeding (6.2%), BNC (6.2%) and urethral stricture (3.5%); in the Hol-TUIP group, the most common complications were UTIs (2.1%), recurrent/persistent LUTS (4.3%), BNC (2.1%) and urethral stricture (4.3%) [18]. However, none of these complications reached statistical significance in either of the treatment arms. Kim et al. [17] similarly found a complication rate of 6.8% in the PVP group and 3.7% in HoLEP group, which was not statistically significant ($p = 0.6$). These studies further support the use of PVP in this cohort.

One of the only studies evaluating TURP in small volume prostates was by Kang et al. [24]. They showed functional improvements in IPSS, Q_{max} , PVR and QoL ($p < 0.05$) 3 months postoperatively in 51 patients with prostates < 30 mL and 135 patients with prostates > 30 mL.

Laser therapies used to treat BPH have focused on higher tissue vapor efficacy, resulting in the current 180 W GreenLight XPS system which has 50% greater firing energy when compared to the 120 W therapy [25]. The high energy delivered by the 180 W could potentially lead to an increase in complications, especially BNCs. One of the most common causes for retreatment following PVP is BNC with rate reported as high as 8.6% [9,26,27]. Krambeck et al. [28] found when patients with small prostates < 40 mL, the incidence of BNCs increased. Similarly, Elshal et al. [29] evaluated Holmium laser ablation of the prostate and PVP using the 80 W potassium titanyl phosphate laser in 109 patients with prostates < 60 mL. Approximately 70 months postoperatively, it was found the incidence of BNCs was associated with a smaller prostate volume regardless of the type of laser intervention.

Another study by Aho et al. [30] compared Hol-TUIP to HoLEP in patients with prostates < 40 mL. In terms of adverse events, both groups showed similar profiles with those receiving HoLEP having a higher incidence of stress urinary incontinence postoperatively. There were no BNCs reported.

Despite this, no patients in our study had a BNC or prostate perforation. A study by Hueber et al. [13] evaluated the 180 W GreenLight XPS system in males with varying prostate sizes with 2 years of follow-up. A total of 1196 patients were divided into two groups: Prostate volume less than 80 mL ($n = 387$; mean 50 mL) and prostate volume greater than 80 mL ($n = 741$; mean 108 mL). In terms of complications, capsular perforation was fairly low in each group with an incidence of 0.5% the PVP less than 80 mL and 0.9% in the PVP greater than 80 mL.

There are a few limitations associated with this study. The surgeons performing the procedure were experts. Furthermore, our data were collected prospectively and was reviewed retrospectively. The sample size was

Table 4 Postoperative outcomes following photovaporization of the prostate.

Variable	Baseline (n = 58)	30 day (n = 54)	p-Value ^a	6 month (n = 38)	p-Value ^b
IPSS	22.8 ± 7.00	10.7 ± 7.4	<0.01	6.31 ± 4.44	<0.01
QoL	4.2 ± 1.04	2.11 ± 1.7	<0.01	1.05 ± 1.22	<0.01
Q _{max} (mL/s)	7.7 ± 4.46	17.250 ± 9.3	<0.01	19.14 ± 7.19	<0.01
PVR (mL)	216 ± 277	32.8 ± 45.3	<0.01	26.23 ± 46.0	<0.01
PSA	1.97 ± 1.76	0.71 ± 0.61	<0.01	0.74 ± 0.63	<0.01

IPSS, International Prostate Symptom Score; PSA, prostate-specific antigen; PVR, postvoid residual; Q_{max}, maximum urinary flow rate; QoL, quality of life.

^a The value of 30 days compared with that of baseline value.

^b The value of 6 months compared with that of baseline value.

relatively small for this cohort. Secondly, our sample was subject to a high attrition rate likely due to the nature of tertiary care failed which lead to a reported median of 6 months follow-up, although the longest follow-up was 22.5 months. In the United States, patients who undergo surgery are more likely to return to their primary care physicians for follow-up care. Thus, capturing long-term follow-up is difficult. In our study, we reported no BNCs, however, this may be due to patient follow-up. The technique we used was anatomic vaporization with initial incisions to the capsule which are unique and ensure an open bladder neck [31]. Despite this and to the best of our knowledge, this is the first study evaluating the use of the 180 W GreenLight XPS system in men with prostates ≤40 mL. Very few studies have conducted BPH surgery in small prostates with no studies utilizing the 180 W system. Furthermore, our results are clinically relevant as there are few studies reporting for this cohort of men. Large prospective, randomized trials with long-term follow-up are needed to further characterize the role of surgical intervention and PVP for patients with small volume prostates and BOO.

5. Conclusion

This study demonstrates the 180 W GreenLight XPS system is safe and effective for men with small prostates. This procedure PVP produced improvements in symptomatic and clinical parameters and should be considered as a therapy for men without any safety concern. It represents a safe surgical option in this under studied population.

Author contributions

Protocol/project development: Kevin C. Zorn, Bilal Chughtai, Alexis Te, Pierre-Alain Hueber.

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Data analysis: Malek Meskawi, Dominique Thomas, Lesa Deonarine, Ramy Goueli.

Manuscript writing/editing: All.

Conflicts of interest

Bilal Chughtai is a consultant for Boston Scientific and Allergan.

Vincent Misrai has received grant from Boston Scientific and Wolf.

Kevin C. Zorn is a proctor and lecturer for Boston Scientific.

All other authors have nothing to disclose.

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