DOI: 10.4081/aiua.2022.2.169

ORIGINAL PAPER

Prostate resection weight matters in severely obstructed men undergoing transurethral resection of the prostate

Filipe Lopes [1], Ricardo Pereira e Silva [1, 2], Miguel Fernandes [1], Tito Palmela Leitão [1, 2], José Palma dos Reis [1, 2]

[1] Urology Department, Centro Hospitalar Universitário Lisboa Norte, Lisbon, Portugal;
[2] Urology University Clinic, Faculty of Medicine, University of Lisbon, Portugal.

Summary ***Objectives:*** *Transurethral resection of the prostate (TURP) remains one of the gold-standard surgical treatments for benign prostatic hyperplasia/lower urinary tract symptoms. The usefulness of a complete adenoma resection is questionable, with studies reporting no impact of the amount of resected tissue on surgical outcomes, irrespective of prostate volume. The aim of this study was to assess whether in less obstructed patients a less extensive TURP may be considered.*

Materials and methods: *Retrospective analysis of 185 men undergoing TURP in one university hospital. Retrieved data included pre-operative prostate volume and Q_{max}, as well as resected prostate weight and post-operative Q_{max}. Patients were divided in two groups according to pre-operative Q_{max} < 10mL/s and ≥ 10 mL/s.*

Results: *A correlation was found between absolute resected prostate weight and post-operative Q_{max} in the group of patients with pre-operative Q_{max} < 10 mL/s (r^2 = 0.038, p = 0.032), independently of the pre-operative prostate volume. This association was neither observed in the group of patients with pre-operative Q_{max} ≥ 10 mL/s (r^2 = -0.033, p = 0.796) nor in whole population analysis (r^2 = 0.019, p = 0.064). Likewise, in the group of patients with pre-operative Q_{max} < 10 mL/s, the improvement in Q_{max} was correlated with absolute resected weight and percentage of prostate resected weight (r^2 = 0.036, p = 0.037 and r^2 = 0.040, p = 0.029, respectively). None of these correlations was found in the group of patients with pre-operative Q_{max} ≥ 10 mL/s (r^2 = 0.009, p = 0.463 and r^2 = -0.018, p = 0.294, respectively).*

Conclusions: *Patients with pre-operative Q_{max} ≥ 10 mL/s may do well with less profound prostate resections, whereas patients with lower pre-operative Q_{max} seem to benefit from a complete adenoma resection.*

KEY WORDS: *Transurethral resection of prostate; Prostatic hyperplasia; Lower urinary tract symptoms; Adenoma; Urologic surgical procedures.*

Submitted 12 May 2022; Accepted 27 May 2022

INTRODUCTION

Benign prostatic hyperplasia (BPH) is one of the most common causes of *lower urinary tract symptoms* (LUTS) in men. Current international guidelines recommend a stepwise approach to the treatment of BPH/LUTS (1).

However, surgery remains the gold-standard in severe or refractory LUTS, and *transurethral resection of the prostate* (TURP) is the procedure of choice for the majority of men with BPH/LUTS, especially for prostate volumes between 30 and 80 mL (1).

Despite all the technological and technical improvements since the initial TURP descriptions almost a century ago (3), there is still controversy regarding the need for a complete prostatic tissue resection. Although some literature recommends a total removal of the adenomatous tissue (4), a relevant body of research supports the thesis that a complete adenoma resection may not be essential, with similar post-operative results with or without it (6). Similarly, a relationship between the amount of resected prostate and the outcomes of the surgery has been pursued, yet no correlation has been found between these two variables, neither in smaller (< 40 g) nor in larger (> 40 g) prostates (6).

TURP is especially effective when *bladder outlet obstruction* (BOO) due to *Benign Prostatic Obstruction* (BPO) is the main cause for the patient's LUTS. A satisfactory surrogate marker for the severity of BOO may however be obtained with urinary flow rate studies, as stated by the *Siroky-Liverpool nomograms*, in which maximum flow rate (Q_{max}) and bladder volume are used to predict BOO (7).

Furthermore, a recent randomized controlled trial was not able to prove a benefit in performing urodynamic studies in men with LUTS, since surgical treatment was necessary in around 37% of patients irrespectively of performing urodynamic studies (8).

