



## Benign Prostatic Hyperplasia

# 180-W XPS GreenLight Laser Therapy for Benign Prostate Hyperplasia: Early Safety, Efficacy, and Perioperative Outcome After 201 Procedures

Alexander Bachmann<sup>a,\*</sup>, Gordon H. Muir<sup>b</sup>, Edward J. Collins<sup>c</sup>, Benjamin B. Choi<sup>d</sup>, Shahin Tabatabaei<sup>e</sup>, Oliver M. Reich<sup>f</sup>, Fernando Gómez-Sancha<sup>g</sup>, Henry H. Woo<sup>h</sup>

<sup>a</sup> Department of Urology, University Hospital, Basel, Switzerland; <sup>b</sup> Department of Urology, King's College Hospital, London, UK; <sup>c</sup> California Urological Services, San Francisco, CA, USA; <sup>d</sup> Department of Urology, Weill Medical College of Cornell University, New York, NY, USA; <sup>e</sup> Department of Urology, Massachusetts General Hospital, Boston, MA, USA; <sup>f</sup> Department of Urology, Harlaching Hospital, Ludwig-Maximilians-University, Munich, Germany; <sup>g</sup> Institute of Advanced Urological Surgery, Madrid, Spain; <sup>h</sup> Sydney Adventist Hospital Clinical School, The University of Sydney, Sydney, Australia

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### Abstract

**Background:** Photoselective vaporisation of the prostate has evolved from the GreenLight 80-W KTP powered laser to the latest 180-W XPS laser involving a MoXy fibre.

**Objective:** Evaluate the prevalence of perioperative complications and short-term outcome for the first time with the XPS laser in men with lower urinary tract symptoms (LUTS) due to benign prostatic enlargement (BPE).

**Design, setting, and participants:** Prospective data were collected from consecutive patients at seven centres worldwide during June 2010 and March 2011. Indication for surgery was based on the European Association of Urology and the American Urological Association guidelines. Patients receiving anticoagulants or those with retention were included and analysed separately.

**Intervention:** 180-W XPS GreenLight laser prostatectomy using the MoXy fibre.

**Measurements:** Standard parameters associated with transurethral prostate surgery and perioperative prevalence of surgery-associated problems or complications were documented.

**Results and limitations:** A total of 201 patients were included in the study. Mean follow-up was 5.8 mo (standard deviation [SD]: 2.8; range: 1–12 mo). A quarter of the patients had a prostate volume  $\geq 80$  ml. For prostates between 51 and 60 ml, a mean of 300 kJ (SD: 112) of energy was applied (lasing time: 35.0 min; SD: 15). Statistically significant improvements were noted in all key parameters postoperatively. The prevalence of perioperative complications was low. Limitations of the study are short duration of follow-up and limited number of available patients for the functional follow-up.

**Conclusions:** The 180-W GreenLight XPS laser is a new effective treatment option with a low prevalence of perioperative complications for patients suffering from LUTS due to BPE.

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\* Corresponding author. Department of Urology, University Hospital Basel, University of Basel, Spitalstr. 21, 4031 Basel, Switzerland. Tel. +41 61 265 7284; Fax: +41 61 265 7323. E-mail address: [bachmanna@uhbs.ch](mailto:bachmanna@uhbs.ch) (A. Bachmann).

## 1. Introduction

Photoselective vaporisation of the prostate (PVP) involving the GreenLight KTP laser was first introduced in 1998 by Malek et al [1]. Green “light” (532 nm) is selectively absorbed within the tissue by haemoglobin (“red”) and not by water and has a short penetration depth of 0.8 mm. Clinical outcome in men with benign prostatic hyperplasia (BPH) including long-term benefits up to 5 yr were subsequently reported in nonrandomised trials [2–5]. Studies also showed a comparable outcome of the 80-W GreenLight PV powered laser with transurethral resection of the prostate (TURP) [6,7]. There followed development of a higher powered laser operating at 120 W (GreenLight HPS) plus a new fibre design, and again benefits were reported including outcome to 3 yr [8–11]. The latest generation of PVP laser is the GreenLight 180-W XPS laser involving a new MoXy fibre that aims to improve efficacy, especially in patients with larger prostate glands. Operating on prostates with volumes >80 ml was considered by some to be too slow with the former 80-W KTP or 120-W HPS GreenLight laser. Thus the manufacturers claim that, to improve operative speed, the rate of vaporisation has increased through a 50% increase in power as well as a 50% increase in laser beam area. The actual depth of vaporisation and coagulation in the tissue remain the same as the 120-W system [12].

