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Monocenter Experience with 532 Nm-Laser Photoselective-Vaporization of the Prostate by GreenLight XPS™ Laser: Is It Really an Endourological Joker Card?

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ABSTRACT

Introduction: In our study, we reported on our monocenter experience with GreenLight (GL) Xcelerated Performance System (XPS)™ /MoXy™ laser fiber (American Medical Systems Inc., Minnetonka, Minnesota), examining its efficacy, safety, and its ability to effectively treat lower urinary tract symptoms (LUTS) in benign prostate obstruction (BPO). We also explored and compared the three different endoscopic approaches used for GL treatment of benign prostatic hyperplasia (BPH), standard photovaporization (PVP), anatomical PVP, and GreenLight XPS™ enucleation of the prostate.

Materials and Methods: Between February 2013 and April 2017, 140 patients, with an average age of 67.7 years (range 47–85), were treated using the XPS™/MoXy™ system in a single-operative urologic center. The data were retrospectively analyzed with an assessment of the main intra- and postoperative outcomes at three, six, 12, and 18 months comparing both subjective (international prostate symptom score [IPSS]) and objective (uroflow [Qmax] parameters and prostate volume) parameters to the preoperative data. Patients underwent standard PVP, anatomical PVP, or prostate photo-selective en-bloc enucleation (PEBE) according to surgeon preferences.

Results: Median prostate volume (MPV) and prostate-specific antigen (PSA) were 69cc and 3.24 ng/dl, respectively. An indwelling catheter, at the time of surgery, was observed in 15% of men. Median operative-laser time and energy applied were 56.4 minutes, 26.5 minutes, and 245813 kJ. Outpatient surgery was feasible with median length of stay at 48 hours. Significant improvement in IPSS and Qmax are observed at all endpoints. No significant intraoperative complications were reported. When stratifying postoperative complications according to the Cavien-Dindo classification, only two cases of high-degree emerged (grades III-IV).

Conclusion: Our data confirm that in treating men with symptomatic benign prostate disease, the GreenLight XPS™/MoXy™ laser fiber is safe and able to achieve challenging results in terms of clinical outcomes and prostate volume reduction. Balance between functional outcomes and complications was great without statistically significant differences, in terms of outcomes, between the different surgical techniques.

INTRODUCTION

In recent years, more and more scientific studies are focusing their attention on minimally invasive laser treatments in men with moderate to severe lower urinary tract symptoms (LUTS) secondary to benign prostatic obstruction (BPO).[1-3] According to the European Association of Urology (EAU) and the American Urological Association (AUA) guidelines, the transurethral resection of the prostate (TURP) has been considered for decades to be the first line endoscopic therapeutic option for these patients. The disadvantage of this resection technique has always been the risk of significant complications, such as bleeding, TURP-syndrome, and a long surgical learning curve.[4-5] The techniques and laser systems currently available are various and differ in the excitation source, the resulting wavelength, the continuous/pulsed-wave mode, and the optical fibres used to deliver the light beam to the tissues.[6]

Figure 1a. GreenLight XPS™ Laser.

Figure 1a. GreenLight XPS™ Laser.

Each laser has, therefore, unique properties resulting in a variety of possible techniques, ranging from vaporization to anatomical resection and enucleation, to offer every patient a tailored surgical option.

GreenLight laser history in BPH begins with Malek, in 1997, when he undertook his 10 first "unripe" prostatic photo-vaporizations using the 60-watt continuous-wave very high power (VHP) laser system. A few years later, in 2001, a more advanced and powerful version was sold: the 120W lithium triborate (LBO) crystal machine high-performance system (HPS). This was also later surpassed in 2010 by the 180W (LBO) crystal GreenLight Xcelerated Performance System (XPS)™ (American Medical System [AMS], Minnetonka, Minnesota) (Figs. 1a and b) with a 532-nm wavelength and a metal-capped fibre which led to an important gain in resistance to degradation, the so-called MoXy™ fiber (Figs. 2a and b).[7-11]