Although considered a safe procedure, sexual side effects after TURP are still an important issue, with 60-70% of patients reporting retrograde ejaculation, and up to 6.5% complaining of erectile dysfunction (9). Other side effects include early urge-incontinence, even though late stress incontinence is rare (0.5%) (10). In recent years, new approaches to TURP have been developed, aiming at the reduction of morbidity while maintaining the benefits of the procedure. In that regard, ejaculation preserving techniques are a promising development, with reports of antegrade ejaculation at 3 months post-op in around 90% of patients undergoing *ejaculation preserving TURP* (epTURP), with symptomatic and functional outcomes similar to the classic technique (11, 12). A vaporization technique using laser (LEST) has also been described, with antegrade ejaculation maintained in up to 80% of

No conflict of interest declared.

patients (13). To our knowledge, no diagnostic feature has been firmly established as a predictor for TURP outcomes. However, the results of this procedure are heterogenous, with studies reporting a failure in symptomatic relief in around 12% of patients (14), raising the possibility that such predictors exist, at least for some patients. These may nevertheless be statistically concealed in the published studies, due to the analysis of the studied populations as a whole, irrespective of important factors such as BOO severity (5). Therefore, the aim of this study is to analyze whether pre-operative BOO severity may affect a possible influence of prostate resected weight in TURP outcomes.

Methods

We conducted a retrospective analysis of patients submitted to TURP in a university hospital between February 2011 and November 2015. Exclusion criteria were previous LUTS surgery, prostate cancer, urethral stricture or voided volumes < 125 mL in uroflowmetry. Pre-operative data was retrieved, including clinical history, comorbid conditions, medications, uroflowmetry and prostate volume (determined by transrectal ultrasound). Post-operatively, weight of the resected dry specimen and post-operative uroflowmetry values were considered. As a second measure of depth of resection, and in order to evaluate a possible influence of pre-operative prostate size, a ratio between the absolute resected prostate weight and prostate volume measured via ultrasound was calculated, henceforth referred to as "*percentage of resected weight*".

All patients were diagnosed with BPH/LUTS refractory to medical treatment with alfa-blockers and/or 5-alfa reductase inhibitors (5-ARI). Surgery was performed by 5 different urologists using monopolar or bipolar standard 26-French resectoscopes (*Karl Storz®*), depending on surgeon preference. The resected tissue underwent fixation with Formalin 10% and was weighted using precision scales in the Pathology laboratory before routine histologic analysis. Bladder catheters were removed 2 to 3 days after the procedure and the patients discharged following spontaneous micturition. Post-operative uroflowmetry was performed 4-6 weeks after surgery.

Patients were stratified in two groups according to pre-operative Q_{max}, following the Siroky-Liverpool nomograms, which define a cut-off value of 10 mL/s as a very strong predictor of BOO (≤ 2 standard deviations of the mean for a voided volume ≥ 125 mL) (7, 15). The first group was comprised of patients with pre-operative Q_{max} < 10 mL/s, and the second included patients with pre-operative Q_{max} ≥ 10 mL/s. Statistical analysis was performed using non-parametric tests as appropriate (given the non-normality of the distributions as determined by Kolmogorov-Smirnov tests) with IBM SPSS® 27.0.

Since the present study was performed in a retrospective fashion, no informed consent was required. Complete anonymity of all patients was, however, ensured.

Results

A total of 185 patients were included, with a mean age of 58.5 (± 7.2) years and a mean pre- and post-operative Q_{max} of 8.8 ± 3.6 and 14.9 ± 7.2 mL/s, respectively. The mean change in Q_{max} after surgery was 6.2 ± 7.1 mL/s. Other demographic and clinical characteristics are displayed in Table 1.

In the whole sample analysis, no statistically significant correlations were found between absolute resected prostate weight or percentage of resected weight and post-operative Q_{max} (r^2 = 0.019, p = 0.063 and r^2 = 0.019, p = 0.064, respectively). Similarly, the pre/post-operative difference in Q_{max} showed no correlation with the resection weight (r^2 = 0.006, p = 0.290) or the percentage of resected prostate weight (r^2 = 0.006, p = 0.283).

When stratifying patients into two groups according to pre-operative Q_{max} < 10 mL/s (n = 121) and ≥ 10 mL/s (n

Table 1.
Patient characteristics.