The International GreenLight Users (IGLU) group was formed as a coalition of eight centres with longtime expertise in laser prostatectomy. They have published pooled data on patients treated with the 80-W PV and 120-W HPS laser systems [9,10]. As some of the first users of the new 180-W XPS system, they present here early outcomes, surgery-associated side effects, and perioperative complication rates.

## 2. Patients and methods

### 2.1. Study population

Prospective data were collected from consecutive patients treated with the 180-W XPS laser therapy at seven centres in Europe, the United States, and Australia during June 2010 and March 2011. Indications for surgery were based on the criteria established by the guidelines of the European Association of Urology or the American Urological Association guidelines on BPH [13,14]. Patients receiving anticoagulants and those with a history of urinary retention or with catheterisation before surgery were not excluded (Table 1). Excluded from the study were patients with prostate cancer and patients with known neurologic disorders or a known history of spinal cord injury, urogenital trauma, bladder neck stricture, or evidence of active urinary tract infection (UTI).

### 2.2. Surgical technique

The procedure was conducted using the “IGLU modular technique,” as previously described [15]. In all procedures, the 180-W XPS GreenLight laser in combination with the MoXy fibre was used. Laser cystoscopes from 22.5F to 26F were used with cooled or room temperature saline irrigation. The maximum power setting was 180 W, adjustable in 10-W steps.

**Table 1 – Baseline patient characteristics**

Parameter/subgroup parameter	Mean plus or minus SD (range) or No. (%)
Age (n = 201)	70.7 ± 9.2 (43–93)
PSA, ng/ml (n = 189)	5.5 ± 6.9 (0.2–77)
Age <70 yr (n = 92)	4.6 ± 4.1 (0.4–22)
Age >70 yr (n = 97)	6.2 ± 8.8 (0.2–77)
PBx before surgery done (n = 25)	11.4 ± 11.8 (0.4–77)
No PBx before surgery done (n = 164)	4.5 ± 4.1 (0.2–21)
Prostate volume ≤40 ml (n = 48)	2.8 ± 4.0 (0.2–22)
Prostate volume >40–80 ml (n = 86)	4.7 ± 3.7 (1.0–21)
Prostate volume >80 ml (n = 49)	9.6 ± 11.0 (0.7–68)
IPSS (n = 132)	19.6 ± 7.7 (2–35)
Q <sub>max</sub> , ml/s (n = 109)	8.4 ± 3.7 (4.1–14.8)
PVR, ml (n = 147)	190 ± 355 (n.m. *–2600)
Prostate volume, ml (n = 194)	67.6 ± 42.1 (6–340)
≤40 ml (n = 51; 26.3%)	31.4 ± 7.8 (6–40)
>40–80 ml (n = 93; 47.9%)	59.8 ± 11.9 (4.1–80)
>80 ml (n = 50; 25.8%)	119.0 ± 50.1 (83–340)
No. of patients on/with:	
Aspirin	55 (27.4)
Coumarin	25 (12.4)
Clopidogrel or prasugrel	9 (4.5)
Catheterisation before surgery	51 (25.4)
History of occasional retention but no catheter before surgery	70 (34.9)
α-Blocker	93 (46.3)
5-ARI	41 (20.4)
History of prostatitis	16 (8)

SD = standard deviation; PSA = prostate-specific antigen; PBx = prostate biopsy; IPSS = International Prostate Symptom Score; Q<sub>max</sub> = maximum flow rate; PVR = postvoid residual (urine); 5-ARI = 5α-reductase inhibitor.  
\* Not measurable in catheterised patients.

### 2.2.1. Assessment

Standard parameters associated with transurethral prostate surgery and the prevalence of surgery-associated problems or complications were prospectively documented and measured preoperatively and at 1 mo, 3 mo, and 6 mo postoperatively. Prostate volume was determined prior to treatment using transrectal ultrasound. Perioperative complications and surgery-related symptoms were recorded.

### 2.3. Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics v.19.0 (IBM Corp, Armonk, NY, USA) software package. Analysis of variance was used for testing numeric data. The paired-sample *t* test was used to analyse the *before* and *after* surgery measures. For categorical data, the chi-square test was utilised. A two-sided *p* < 0.05 was considered statistically significant. Results are given as mean plus or minus standard deviation (SD) or number of available cases (percentage). Logistic regression was used to estimate predictive factors associated with surgery-related symptoms or complications. Odds ratios (ORs) with 95% confidence intervals (95% CIs) are presented including the significance level.

