Post-Operative Acute Urinary Retention After Greenlight Laser. Analysis of Risk Factors from A Multicentric Database

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Purpose: Greenlight laser is a mini-invasive technique used to treat Benign Prostatic Obstruction (BPO). Some of the advantages of GreenLight photoselective vaporization (PVP) are shorter catheterization time and hospital stay compared to TURP. Post-operative acute urinary retention (pAUR) leads to patients' discomfort, prolonged hospital stay and increased health care costs. We analyzed risk factors for urinary retention after GreenLight laser PVP.

Materials and Methods: In a multicenter experience, we retrospectively analyzed the onset of early and late post-operative acute urinary retention in patients undergoing standard or anatomical PVP. The pre-, intra- and post-operative characteristics were compared betweene patients who started to void and the patients who developed post-operative urinary retention.

Results: The study included 434 patients suitable for the study. Post-operative acute urinary retention occurred in 39 (9%). Patients with a lower prostate volume ($P < .001$), an adenoma volume lower than 40 mL ($P < .001$), and lower lasing time ($P = .013$) had a higher probability to develop pAUR at the univariate analysis. The multivariate logistic regression confirmed that lower lasing time (95% CI: 0.86-0.99, OR = 0.93, $P = .046$) and adenoma volume (95% CI: 0.89–0.98, OR = 0.94, $P = .006$) are correlated to pAUR. Furthermore IPSS $\geq$ 19 (95% CI: 1.19-10.75, OR = 2.27, $P = .023$) and treatment with 5-ARI (95% CI: 1.05-15.03, OR = 3.98, $P = .042$) are risk factors for pAUR.

Conclusion: In our series, post-operative acute urinary retention was related to low adenoma volume and lasing time, pre-operative IPSS $\geq$ 19 and 5-ARI intake. These data should be considered in deciding the best timing for urethral catheters removal.

Keywords: laser; prostatectomy; retention

INTRODUCTION

GreenLight laser is one of the most versatile and safest procedures to treat Benign Prostatic Obstruction (BPO), with the possibility to perform standard vaporization (sPVP), anatomical vaporization (aPVP) or pure enucleation (GreenLEP) (1-3). Which technique should be preferred in terms of outcomes and adverse events is still a matter of debate. In a previ-

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Table 1. Patients's pre-, intra- and post-operative characteristics stratified according acute urinary retention incidence.

Variables [a]	Overall (n = 434)	No pAUR (n = 395)	pAUR (n = 39)	*P*
Age (years) mean ± SD	68.9 ± 8.3	68.7 ± 8.3	70.0 ± 8.3	.359
Prostate volume (TRUS) (mL)				< .001
median [IQR]	55 [43-70]	58.5 [45-74]	45 [35-55]	< .001
Adenoma volume (TRUS) (mL) median [IQR] n (%)	36 [25-50]	38 [25-50]	25 [20-35]	
< 40 ml	238 (54.8%)	206 (52.2%)	32 (82.1%)	< .001
> 40 ml	196 (45.2%)	189 (47.8%)	7 (17.9%)	
BPO/LUTS therapy n (%)				
None	81 (18.7%)	71 (18.0%)	10 (25.6%)	.037
Alpha-blockers	227 (52.3%)	213 (53.9%)	14 (35.9%)	
5-ARI	16 (3.7%)	12 (3.0%)	4 (10.3%)	
Combination	110 (25.3%)	99 (25.1%)	11 (28.2%)	
Phytotherapy n (%)				
Yes	59 (13.6%)	56 (14.2%)	3 (7.7%)	.260
No	375 (86.4%)	339 (85.8%)	36 (92.3%)	
Pre-operative IPSS median [IQR] n (%)	23 [19-28]	22 [19-28]	24 [21-28]	.132
< 19	93 (21.4%)	89 (22.5%)	4 (10.3%)	.075
≥ 19	341 (78.6%)	306 (77.5%)	35 (89.7%)	
Indwelling catheter history n (%)				
Yes	62 (14.3%)	59 (14.9%)	3 (7.7%)	.217
No	372 (85.7%)	336 (85.1%)	36 (92.3%)	
Post-operative Catheterization time (days) median [IQR]	2 [1-3]	2 [1-3]	1 [1-3]	.248
Anesthesia n (%)				
Spinal	402 (92.6%)	365 (92.4%)	37 (94.9%)	.574
General	32 (7.4%)	30 (7.6%)	2 (5.1%)	
Surgical technique n (%)				
Standard PVP	243 (56.0%)	219 (55.4%)	24 (61.5%)	.464
Anatomic PVP	191 (44.0%)	175 (44.6%)	15 (38.5%)	
Energy used (kJ) median [IQR]	210[152.178-304.594]	214.45[153.11-315]	190[149.64-246.04]	.148
Energy density (kJ/mL) median [IQR]	4.1 [2.6-5.3]	4.1 [2.5-5.4]	4.1 [3.2-5.2]	.573
Operative time (min) median [IQR]	52 [40-70]	52 [40-70]	52 [35-60]	.314
Lasing time (min) median [IQR]	24.6 [18-35]	25 [18-35.1]	20 [16-26]	.013