	Mean ± SEM	Median ± IQR	Range
Age (y)	58.5 ± 0.53	59 ± 9	37-77
Prostate volume (mL)	51.78 ± 1.13	50 ± 22.5	25.0-103.0
Uroflowmetry Q_{max}			
Pre-op (mL/s)	8.78 ± 0.26	8.3 ± 5	2.0-18.0
Post-op (mL/s)	14.9 ± 0.53	14 ± 10.3	2.0-45.0
Difference (mL/s)	6.2 ± 0.52	5.6 ± 9	-7.2-34.8
Resected weight (g)	7.7 ± 0.40	6 ± 5.5	0.4-28.0
PRW (%)	15.2 ± 0.74	13 ± 11.5	1.0-54.0
Frequency comorbid conditions			
Diabetes mellitus (n %)			16 (8.8)
Neurologic disease (n %)			8 (4.3)
Previous AUR (n %)			14 (7.7)
Medications			
Anti-cholinergic (n %)			8 (4.4)
Alfa-blocker (n %)			170 (92.9)
5-ARI (n %)			115 (62.8)

SEM: Standard error of the mean; IQR: Interquartile range; PRW: percentage of resected weight; AUR: Acute urinary retention; 5-ARI: 5-alfa reductase inhibitor.

Table 2.
Group characteristics comparison.

	Pre-operative Q_{max} N = 121 < 10 mL/s (N = 121)	≥ 10 mL/s (N = 64)	P-value
Age (y) mean (SEM)	59.0 (2.7)	57.5 (2.6)	0.097†
Prostate volume (ml) mean (SEM)	51.4 (4.0)	52.4 (3.8)	0.540†
Uroflowmetry Q_{max}			
Pre-op (ml/s) mean (SEM)	6.6 (1.4)	12.8 (1.5)	0.000†
Post-op (ml/s) mean (SEM)	14.3 (2.7)	16.2 (2.6)	0.028†
Difference (ml/s) mean (SEM)	7.7 (2.5)	3.4 (2.3)	< 0.001†
Resected weight. g. mean (SEM)	7.5 (2.4)	8.0 (2.1)	0.106†
PRW. %. mean (SEM)	14.8 (3.2)	16.0 (3.1)	0.109†
Comorbid conditions			
Diabetes mellitus (n %)	9 (7.4)	7 (10.9)	0.432‡
Neurologic disease (n %)	5 (4.1)	3 (4.7)	0.860‡
Previous AUR (n %)	9 (7.4)	5 (7.8)	0.928‡
Medications			
Anti-cholinergic (n %)	3 (2.5)	5 (7.8)	0.087‡
Alfa-blocker (n %)	110 (90.9)	60 (93.8)	0.372‡
5-ARI (n %)	74 (61.2)	41 (64.1)	0.650‡

SEM: Standard error of the mean; PRW: percentage of resected weight; AUR: Acute urinary retention; 5-ARI: 5-alfa reductase inhibitor.
†: Mann-Whitney test; ‡: Chi-square test; significant differences are highlighted in bold.

= 64), no differences in demographic or clinical characteristics were found, with the exception of post-operative Q_{max} and Pre/post-operative difference in Q_{max} (Table 2). Post-operative maximum flow was superior in patients with already higher pre-operative Q_{max} (16.2 mL/s *vs* 14.3 mL/s, p = 0.028). Both groups showed a significant increase in Q_{max} post-operatively when compared to baseline maximum flow, although this increase was higher in the group with pre-operative Q_{max} < 10 mL/s (7.7 mL/s *vs* 3.4 mL/s, p < 0.001).

In the group of patients with pre-operative Q_{max} < 10 mL/s, post-operative Q_{max} was correlated with absolute resected prostate weight (r^2 = 0.038, p = 0.032), as well as with percentage of resected prostate weight (r^2 = 0.051, p = 0.013). In these patients, the difference in pre/post-operative Q_{max} was also strongly associated with absolute resected prostate weight (r^2 = 0.036, p = 0.037) and percentage of resected prostate weight (r^2 = 0.040, p = 0.029) (Figures 1, 2).

Neither of the above-mentioned correlations were established in the group of patients with pre-operative Q_{max} ≥ 10 mL/s. Absolute resected prostate weight and percentage of resected prostate weight were not associated with post-operative Q_{max} (r^2 = -0.033, p = 0.796 and r^2 = -0.009, p = 0.458, respectively), nor with peri-operative change in Q_{max} (r^2 = 0.009, p = 0.463 and r^2 = -0.018, p = 0.294, respectively) (Figures 1, 2).

Discussion

Although many new techniques have evolved in recent years regarding the surgical management of BPH/LUTS, TURP remains as the gold-standard surgical therapy in most men with prostatic volume between 30-80 mL (16). However, the extension of adenoma resection is under debate, since some studies reported similar outcomes between complete and partial adenoma resection (6).