## 3. Results

### 3.1. Patient characteristics

Table 1 shows the baseline characteristics of the 201 patients treated with the GreenLight 180-W XPS laser. Prior to surgery, 70 patients (34.9%) reported previous occasional urinary retention, and 51 patients (25.4%) were catheterised. Of the patients included, 25 (12.4%) had a preoperative

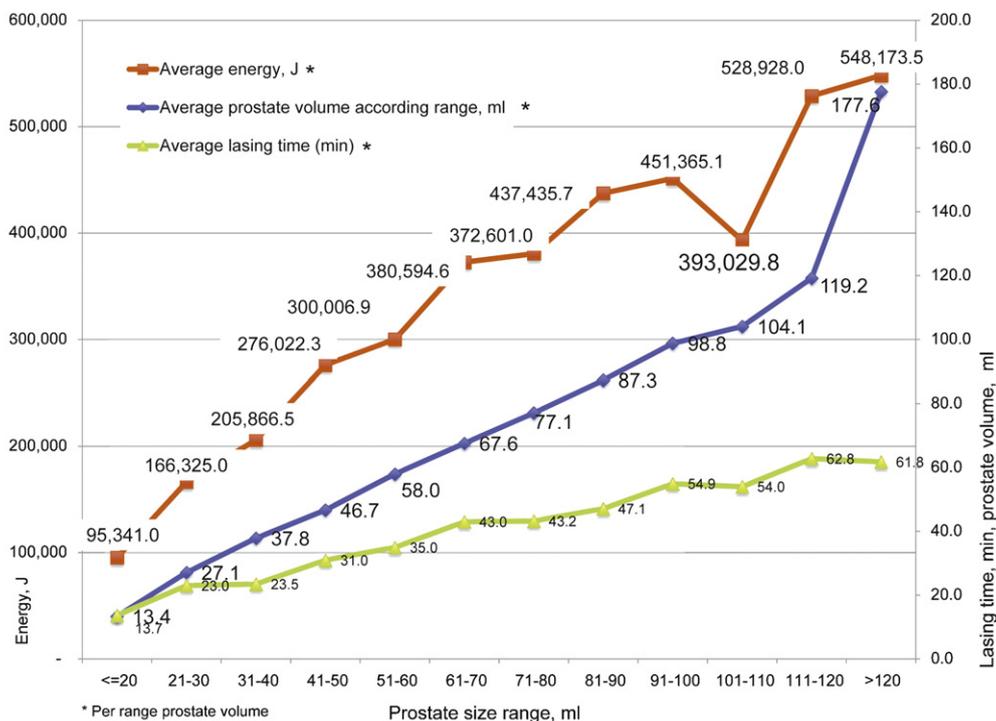


Fig. 1 – 180-W XPS GreenLight operative characteristics including lasing time and energy usage according to prostate volume.

prostate biopsy with no evidence of prostate cancer; 37.8% ( $n = 76$ ) were treated in Basel, 16.9% ( $n = 34$ ) in Madrid, 13.9% ( $n = 28$ ) in Munich, 12.4% ( $n = 25$ ) in Sydney, 10% ( $n = 20$ ) in New York, 6% ( $n = 12$ ) in London, and 3% ( $n = 6$ ) in San Francisco.

### 3.2. Operating parameters

Data on energy applied are available for 191 patients and was  $324 (\pm 187; 50\text{--}1378)$  kJ on average. Finally  $5.3 (\pm 2.3)$  kJ energy was applied for each 1 ml of transrectally measured prostate volume. For prostates  $<40$  ml, a mean of  $5.8 (\pm 2.6)$  kJ/ml was applied. Figures for larger prostates were  $5.5 (\pm 2.2)$  kJ/ml and

$4.3 (\pm 1.9)$  kJ/ml for prostates 41–80 ml and  $>80$  ml, respectively. Fig. 1 shows the average applied energy and lasing time based on prostate size. In prostates  $<40$  ml, 40–80 ml, and  $>80$  ml, the mean number of fibres used was  $1.0 (\pm 0.2)$ ,  $1.2 (\pm 0.4)$ , and  $1.6 (\pm 0.6)$ , respectively.

### 3.3. Efficacy

Mean follow-up was  $5.8 (\pm 2.8; \text{range: } 1\text{--}12)$  mo. Functional outcome up to 6 mo is shown in Table 2. Statistically significant improvements were noted in all key parameters measured as early as 1 mo post-treatment ( $p < 0.001$ ), except residual volume ( $p = 0.001$ ).