[a]Table values are n (%), mean ± SD or median [IQR].
Abbreviations: TRUS, trans-rectal ultrasound; BPO, Benign Prostatic Obstruction; LUTS, lower urinary tract symptoms; IPSS, International Prostate Symptom Score; pAUR, post-operative acute urinary retention.

ous paper, we showed similar functional results and complication rates after aPVP and sPVP[4]. Some of the advantages of GreenLight photoselective vaporization (PVP) are shorter catheterization time and hospital stay compared to transurethral resection of the prostate (TURP)[5]. Post-operative acute urinary retention leads to patients' discomfort, prolonged hospital stay and increased health care costs[6]. In a recent review, post-operative acute urinary retention (pAUR) and clot retention in patients undergoing monopolar o bipolar TURP, GreenLight PVP and Holmium laser enucleation of the prostate (HoLEP) were reported between 0-6% and 0-15.5%, 1-5% and 0-5% and 2-50% and 0-12%, respectively[7]. Different hypotheses have been postulated to explain this phenomenon, but no clear conclusions or indications have been reached[7-10]. Understanding risk factors of post-operative acute urinary retention would allow better tailoring of the procedures and of post-operative care. Based on these considerations, we decided to analyze a large multicenter cohort of patients in order to evaluate the characteristics of patients developing pAUR and to identify independent risk factors possibly influencing this event in patients with BPO treated by 180W LBO laser.

MATERIALS AND METHODS

We retrospectively analyzed the onset of early post-operative acute urinary retention in patients undergoing standard or anatomical PVP for lower urinary tract symptoms (LUTS) secondary to BPO, in a multi-institutional prospectively collected database, including 20 centers, with one or two experienced surgeons per center, between September 2011 and October 2018 using the 180-W XPS GL system. Post-operative urinary retention was considered as the inability to urinate after the removal of bladder catheter. Expert surgeons performed all the procedures. Informed consent was obtained from all individual participants included in the study. After the approval of our local ethical committee (protocol number: 1550/2017 SS Annunziata Hospital, "G. D'Annunzio" University of Chieti, Chieti, Italy) a retrospective analysis of the institutional prospectively maintained database of all patients who underwent Greenlight laser PVP was performed. Indications to Greenlight PVP was indwelling urinary retention and failure of medical therapies for LUTS. Data were collected from patients' charts and outpatient clinical consultations. Inclusion criteria were: availability of data about prostate volume evaluated with trans-rectal ultrasound (TRUS), lower urinary tract symptoms therapy, pre-operative International Prostate Symptom Score (IPSS), history of catheterization or urinary retention, type of anesthesia (spinal or general), surgical technique (anatomical versus standard PVP), operative time, lasing time, energy used, energy density, catheterization time and post-operative acute urinary retention. Exclusion criteria were: history of prostate cancer, neurogenic bladder disease, previous prostate surgery as well as those who underwent GreenLEP or contemporary urethrotomy, treatment of bladder stones or bladder tumors and conversion to TURP. Antibiotic prophylaxis was administered to all patients according to local protocols. Surgical procedures were performed according to surgeon's preferences, as previously described[1,11].
In all procedures a cystoscopy to exclude bladder tumors was performed, then ureteral orifices and striated sphincter were visualized. In sPVP after the creation of

Table 2. Multivariate logistic regression analysis of the probability to develop post-operative AUR.