The outcome of surgical treatment of BPH depends on many factors, both related and unrelated to the surgical procedure itself. Recent studies analyzed the applicability of machine learning in predicting these outcomes (17). Symptomatic relief achieved following TURP is the pri-

Figure 1.
Post-operative Q_{max} (mL/s) per absolute resected weight in patients with pre-operative Q_{max} < 10 mL/s and ≥ 10 mL/s.

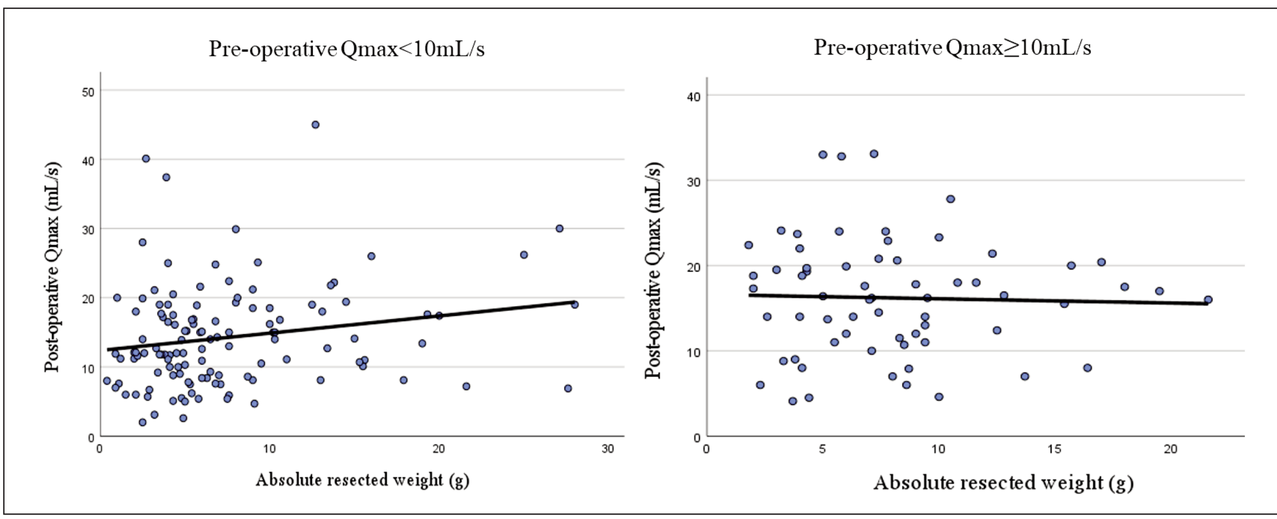
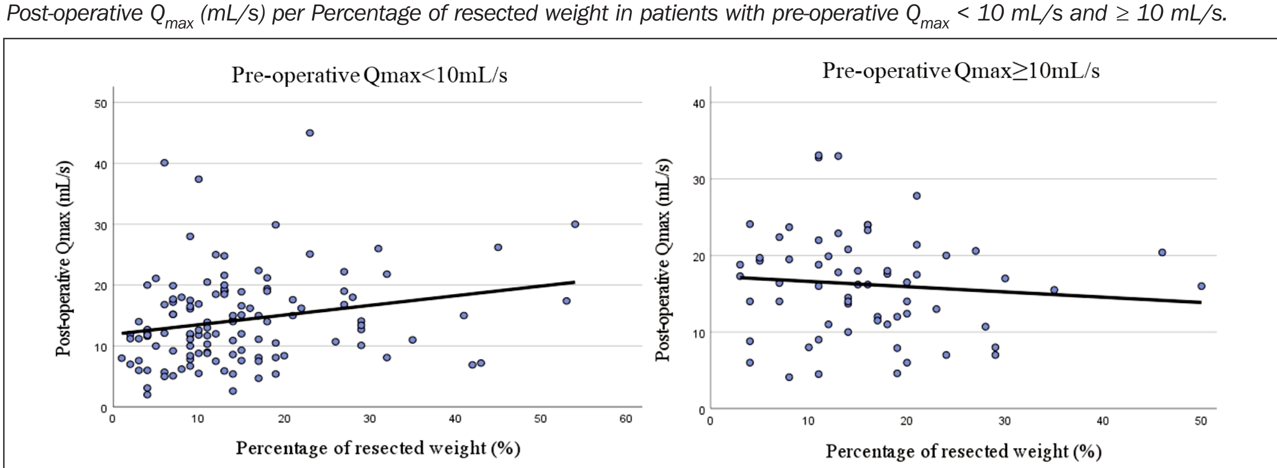