Table 2 – Pre- and postoperative functional standard parameters after 180-W XPS GreenLight laser therapy\*

Parameter	Baseline	1 mo	3 mo	6 mo
IPSS	$19.6 \pm 7.7$ ( $n = 132$ )	$8.1 \pm 5.8^{\dagger}$ ( $n = 67$ )	$8.5 \pm 6.2$ ( $n = 80$ )	$9.4 \pm 6.8$ ( $n = 21$ )
$Q_{\max}$ , ml/s	$8.4 \pm 3.7$ ( $n = 109$ )	$15.1 \pm 10.4^{\dagger}$ ( $n = 49$ )	$18.8 \pm 9.3$ ( $n = 76$ )	$21.0 \pm 1.6$ ( $n = 5$ )
PVR, ml	$190 \pm 355$ ( $n = 147$ )	$29 \pm 66^{\dagger}$ ( $n = 73$ )	$51 \pm 89$ ( $n = 83$ )	$35 \pm 67$ ( $n = 21$ )
IPSS-QOL	$3.9 \pm 1.1$ ( $n = 151$ )	$1.8 \pm 1.4^{\dagger}$ ( $n = 71$ )	$1.6 \pm 1.4$ ( $n = 63$ )	$1.4 \pm 1.5$ ( $n = 16$ )
PSA, ng/ml	$5.5 \pm 6.9$ ( $n = 189$ )	–	$2.6 \pm 3.4^{\dagger}$ ( $n = 54$ )	$2.0 \pm 1.2$ ( $n = 16$ )
Prostate volume with preoperative values <sup>§</sup>				
<40 ml	$31.4 \pm 7.7$ ( $n = 51$ )		$23.3 \pm 2.9^{\dagger}$ ( $n = 3$ )	
41–80 ml	$59.8 \pm 11.9$ ( $n = 93$ )		$35.7 \pm 9.3^{\dagger}$ ( $n = 19$ )	
>80 ml	$119.0 \pm 50.0$ ( $n = 50$ )		$58.3 \pm 13.5^{\dagger}$ ( $n = 8$ )	

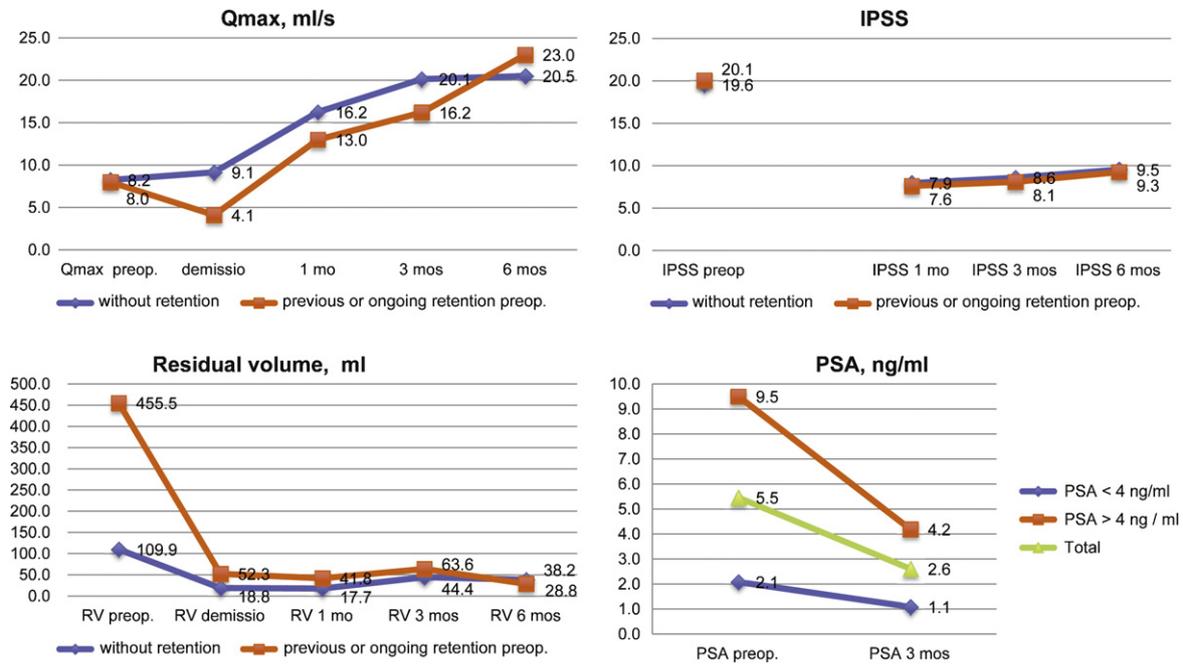
IPSS = International Prostate Symptom Score;  $Q_{\max}$  = maximum flow rate; PVR = postvoid residual (urine); QOL = quality of life; PSA = prostate-specific antigen.