From the International Green-Light User (IGLU) group, the standardization of the photoselective vaporization of the prostate (PVP) was adopted.[12] This technique was described following different surgical steps: the first step was represented by a preliminary cystoscopy followed by the creation of a working space. Then, the lateral lobes are lasered and the paracollicular tissue is vaporized. Lastly, the median lobe and the bladder neck are treated.[12]

To overcome the limitations of PVP, such as the difficulty in identifying the cleavage planes and the treatment of large volume glands, other alternative techniques were further proposed,[13-14] such as the anatomical PVP and the photo-selective en bloc enucleation (PEBE).[15-16]

In the current literature, with some exceptions,[17] robust and long-term data to support GreenLight XPS™ PVP as a safe treatment of choice for men with LUTS secondary to BPH are lacking. Furthermore, only a few studies to date have performed a meticulous evaluation of the different PVP techniques, as strong scientific debate continues when comparing them to each other (PVP standard versus anatomical PVP and PEBE) and the superiority of one procedure over the other.[17-18]

In view of this, we have analyzed our data with the aim of evaluating the efficacy-safety of the latest version of the

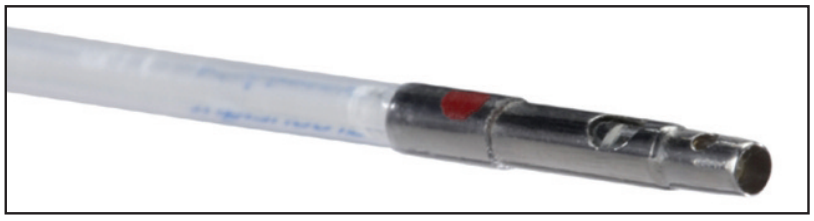

Figure 2a. MoXy™ Fiber.

Figure 2b. MoXy™ Fiber.

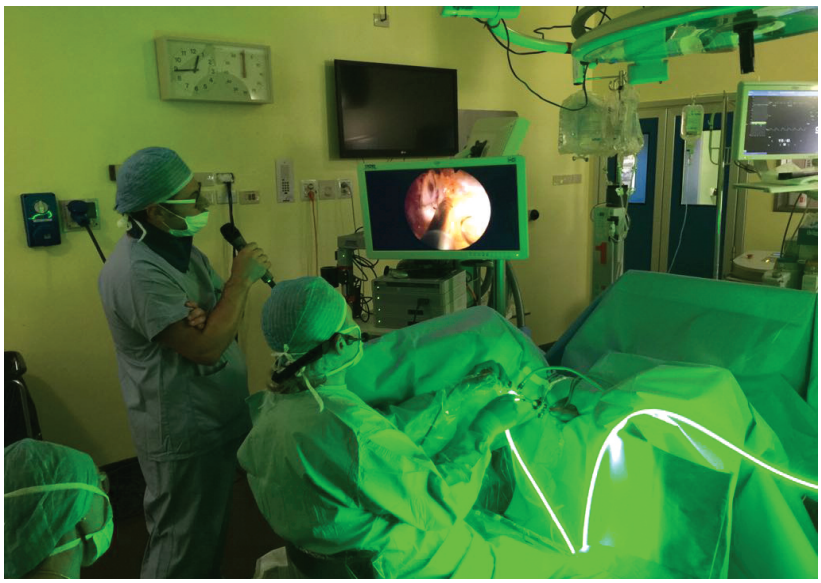

Figure 3. Dr. L. Cindolo during PVP GL procedure.

Table I
Patients' characteristics

Variables	n (%)
Age	Mean (median) 67.7 (67) IQR 73–62
ASA score	I 19 (13.5) II 101 (72.1) III-IV 20 (14.2)
Aspirine use	32 (22)
Antiplatelet use	12 (8.5)
Anticoagulant use	4 (2.8)
5-ARI use	63 (45)
Alpha-blockers use	109 (77.8)
Previous urethral stricture	17 (12)
Indwelling catheter	21(15)
TRUS prostate volume	Mean (median) 69 (60) IQR 90–49
PSA, ng/ml	Mean (median) 3.24 (2.48) IQR 4.3–1.2
IPSS	Mean (median) 24.7 (25) IQR 27–23
Qmax	Mean (median) 8.7 (9) IQR 10–7.2

GreenLight XPS™ laser system for standard PVP (532 nm-laser photovaporization with GreenLight XPS™) and the impact of this technique on perioperative and postoperative outcomes.