Figure 2.
Post-operative Q_{max} (mL/s) per Percentage of resected weight in patients with pre-operative Q_{max} < 10 mL/s and ≥ 10 mL/s.



mary goal of this procedure and is best measured through symptom scores, such as the *International Prostate Symptom Score* (IPSS). IPSS was found to be correlated with other clinical parameters, such as Q_{max} (18). Pre- and post-operative improvement in uroflowmetry is therefore commonly used as an objective method for surgical effectiveness assessment (16). In agreement with previous studies, our analysis failed to find an association between the extension of adenoma resection and post-operative outcomes in the whole sample analysis. Similarly to the present study, other reports explored the influence of pre-operative prostate volume in this correlation, yet no differences were noted (6). These studies concluded that post-operative clinical and symptomatic improvement was not impacted by the resected volume.

The same conclusion was obtained through a different line of investigation. With the intent of avoiding sexual side-effects of TURP, recent surgical techniques have been developed, which include the epTURP, in which pre and paracollicular tissue is spared (11). Although not formally measured, the preservation of some prostatic tissue results in an expected decrease of resected weight. In the available literature, the outcomes (IPSS, Q_{max}, voided volume and post-void residual) of epTURP are reported as similar to the classic technique, implying that an incomplete adenoma resection may be a viable option (12). However, further studies are necessary to confirm these results, especially since long-term surgical outcomes of this procedure are scarcely reported, with only one available study reporting favorable results at a follow-up of 60 months (11).

Although BOO diagnosis may only be obtained through pressure/flow studies, maximum flow rate obtained via uroflowmetry is much more frequently used, due to its availability, reduced invasiveness and cost, when compared to urodynamic studies (19). Furthermore, the recent UPSTREAM trial did not prove an advantage in performing urodynamic tests in men with BPH/LUTS, showing similar surgery rates, as well as clinical outcomes in both arms of the study (8). While of unquestionable usefulness in certain patient groups, pressure/flow studies seem not to add value in the diagnostic process of the majority of non-neurogenic male LUTS, in which cases uroflowmetry might be enough to diagnose BOO. In fact, *Siroky-Liverpool uroflowmetry nomograms* predict this condition with great efficacy using bladder volume and maximum flow rate. As stated by the authors, a $Q_{max} < 10$ mL/s is a strong predictor of a clinically relevant BOO for bladder volumes of 125 mL or higher (7). More recent investigations reported that around 90% of men with a severe BOO (grade III-VI - Schäfer classification (20, 21) had a $Q_{max} < 14$ mL/s on uroflowmetry, whereas only 6% of all men with a low-grade BOO (Grade I-II) had a $Q_{max} < 10$ mL/s (22). Furthermore, a recent study reported that men with $Q_{max} < 10$ mL/s were more likely to develop an acute urinary retention episode (hazard ratio: 5.6) when compared to men with $Q_{max} \geq 10$ mL/s (23). This cut-off value was thus used to dichotomize between patients considered as severely obstructed ($Q_{max} < 10$ mL/s) and patients with mild to moderate voiding dysfunction ($Q_{max} \geq 10$ mL/s).

The influence of the extent of prostatic resection in TURP outcomes has been the scope of some research. However, to our knowledge this is the first analysis of the influence of pre-operative Q_{max} in this relationship. In fact, none of the above-mentioned studies could certify the presence of BOO as a cause for LUTS, since none report urodynamic tests. Therefore, it is possible that some patients in these analyses were actually not suffering from true BOO.

Our analysis suggests that in patients with pre-operative $Q_{max} < 10$ mL/s, a more thorough resection of the prostate is associated with better surgical outcomes. This association was not present in patients with pre-operative $Q_{max} \geq 10$ mL/s, although surgery was beneficial in both groups. As suggested by other authors, prostate initial volume could play a role in this relationship, since a larger amount of tissue may need to be resected in order to treat BOO in larger rather than in smaller prostates. However, no such influence seems to exist, as the ratio between resected weight/prostate volume is similarly correlated with post-operative Q_{max} only in the group of patients with pre-operative $Q_{max} < 10$ mL/s. Similar findings were previously reported by another study (6).