\* Mean plus or minus standard deviation values shown and the number of patients for whom data are available.

<sup>†</sup> Highly significant to baseline  $p < 0.001$ .

<sup>‡</sup>  $p = 0.001$ .

<sup>§</sup> Transrectal prostate volume measurement usually is of importance after 6 or 12 mo. Therefore only a few transrectally measured values are available for 3 mo.



**Fig. 2 – Change in maximum flow rate (Q<sub>max</sub>), postvoid residual volume (RV) of urine, and International Prostate Symptom Score (IPSS) in spontaneously voiding and retention patients prior to treatment with the 180-W GreenLight laser. Change in prostate-specific antigen (PSA) according to baseline PSA level.**

Being in retention did not have a negative impact on outcome after 180-W XPS GreenLight laser prostatectomy. Maximum flow rate (Q<sub>max</sub>) changed in patients without retention before surgery as follows (baseline to 1–3 mo): 8.0 ± 5.0 ml/s to 16.2 ± 11.6 ml/s to 20.5 ± 10.1 ml/s (Fig. 2). The postoperative International Prostate Symptom Score (IPSS) was similar in both groups (Fig. 2).

Mean prostate-specific antigen (PSA) levels fell significantly by 53% after 3 mo and by 63% after 6 mo (*p* < 0.001) (Table 2). In patients <70 yr of age (because these are the patients for whom PSA status pre- and postoperatively is important), PSA dropped from 4.6 (±4.0) ng/ml to 1.8 (±1.9) ng/ml (–60%) and to 1.0 (±0.8) ng/ml (–78%) after 3 and 6 mo, respectively. Decrease in baseline PSA was greatest in patients with a preoperative PSA level >4 ng/ml (Fig. 2). At 3 mo, prostate volume fell by 25%, 40%, and 51% in patients with preoperative prostate size <40 ml, 41–80 ml, and >80 ml, respectively (Table 2).

The TURP loop was used to optimise safety or handling in 2% of patients (1 of 51) with small prostates (<40 ml), 6.5% (6 of 93) in prostates 40–80 ml, and 16% (8 of 50) in prostates >80 ml.

**3.4. Complications**

Table 3a shows the intraoperative complications. No statistically significant relationship was calculated for the ongoing use of anticoagulation, prostate size, history of previous retention or history of prostatitis, and prevalence of a specific complication. Preoperative catheterisation (*p* = 0.024), capsule perforation (*p* = 0.002), and use of the TURP loop (*p* < 0.001) were significantly related to impaired visibility due to bleeding during the operation. Logistic

regression analysis revealed that capsule perforation (OR: 9.209; 95% CI, 1.186–71.502; *p* = 0.034) and the use of the TURP loop (OR: 11.674; 95% CI, 2.026–67.264; *p* = 0.006) were significantly linked with intraoperative bleeding. The use of the TURP loop was significantly associated with capsule perforation (*p* < 0.001). No associations were found between postoperative retention and drainage before surgery, prostate size, capsule perforation, or applied energy. No blood transfusions were required. One patient (0.8%) required a reoperation during his hospital stay (TURP due to insufficient apical tissue removal; catheter preoperatively).

Based on local reimbursement policies, duration of catheterisation was on average 49.5 ± 15.6 h in Germany and Switzerland and 20.4 ± 27.2 h in the other centres. Of note, there was no difference in duration of catheterisation in patients with or without retention (39.1 ± 28.1 h vs 35.8 ± 24.2 h). In addition, the duration of catheterisation was not different between patients with small (<40 ml), medium (40–80 ml), and large (>80 ml) prostate volume (37.2 ± 20.1 h vs 35.3 ± 21.4 h vs 44.2 ± 35.4 h). Mild dysuria was observed in 10.5% (8 of 76) of the available cases after 1 mo, 10.6% (7 of 66) after 3 mo, and 5% (1 of 20) after 6 mo. Moderate dysuria was observed in 1.3% (1 of 76) of patients. UTIs were seen in 4.1% (3 of 74) and 2.8% (2 of 72) of patients after 1 and 3 mo, respectively. Table 3b shows the prevalence of complications classified by the Clavien-Dindo classification [16].