	Adj OR*	pAUR 95% CI	*P*
Pre-operative IPSS			
< 19	1	-	
≥ 19	2.27	1.19 - 10.75	.023
BPO/LUTS therapy			
None	1.78	0.72 - 4.41	.212
Alpha-blockers	1	-	
5-ARI	3.98	1.05 -15.03	.042
Combination	1.74	0.72 - 4.21	.216
Adenoma volume	0.94	0.89 - 0.98	.006
Prostate volume	1.03	0.99 - 1.07	.184
Energy used (kJ)	1.00	1.00 - 1.00	.138
Lasing time (min)	0.93	0.86 - 0.99	.046

a working space at 5 and 7 o'clock, the prostate was vaporized in circumferential manner from the prostatic urethra towards the prostatic capsule (inside out). Differently, in aPVP after vaporization of the adenoma at the apex up to the localization of the capsule, the surgeon carried out a bilateral incision lateral to verumontanum and using the tip of resectoscope performes a mechanical dissection of the tissue. The dissection plane is followed towards the bladder neck at 6 o'clock and during the dissection the tissue is vaporized, which is obtained by firing the laser towards prostatic urethra (outside in). Depending on the center, a 24.5-Ch (Richard Wolf, Germany) or 26-Ch (Karl Storz, Germany) resectoscope with a laser bridge were used. In both techniques, all the tissues were vaporized and morcellation was not necessary.

Considered pre-operative variables were: prostate volume, drugs treatment for LUTS, IPSS, the presence of indwelling bladder catheter. Intra-operative variables were: type of anesthesia, operative time, lasing time, energy used, energy density and surgical technique. The post-operative variable was catheterization time and the incidence of early and late (at 90 post-operative days) urinary retention.

Statistical analysis

Descriptive analyses were performed for total sample and according to the reporting of post-operative AUR, calculating means and standard deviations (SD) of normally distributed continuous variables, such as age, based on their distribution (assessed using Shapiro–Wilk test) and median and interquartile range (IQR) for non-normal variable (e.g. adenoma volume, energy and irradiation time). Frequencies and related percentages were reported to synthesize categorical variables. Univariate analyses, aimed at identifying factors potentially associated with the development of post-operative AUR, were carried-out using chi square test for comparing categorical variables and using t Student test or Mann-Whitney test for numeric continuous variables as appropriate. The normality of these variables was tested using the Shapiro Wilk test. Factors showing a $P <$ .200 at univariate analysis were, therefore, included in the multivariate analysis and a logistic regression was performed.