MATERIALS AND METHODS

After the approval of our local ethical committee, a retrospective analysis of the institutional prospectively maintained database of all patients underwent PVP by the GreenLight XPS™ laser. Surgical procedures were completed between February 2013 and April 2017 in the Urology Department of ASL Abruzzo2, from a single surgeon (Fig. 3). Patients with missing preoperative characteristics were excluded from the analyses.

All patients underwent PVP, adopting the different techniques: standard PVP, anatomical PVP, and PEBE following the choice of the surgeon. All procedures were performed under general or spinal anesthesia and preoperative antibiotic prophylaxis was administered to all patients according local practice guidelines.

Preoperative variables were examined; age was evaluated as a continuous variable, medical history was abstracted from patients' charts and included comorbidity score stratified according to the American Society of Anesthesiology and antiplatelet and anticoagulant medication. The previous BPH history (medical and surgical) was also abstracted: history of the previous TURP, history of catheterization/retention, and use of medications like an alpha-blocker and inhibitors of five alpha reductase. Preoperative symptoms index score (international prostate symptoms score [IPSS]), Qmax parameters, and prostate-specific antigen (PSA) levels were also included and coded as continuous variables. Operative characteristics were collected: total operative time, lasing time, energy use (kJ), and energy density delivery (kJ/cc), which was calculated by dividing energy use per prostate volume.

Patients were followed postoperatively at three, six, and 12 months and assessments and visits included symptoms score (IPSS), Qmax parameters, and assessment of PSA level. Follow-up was calculated as time from surgery to

last visit. Perioperative and postoperative complications were also recorded. Perioperative complications included complications that happened intraoperatively and during hospitalization: bleeding, capsular perforation, conversion to monopolar TURP, failure to remove catheter, and hospital stay. Postoperative complications included complications after hospital discharge. It was recorded between discharge and six months after surgery. All complications were graded according to the Clavien-Dindo classification.[19]

Finally, we compared the intra- and postoperative data of the PVP standard technique versus the anatomic PVP or PEBE.

RESULTS

Patients' characteristics are illustrated in Table I. All patients (140) were treated with GreenLight 180W XPS™ for symptomatic BPO. The median follow-up was 18 months (range 1–48 months). The mean and median prostate volume were 69.6 and 60cc, respectively (range 49–90cc). Median age at surgery was 67.7 years (range 47–85), and 120 (85.7%) patients were stratified to ASA I–II and 20 (14.2%) to ASA III-IV. The number of patients that used aspirin, antiplatelets, or anticoagulant therapy was 32 (22.8%), -12 (8.5%), and 4 (2.8%). Regarding BPO history, alpha-blockers were used in 109 patients (77.8%) and five alpha reductase inhibitors were used in 63 patients (45%). Sixty patients were receiving therapy with both drugs. The previous urethral stricture was present in 17 (12.1%) patients and 21 (15%) had an indwelling urinary catheter at the time of surgery.

The perioperative characteristics are illustrated in Table II. The median lasing time was 24 minutes, with a median total delivered energy of 223 kJ.

Postoperative clinical outcomes illustrated a significant IPSS and PSA reduction compared to the baseline throughout follow-up (Figs. 4 and 5). Objective outcome data, like uroflowmetry parameters, were also significantly improved after surgery (Fig. 6).

Based on the Clavien-Dindo classification, we observed 89 (63.5%) complications of grade I, 63 (45%) of grade II, and only two (1.4%) of grade III-IV. Five patients underwent reoperation

Table II
Perioperative characteristics

Variables	n (%)
Lasing time	
Mean (median)	26.5 (24)
IQR	34.7–16
Operative time	
Mean (median)	56.4 (55)
IQR	65–40
Energy use (KJ)	
Mean (median)	245813(223500)
IQR	329250–141000
Hospital stay (h)	
Mean (median)	48 (48)
IQR	2–1
Catheterization time (h)	
Mean (median)	36 (24)
IQR	2–1