No de novo erectile dysfunction was reported by any patient during the 3-mo follow-up. The International Index of Erectile Function score dropped from 32.5 ± 21.4 preoperatively (*n* = 51) to 23.4 ± 19.3 (*n* = 27) at 3 mo (mild erectile dysfunction).

**Table 3a – Intraoperative complications in men treated with the Greenlight XPS laser including overall incidence and incidence in subgroups**

Variable	Overall no./total no. (%)	Subgroups	No./total no. subgroup (%)	p			
Impaired visibility due to bleeding	20/201 (10)	On anticoagulant therapy	2/25 (8)	NS			
		Not on anticoagulant therapy	18/176 (10.2)				
		On clopidogrel	1/9 (11.1)	NS			
		Not on clopidogrel	19/192 (9.9)				
		Prostate size <40 ml	4/51 (7.8)	NS			
		Prostate size 40–80 ml	10/93 (10.8)				
		Prostate size >80 ml	6/50 (12.0)				
		History of previous retention	12/70 (17.1)	NS			
		No history of retention	8/131 (8.0)				
		History of prostatitis	3/16 (18.8)	NS			
		No prostatitis	17/185 (9.2)				
		Catheterisation	12/70 (17.1)	0.024			
		No catheterisation	8/131 (6.1)	0.002			
		Capsule perforation	4/7 (57.1)				
		No capsule perforation	16/194 (8.2)	<0.001			
		Use of TURP loop	7/15 (46.7)				
No use of TURP loop	13/186 (7.0)	NS					
Capsule perforation	7/201 (3.5)		Prostate size <40 ml	4/51 (7.8)			
			Prostate size 40–80 ml	3/93 (3.2)			
			Prostate size >80 ml	0/50			
			History of prostatitis	1/16 (6.3)	NS		
			No prostatitis	6/185 (3.2)			
			Use of TURP loop	4/15 (26.7)	0.001		
			No use of TURP loop	3/186 (1.6)			
			Retention during hospital stay	10/201 (5)	History of previous retention	6/70 (8.6)	NS
					No history of previous retention	4/131 (3.1)	
					Drainage before surgery	3/45 (6.7)	NS
					No drainage before surgery	7/150 (4.7)	
					Prostate size <40 ml	3/51 (5.9)	NS
					Prostate size 40–80 ml	2/93 (2.2)	
					Prostate size >80 ml	4/50 (8.0)	
					Capsule perforation	0	NS
		No capsule perforation			10/194 (5.2)		
Applied energy <3000 J/ml	2/32 (6.3)	NS					
Applied energy 3000–7000 J/ml	5/122 (4.1)						
Applied energy >7000 J/ml	2/37 (5.4)						

NS = not significant; TURP = transurethral resection of the prostate.

**Table 3b – Prevalence of surgery-related complications based on the Clavien-Dindo classification 2004 within a 3-mo follow-up**

Type of complication	Clavien-Dindo grade, 2004	Treatment	Discharge up to 1 mo postoperatively No./total No. (%)	1–3 mo No. Total No. (%)	Overall reported
Mild dysuria	1	Conservative, analgetics, antipyretics	8/76 (10.5)	7/66 (10.6)	
Moderate dysuria	1	Conservative, analgetics, antipyretics	1/76 (10.5)	–	
Urethral stricture (no surgery)	1	Conservative	1/75 (1.3)	1/72 (1.4)	
Temporary urinary incontinence (urge/stress)	2	Conservative, anticholinergics	4/75 (5.6)	4/72 (5.3)	
Urinary tract infection	2	Antibiotics, antipyretics	3/74 (4.1)	2/72 (2.8)	
Retention (including patient's previous history of retention)	3a	Indwelling catheter	2/75 (2.7)	2/72 (2.8)	
Inability to pass urine	3b	TURP (apical resection)	–	–	1/201 (0.5)

NS = not significant; TURP = transurethral resection of the prostate.