RESULTS

The multicenter database included 434 patients suitable for the study. Post-operative acute urinary retention occurred in 39 patients (9%). All the cases of pAUR occurred due to the inability to void after bladder catheter removal, in the absence of bleeding or retention due to clots or hemorrhage. Patients who developed pAUR were treated with application of bladder catheter for 5 days (± 4.5). No further episode of AUR occurred, the patients did not require reintervention or ancillary procedures/exams (urodynamic evaluation) at 90 post-operative days. The characteristics of the study population are shown in Table 1. History of preoperative urinary retention in the pAUR and no pAUR groups was 7.7% and 14.9%, respectively ($P = .217$). Referring to pre-operative variables, a lower prostate volume was present in patients who developed pAUR (45 mL, IQR 35-55 versus 58.5 mL, IQR 45-74, $P < .001$). Patients with an adenoma volume less than 40 mL had a higher probability to develop pAUR at univariate analysis (82.1%, $P < .001$) and the type of the pre-operative medical treatment for BPO was linked to the risk of failure of early catheter removal after surgery. On the contrary, the incidence of pAUR was not affected by age, IPSS score and indwelling catheter history (Table 1). However, in patients with an IPSS score ≥ 19 the P was equal to .075, suggesting an increased occurrence of pAUR. The multivariate logistic regression showed that an IPSS ≥ 19 was associated with higher probability to develop postoperative AUR (95% CI: 1.19-10.75, OR = 2.27, $P = .023$). Analyzing intra-operative findings at the univariate analysis, surgical techniques (standard or anatomical PVP), operative time, energy used and density and type of anesthesia (general or spinal) did not differ between the two groups (**Table 1**). Interestingly, at the univariate analysis lower lasing time correlated to the incidence of pAUR ($P = .013$). This datum received a borderline confirmation at the multivariate logistic regression analysis with an OR of 0.94 (0.88–1.00). Age-adjusted logistic regression showed that the higher was the adenoma volume the lower was the probability to develop a post-operative AUR. Furthermore, an increase in adenoma volume of 1 mL was associated with a decrease of the probability of post-operative AUR of 6% (95% CI: 0.89-0.98, OR = 0.94, $P = .006$). On the contrary prostate volume was not statistically significant at the multivariate analysis ($P = .184$), despite its statistical significance at the univariate analysis. Moreover, the multivariate logistic regression confirmed that energy used during surgery did not influence the incidence of pAUR. In addition, the difference between the two groups in terms of medical treatments have preserved their significance. Patients treated with 5 alpha-reductase inhibitors (5-ARI) reported a higher probability of pAUR than those treated with alpha-blockers or no treatments with an OR equal to 3.98 (95% CI: 1.05-15.03, $P = .041$). The complete multivariate logistic regression analysis of the probability to develop post-operative AUR are reported in Table 2. Instead, the two groups did not have a significant difference in term of post-operative catheterization time ($P = .248$).

DISCUSSION

TURP is still considered the gold standard for BPO surgical treatment. Nevertheless, in the last decade, guidelines have started to include GreenLight and Holmium laser among BPO treatment options. A recent survey reported how most urologists follow the EAU guide-

lines for LUTS in men with a growing interest in laser procedures[12]. One of the advantages of these technological improvements is to perform mini-invasive procedures and the possibility to perform tailored surgery based on patients' characteristics. Laser treatments in BPO ensure the same surgical outcomes of traditional ones with different laser prostatectomy techniques and minor invasiveness[3,5,13-16]. Hematuria, post-operative acute urinary retention and urinary tract infections are the three common peri-operative and early complications in prostate surgery for BPO[7,17]. Urinary retention after removal of bladder catheter is a cause of patient's dissatisfaction and delay the return to normal activity. In the literature, data on prediction of re-catheterization after endoscopic prostate surgery for BPO are sparse, retrospective and heterogeneous. In patients undergoing TURP, catheterization for clot retention is variable between different series (0-15.5%) and is one of the most common causes. Other potential elements for persistent obstruction are residual chips of prostatic tissue obstructing the urethra, or underactive bladder[7,8,18]. Further factors investigated with discordant results in patients undergoing TURP, HoLEP or GreenLight Laser PVP were bladder over-distension during surgery, history of diabetes mellitus, age, and several comorbidities such as coronary heart disease, renal insufficiency, and Alzheimer's disease[7,9,10].