Table III
Perioperative and postoperative complications

Outcomes	n (%)
Perioperative complications	
Intraoperative complications	
Bleeding	4 (2.8)
Capsular perforation	0
Conversion to standard TURP	4 (2.8)
First voiding trial failure	14 (10)
Postoperative complications (0-6 months)	
Clavien-Dindo grade I	
Hematuria	10 (7.1)
Irritative symptoms	35 (25)
Urinary incontinence	18 (12.8)
Urinary retention	12 (8.5)
Others	14 (10)
Total	89 (63.5)
Clavien-Dindo grade II	
Hematuria	
UTI	6 (4.2)
Irritative symptoms	15 (10.7)
Stricture	10 (7.1)
Urinary incontinence	10 (7.1)
Urinary retention	22 (15.7)
Others	/
Total	/
Clavien-Dindo grade III-IV	
Hematuria	63 (45)
Stricture	0
Urinary retention	0
Others	0
Total	2 (1.4)
	2 (1.4)
Total overall grades	154

Table IV
Standard PVP versus anatomical/PEBE

Characteristics	Standard-PVP	Anatomical-PVP or PEBE
Number of cases	86	54
Protate Volume cc	74	63
Lasing time	25.9	28.2
Operative time	56.8	55.6
Energy use (KJ)	242121	259920
Hospital stay (h)	48	48
Catheterization time (day)	1.5	1.6
IPSS decrease at 6 months	-15.4	-16.1
PSA decrease at 6 months	-0.7	-1.2
Qmax increase at 6 months	+10.3	+11
Early complications	38.	33
Delayed complications	15.	12

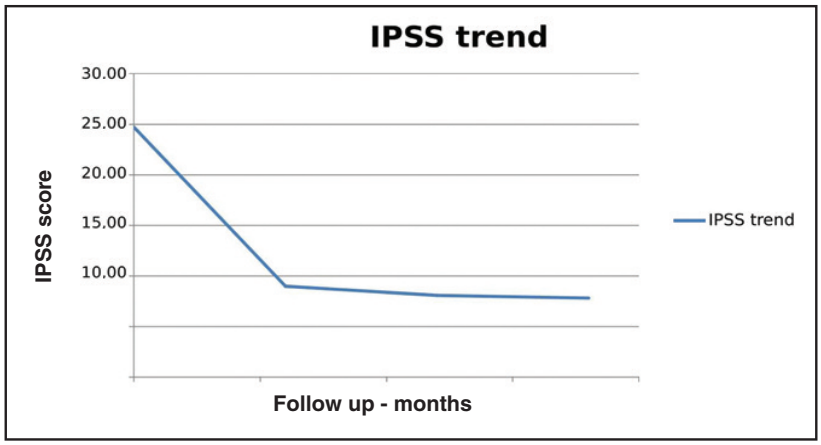

Figure 4. International Prostatic Symptoms Score (IPSS) trend during follow-up.

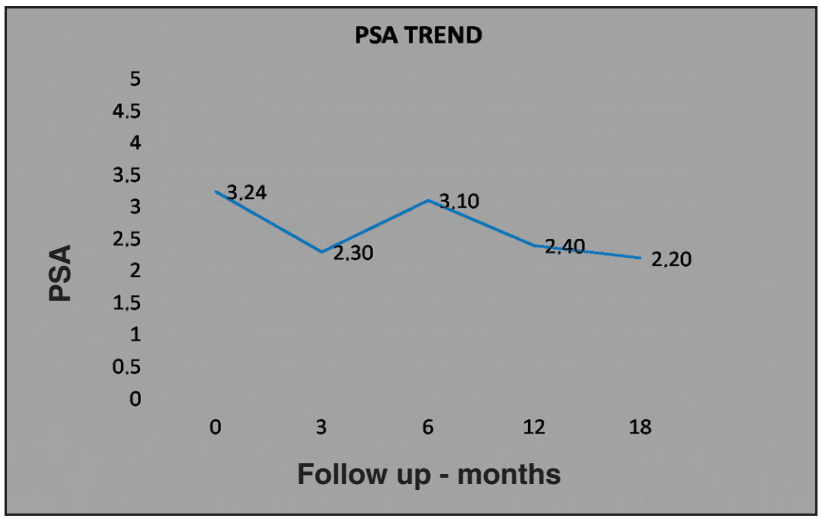

Figure 5. Prostate-specific antigen (PSA) trend during follow-up.

after the first PVP (Table III). In Table IV, we summarized and compared the clinical postoperative data relative to the patients treated with the standard PVP technique versus anatomic PVP or PEBE, showing no statistical differences between the three techniques.