#### 4. Discussion

The present study is the first publication of a large multicentre series of patients treated with the 180 XPS GreenLight laser. As with previous versions of the GreenLight laser, our results show improvements in the standard parameters measured including IPSS,  $Q_{max}$ , and

postvoiding residual (PVR). Even for patients in retention, the 180-W XPS laser prostatectomy seems to be an effective option, and these results support the early data reported by others [17,18]. Analysis of IPSS subgroups shows a significant improvement in all parameters, favouring the “weak stream” and “intermittency” domain. The findings in the present study for changes in IPSS,  $Q_{max}$ ,

**Table 4 – Comparative outcome with the 180-W XPS and 120-W HPS GreenLight lasers**

Study	No. of patients	System	Time point	Change in IPSS	Change in Q <sub>max</sub>	Change in PVR
Current study	201	XPS	3 (6) mo	19.6 ± 7.7 to 9.4 ± 6.8	8.4 ± 3.7 to 21 ± 1.6	190 ± 355 to 35 ± 67
Taşçı et al [19] <sup>*</sup>	517	HPS	6 mo	22.8 ± 4.7 to 6.0 ± 1.3	9.0 ± 4.7 to 19.6 ± 2.5	125 ± 104 to 12 ± 15
Capitán et al [20] <sup>*</sup>	50	HPS	6 mo	23.5 to 8.3	8.9 to 23.9	NA
Woo and Hossack [21]	46	HPS	12 mo	20 ± 7.0 to 8.1 ± 6.1	7.6 ± 3.5 to 22.5 ± 10.3	155 ± 155 to 59 ± 87
Bruyère et al [22]	112	HPS	6 mo	20.2 ± 6.9 to 6.6 ± 5.9	8 ± 5 to 19 ± 43	102 ± 125 to 29 ± 47
Al-Ansari et al [11] <sup>†</sup>	54	HPS	3 yr	27.2 ± 2.3 to 11	6.9 ± 2.2 to 18	53.2 ± 25 to 12
Chiang et al [29]	50	HPS	6 mo	21.6 ± 5.6 to 6.8 ± 2.3	4.3 ± 4.5 to 19.3 ± 4.4	171.8 ± 47.4 to 24.8 ± 2.3
Spalivero et al [8] <sup>‡</sup>	49	HPS	6 mo	22 to 5 <sup>§</sup>	9.4 to 18.8	19 to 7
Ruszat et al [23]	32	HPS	6 mo	20.9 ± 6.6 to 8.8 ± 5.3	12.4 ± 6.1 to 23.7 ± 9.1	155 ± 133 to 30 ± 47

IPSS = International Prostate Symptom Score; Q<sub>max</sub> = maximum flow rate; PVR = postvoid residual (urine); NA = not applicable.  
<sup>\*</sup> Rounded values.  
<sup>†</sup> Follow-up approximate values.  
<sup>‡</sup> Median values.  
<sup>§</sup> American Urological Association scores.

and PVR appear comparable with those reported for the 120-W laser (Table 4) [8,11,19–23].

The previous report on the safety of the 180-W XPS laser indicated there were no severe intraoperative complications (bleeding, transfusion, absorption syndrome) [16]. Of the 60 patients in that study, urosepsis was reported in one patient, and three patients required recatheterisation. In the current study, bleeding resulting in impairment of vision was the most common intraoperative complication and was more frequent in patients with preoperative catheterisation, small prostates, and during capsule perforation. The use of the TURP loop was required primarily for managing bleeders after capsule perforation. Although the coagulation properties of the 180-W XPS system are improved over the 120-W HPS, managing these problems sometimes remains challenging, principally because pressure cannot be brought directly onto bleeding arteries to cause haemostasis before coagulation. Bae et al [24] reported a 16.5% rate of additional TURP in a series of 309 patients undergoing holmium laser enucleation of the prostate. In another series on holmium laser prostatic resection, 2 of 56

patients (3.6%) required bipolar TURP to aid resection of the apex [25]. A review of the published studies on the holmium laser and the 532-nm laser indicates that these lasers are promising alternatives to TURP and open prostatectomy [26]. A further meta-analysis by Ahyai and associates also supports this finding [27].

The rate of postoperative urinary retention was low, even considering the inclusion criteria. These findings are comparable with those previously reported with the 120-W HPS laser prostatectomy. The intraoperative complications that were reported with the 120-W HPS laser include bleeding (3–13%) [19,23], capsule perforation (3.1–5%) [19,23], and conversion to TURP (1.8–8%) [19,23]. Up to 6 mo postoperatively, the complications indicated in studies were haematuria (1.4–12%) [8,19,20], recatheterisation (4.4–5.3%) [19,21], dysuria (18–93.3%) [11,23], UTI (2–15%) [8,19,20,23], stress incontinence (6.6%) [19], urge incontinence (3.3%) [19], acute urine retention (8%) [20], and blood transfusion (2%) [23]. Midterm complications included urethral stricture (3.5–6%) [19,20], bladder neck contracture (1.1–7.4%) [11,19,21,23], incontinence (2%) [20], haematuria