In the literature GreenLight laser has been reported to have shorter catheterization time compared to TURP [19,20]. In this study, we retrospectively analyzed our multicenter experience in order to understand if there are pre-, intra- or post-operative factors that could determine a higher risk of pAUR. Several papers demonstrated that chronic urinary retention and age did not have a negative impact on the possibility to resume normal voiding function after catheter removal in patients having GreenLight vaporization[20]. In agreement with a previously published articles[21,22], we did not find a statistically significant difference in patients with a history of indwelling catheter and a correlation with age between the two groups (P = .217 and P = .359, respectively). Multivariate analysis also confirmed these data. As previously reported, even different surgical techniques (standard versus anatomical PVP) did not influence failure of catheter removal[4]. In one of our recent papers, where we compared the results of patients undergoing sPVP or aPVP, the median catheterization time was 1 day for both groups with a post-operative acute urinary retention of 8.9 and 9.2% in sPVP and aPVP (P = .872), respectively[4]. These data were confirmed as well in this specific analysis of our series. The type of surgical technique and the post-operative catheterization time did not reach statistical significance between the two groups (P = .464 and P = .248, respectively).

At univariate analysis of our multicenter database, smaller prostate, adenoma volume less than 40 mL and lower lasing time correlate with an increased risk of post-operative catheter removal failure. The importance of adenoma volume and lasing time were confirmed at the logistic regression, while prostate volume was not significant. The presence of smaller adenoma volume in patients with pAUR did not influence further intra-operative aspects except the lasing time. In fact, we did not find any difference at the univariate and multivariate analyses between the two groups in terms of operative time, energy delivered and density even though the patients who developed pAUR had lower prostate and adenoma volumes (**Table 1**). These data might be explained by inefficacious vaporization related to inadequate adenoma removal with excessive energy absorption by the prostatic tissue, which might have an inflammatory and irritating effect. Ineffective tissue removal together with an inflammatory effect might be two factors affecting de novo urinary retention after surgery. In our series, men with a history of severe LUTS may be at risk of pAUR compared to patients with moderate LUTS. This aspect has been never investigated in other reports[9,10,20]. Our consideration is due to the correlation between treatment with 5-ARI at the univariate and multivariate analysis and an IPSS score $\geq$ 19 at the multivariate analysis, with the occurrence of pAUR. In addition, we hypothesize that a pre-existing inflammatory component might influence the rate of pAUR. The pAUR group was composed by men with a lower prostate and adenoma volume, but with a higher rate of 5-ARI assumption in combination or monotherapy (28.2 versus 25.1% and 10.3 versus 3%, respectively) than the no pAUR group. As we know, treatment with 5-ARI should be considered in patients affected by moderate to severe LUTS[23-25]. This drug acts by inhibiting cells proliferation and inducing apoptosis of prostatic epithelial cells. Furthermore, the reduction of expression of Cox-2 and RhoA in the prostatic tissue probably attenuate the inflammation process [26]. For these reasons, the presence in the pAUR group of a higher rate of assumption of 5ARI in patients with low prostate volume and high IPSS value might be explained by an inflammatory component responsible of the post-operative urinary retention. Obviously, this is a hypothesis needing further investigations. Concerning the operative time, Bae et al[9] previously reported that operative time is a risk factors for pAUR. The authors presumed that the longer operative time caused a prolonged bladder distension. This over-distension may result in temporary bladder dysfunction. In our series, as well as in the series reported by Kim et al[10], we did not find a correlation between operative time and failure of catheter removal (P = .314).

Some limitations are present in this study. First of all it is a retrospective analysis, with a small sample size. The lack of details about the comorbidity profile, preoperative urodynamic parameters and post void residual urine of our study population may be misleading. Another confounding factor might be the multi-center nature of this study involving several surgeons with not clustered data analyses. In the future, larger prospective studies are needed to better investigate these issues. However, the major strength of our work, in spite of these limitations, is that it is the first study in the literature trying to analyze the risk factors for post-operative catheter removal failure in patients undergoing Greenlight laser PVP.

CONCLUSIONS

In our series, we analyzed pre-, intra- and post-operative factors affecting urinary retention after GreenLight PVP. Low adenoma volume and lasing time, pre-operative IPSS $\geq$ 19 and 5-ARI intake resulted as risk factors for pAUR. These variables might be analyzed with prospective studies to confirm our data and for the timing of catheter removal in this subgroup of patients in order

to better organize hospitalization and recovery.

CONFLICT OF INTEREST

The Authors declares that there is no conflict of interest

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