DISCUSSION

In this article, we described our single-center series experience with photo-selective vaporization of the prostate using the GreenLight XPS™ 180W generator using different endourological surgical techniques, ranging from a "simple"-standard PVP, to a more complex enucleation technique, passing through an anatomical approach. With the arrival of the new 180W XPS generator, many studies on this topic have been published, most of them with excellent results, both in terms of safety and effectiveness counting, with some exceptions during short follow-up periods.[20-23] Our data illustrated a great efficacy, independently from the prostate volume and the surgical technique used. In this study, we examined the intraoperative data as well as the postoperative data. With regard to the operative data, we have found that the average operative time (OT) and laser time (LT) obtained in our PVP procedures (median OT 56.4 minutes and median LT 26.5 minutes) are very similar to the data of the current literature, presented by several scientific papers.[24-25] In addition, the duration of the catheterization days and the length of the postoperative stay (median indewelling catheter 36 hours; median postoperative stay 48 hours) were also fully consistent with the results obtained and published in other important studies, excluding some experiences.[26-27]

Urinary symptoms (IPSS) and uroflow Qmax were all significantly improved compared to baseline and this included the last follow-up (IPSS was 7.8 and Qmax was 21.9). These data show the potential of PVP to successfully treat patients with BPO with different preoperative characteristics or glands of different volume, and we reported no changes toward deterioration in our median follow-up. Similarly, serum PSA also follows this trend with no increase after surgery.

Intraoperative complications are in line with expectations from GL PVP, in general, as there is no increase in the incidence of significant intraoperative bleeding in comparison to previous generator studies (3%–13% and 3.5%–5%, respectively).[28-29]

We reported four cases converted to TURP, which has been described up to 1.8%– 5.2% in some studies,[29-30] and no case of capsular perforation. The results are in line with those highlighted by the GOLIATH 12-month follow-up study.[31]

The most frequent postoperative complications, in this study, were low-grade ones (grades I and II, 63.5% and 45% respectively, based on the Clavien-Dindo classification), mostly irritative symptoms—such as urinary incontinence—and there was no severe hematuria. Our low-grade complications were slightly higher than the data published by the majority of the sector studies and, also in comparison with the 12 month GOLIATH study, in which 107 low-grade complications were reported (lower or equal to grade 2 according to the Clavien classification).[31] After evaluating Clavien grade III and IV complications, only two cases emerged. One patient developed deep venous thrombosis in postoperative surgery while another suffered from pulmonary embolism on the ninth day after surgery (substantially lower percentages if related to most of the works currently in the literature).[25-31] Only five cases of re-treatment emerged at the last urological check.

Finally, we analyzed and compared our GL PVP standard and anatomical and PEBE/GreenLEP data, grouping the last two techniques into a single group, given the low number of enucleation techniques.