**Table 5 – Comparative energy usage and lasing time per prostate volume 80-W KTP, 120-W HPS, and 180-W XPS GreenLight lasers**

Study	Laser	Prostate volume, ml	Lasing time, min	Energy usage, kJ
Current study	180 W	67.6 ± 42.1	38.2 ± 20.4	324.4 ± 187.5
		≤40	22.2 ± 11.3	179.3 ± 89.1
		40–80	36.9 ± 16.1	323.6 ± 137.3
		>80	55.9 ± 16.7	474.1 ± 225.0
Taşçı et al [19]	120 W	<70	NA	146.2 ± 58.3
		≥70	NA	185.7 ± 63.8
Capitán et al [20]	120 W	51.3 ± 14.7	NA	238.4
Woo and Hossack [21]	120 W	66 (13–247) <sup>*</sup>	53 ± 24	357 ± 171
Bruyère et al [22]	120 W	60 (17–215) <sup>*</sup>	NA	255 ± 129
Chiang et al [29]	120 W	60.3 ± 27.7	50 ± 44.2	206.7 ± 92.3
Ruszat et al [23]	120 W	67.4 ± 46.9	33.2 ± 23.6	187 ± 129
Average 120 W	–	About 61.3	–	About 251.3
Ruszat et al [5]	80 W	56.1 ± 25.3	NA	206 ± 94
Te et al [30]	80 W	54.6 ± 31.7	38.7 ± 23.3	103.5 ± 64.5
Average 80 W	–	About 55.4	38.7 ± 23.3	About 154.5

NA = not available.  
<sup>\*</sup> Median (range).

(2.8%) [8], prostatitis (1.4%) [8], retrograde ejaculation (14.3%) [8], and reoperation due to recurrence (2–11%) [11,19,23].

The key feature of the new 180-W XPS laser is faster speed of lasing and higher energy application. Data from perfused porcine kidney studies show that the GreenLight 180-W XPS laser removes tissue twice as fast as the GreenLight 120-W HPS laser; however, human clinical data have yet to confirm these *ex vivo* observations [28]. Malek et al reported comparative results with the GreenLight 120-W HPS and GreenLight 180-W XPS lasers in living dog prostates [12]. The 180-W laser created a 76% larger cavity (mean: 11.8 vs 6.7 cm<sup>3</sup>;  $p = 0.014$ ), vaporised tissue at a 77% higher rate (mean 2.3 vs 1.3 cm/min;  $p = 0.03$ ), and did so in 37% less time per volume vaporised (0.5 vs 0.8 min/ml;  $p = 0.003$ ).

Table 5 shows the comparative energy usage and lasing times reported with the three systems [5,19–23,29,30]. On average, with the 80-W PV system a prostate of 55 ml was treated with 154 kJ, with the 120-W HPS laser a prostate size of 61 ml was vaporised with 251 kJ (+60%), and with the 180-W XPS laser a 67-ml prostate was treated with 324 kJ. Compared with the 80-W PV system, the 180-W XPS applies almost three times the energy with the same lasing time (about 38 min), without increasing side effects including in patients receiving anticoagulants, with indwelling catheters, or previously in retention (Table 5).

Limitations of the study are the short follow-up and limited number of available patients. However, because this paper focusses only on the perioperative prevalence of complications, a 3- to 6-mo follow-up seems to be acceptable. Another drawback could be the different local patient management policies based on the mixture of university and private practise settings. But this can be considered to reflect the real world as well in prostate surgery worldwide.

## 5. Conclusions

The new 180-W XPS GreenLight laser system using the MoXy fibre provides a safe and efficient treatment option for patients suffering from lower urinary tract symptoms due to benign prostatic enlargement, even in patients with larger prostates. Due to the 180-W higher power and the increased fibre durability, handling of the XPS procedure is easier and appears more efficient in terms of tissue removal. Functional follow-up of a significantly larger number of patients with longer follow-up is needed to draw a final conclusion.

**Author contributions:** Alexander Bachmann had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study concept and design:** Bachmann, Woo.

**Acquisition of data:** Bachmann, Muir, Collins, Choi, Reich, Gómez-Sancha, Woo.

**Analysis and interpretation of data:** Bachmann, Muir, Woo, Gómez-Sancha.

**Drafting of the manuscript:** Bachmann, McKillop, Muir, Woo.

**Critical revision of the manuscript for important intellectual content:** Bachmann, Muir, Woo, Reich, Tabatabaei, Choi, Collins, Gómez-Sancha.

**Statistical analysis:** Bachmann, Woo, Muir.

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