When adopting a standard PVP tech-

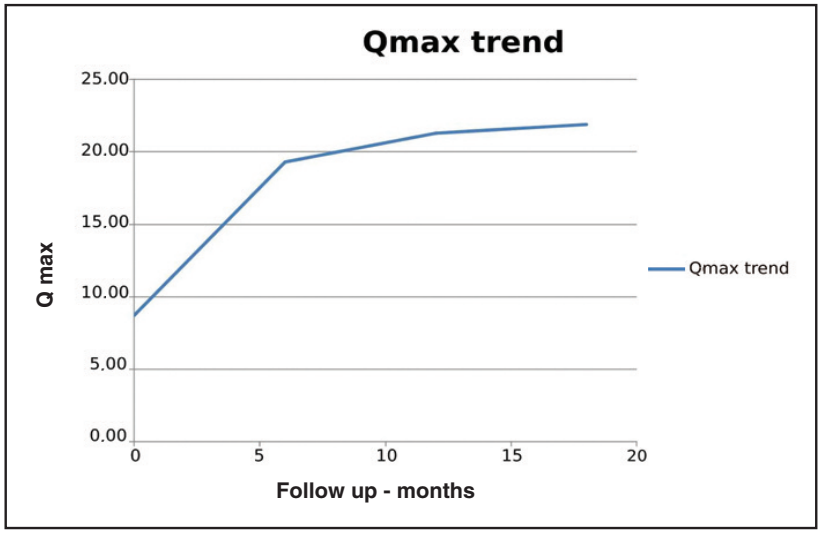

Figure 6. Qmax (maximum urinary flow rate) trend during follow-up.

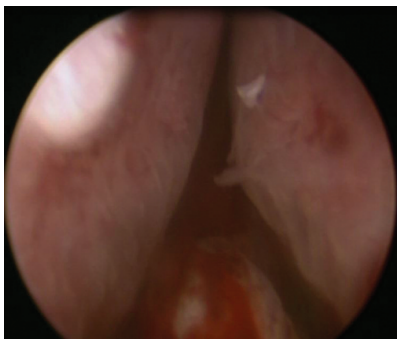

Figure 7. Beginning procedure after bladder inspection.

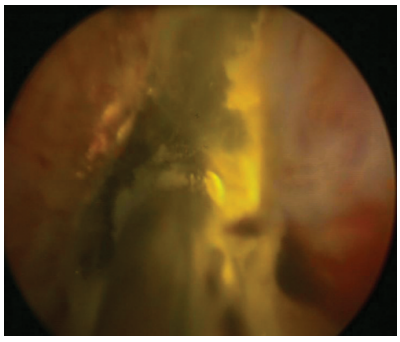

Figure 8. Initial incision and preparation of the groove at 5 o'clock from the bladder neck to the verumontanum in the left prostate lobe.

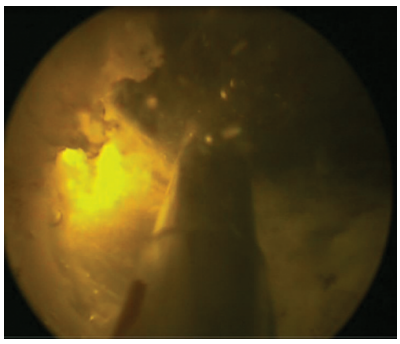

Figure 9. Incision and preparation of the groove at 7 o'clock from the bladder neck to the verumontanum in the right prostate lobe.

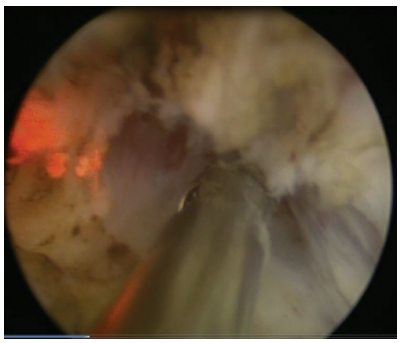

Figure 10. Anatomical plane between adenoma and prostatic capsule in the left prostate lobe.

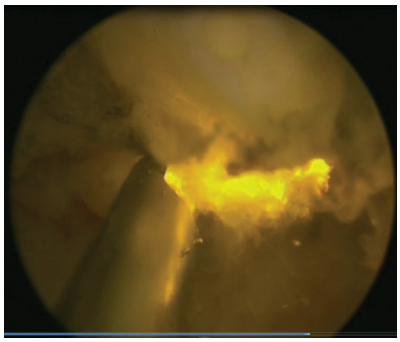

Figure 11. Anatomical vaporization of the left prostate lobe.

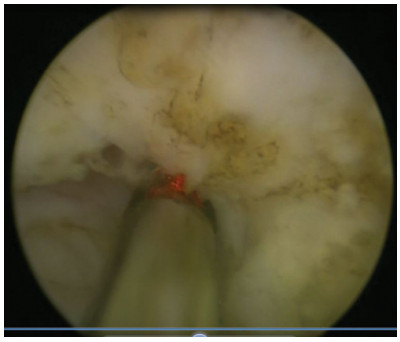

Figure 12. Anatomical plane between adenoma and prostatic capsule in the right prostate lobe.

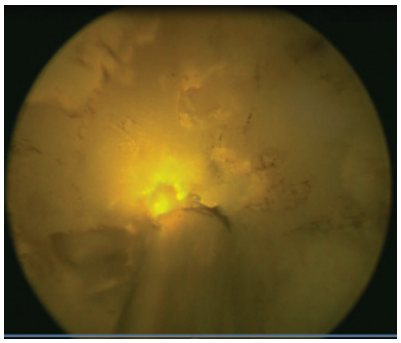

Figure 13. Anatomical vaporization of the right prostate lobe.

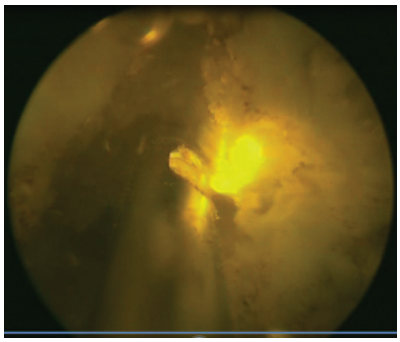

Figure 14. Prostate floor tissue treatment and vaporization of the median lobe.

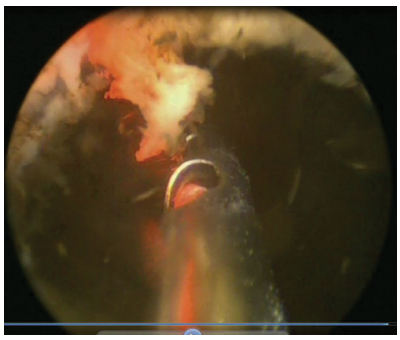

Figure 15. Case-procedure completion.

nique, the surgeon ablates the adenomatous tissue by vaporization from the prostatic urethra toward the prostatic capsule (inside out) in a centrifuge way. On the other hand, the laser energy is only used to find and develop the plane between the prostatic capsule and the adenoma, dissecting and detaching the prostatic lobes (outside in) in a circular way during an enucleating technique (Figs. 7–15).[32] As for all the enucleating techniques, the intervention requires an additional time for the final morcellation of the detached tissue.

Currently, only a few studies have focused their attention on these three techniques, comparing them and making a comparison between the results obtained.[18-33] Our experience showed no statistically significant differences in the analysis of the outcomes resulting from the three endourological techniques, with a slight trend in favor of the two techniques—anatomical and enucleation—with regard to the objective uroflumetometric parameters of Qmax and IPSS as well as the number of early and late total complications at the last follow-up.

This study has several limitations. The major ones are related to its retrospective nonrandomized design, nondifferentiation, and subdivision into groups of the variable prostate volume and the inclusion of patients treated during the surgeon learning curve for the three techniques.

Other limitations are due to the assessment of postoperative events (such as incontinence) based only on clinical interview. In addition, sexual function and the impact of surgeons' experience were not evaluated. However, despite all these limitations, our study: (1) confirms the safety, effectiveness, and reliability of the GreenLight XPS™ laser for surgical management of prostatic obstruction, which ensures optimal benefits for the patients with different profiles in terms of complications; (2) confirms the versatility of the GreenLight XPS™ laser system; and (3) demonstrates, for the first time, the clinical efficacy of the different techniques.

CONCLUSION

Our experience suggests that the endourological approach of the GreenLight XPS™ generator, in combination with the last MoXy™ fiber, is an effective tool in improving the bothersome LUTS in men with BPO/BPH, while maintaining and improving the previously accepted short hospital stay, catheterization time, and safety profile with the first generation GreenLight XPS™ lasers.

The availability of three different techniques allows all urologists with variegate experience to adopt this technology. Standard PVP remains a viable option for the resolution of bladder obstruction. Anatomical vaporization seems to be the best-balanced technique that can be learned quickly and can be adopted even for large prostates. Finally, enucleation techniques are to be preferred for shorter operative time and best long-term outcomes. STI

AUTHORS' DISCLOSURES

Dr, Cindolo received surgical tutoring honoraria from American Medical Systems Inc.

All other authors have no conflicts of interest to disclose.

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