These results suggest that severely obstructed patients may profit from a complete adenoma resection. Conversely, men with higher maximum flow rates may be good candidates for techniques with less morbidity, such as epTURP. If further studies confirm our results, surgeons should be encouraged to adapt their TURP technique to the patients' pre-operative clinical details and expectations concerning surgical side effects, in a patient-tailored way.

The present study has several limitations. First, the retrospective design may be a source of bias. Second, we did not consider symptom scales such as IPSS in our analysis, mainly due to a high level of missing data. Even though previous studies proved a high correlation between maximum flow rate and IPSS (18), LUTS grading and change after surgery would have been of great value in the analysis. Another source of relevant information would be urodynamic studies, which in our center are not routinely performed to all men with BPH/LUTS. Furthermore, in our study, the resected prostate weight was measured in the Pathology laboratory after fixation with formaldehyde, using precision scales. This fixation method results in a considerable reduction in specimen weight, and therefore this parameter, while valid for analysis within our studied group, is not directly comparable to previous studies (24).

In conclusion, our analysis suggests that patients with pre-operative $Q_{max} < 10$ mL/s undergoing TURP benefit from a complete adenoma resection, since resected prostate weight is directly correlated to post-operative Q_{max} and pre/post-operative difference in Q_{max}. The same does not apply for patients with pre-operative $Q_{max} \geq 10$ mL/s, in which post-operative Q_{max} and Q_{max} improvement after surgery are independent of resected prostate weight. Our results suggest that men with higher pre-operative Q_{max} may do well with less thorough prostate resections, potentially avoiding important side-effects of TURP.

References

1. Gravas S, Cornu JN, Gacci M, et al. Management of non-neurogenic male LUTS. In: EAU Guidelines. EAU Guidelines Office; 2020.

2. Parsons JK, Dahm P, Köhler TS, et al. Surgical management of lower urinary tract symptoms attributed to benign prostatic hyperplasia: AUA Guideline Amendment 2020. J Urol. 2020; 204:799-804.

3. Walker KM. Per-urethral operations for prostatic obstruction. Br Med J. 1925; 1:201-204.

4. Milonas D, Verikaite J, Jievaltas M. The effect of complete transurethral resection of the prostate on symptoms, quality of life, and voiding function improvement. Cent Eur J Urol. 2015; 68:169-174.

5. Park HK, Paick SH, Lho YS, et al. Effect of the ratio of resected tissue in comparison with the prostate transitional zone volume on voiding function improvement after transurethral resection of prostate. Urology. 2012; 79:202-206.

6. Hakenberg OW, Helke C, Manseck A, Wirth MP. Is there a relationship between the amount of tissue removed at transurethral resection of the prostate and clinical improvement in benign prostatic hyperplasia. Eur Urol. 2001; 39:412-417.

7. Siroky MB, Olsson CA, Krane RJ. The flow rate nomogram: II. Clinical correlation. J Urol. 1980; 123:208-210.

8. Drake MJ, Lewis AL, Young GJ, et al. Diagnostic assessment of lower urinary tract symptoms in men considering prostate surgery: a noninferiority randomised controlled trial of urodynamics in 26 hospitals. Eur Urol. 2020; 78:701-710.

9. Chung A, Woo HH. Preservation of sexual function when relieving benign prostatic obstruction surgically: Can a trade-off be considered? Curr Opin Urol. 2016; 26:42-48.

10. Rassweiler J, Teber D, Kuntz R, Hofmann R. Complications of transurethral resection of the prostate (TURP)-Incidence, management, and prevention. Eur Urol. 2006; 50:969-980.

11. Alloussi SH, Lang C, Eichel R, Alloussi S. Ejaculation-preserving transurethral resection of prostate and bladder neck: Short- and long-term results of a new innovative resection technique. J Endourol. 2014; 28:84-89.

12. Ben Rhouma S, Ben Chehida MA, Ahmed S, et al. MP42-18 Can we preserve ejaculation after transurethral resection of the prostate ? Comparative study between the conventional technique and a new technique about 70 cases. J Urol. 2016; 195:e577.

13. Leonardi R. The LEST technique: Treatment of prostatic obstruction preserving antegrade ejaculation in patients with benign prostatic hyperplasia. Arch Ital di Urol Androl. 2019; 91:35-42.

14. S Sun F, Sun X, Shi Q, Zhai Y. Transurethral procedures in the treatment of benign prostatic hyperplasia: A systematic review and meta-analysis of effectiveness and complications. Medicine (Baltimore). 2018; 97:e13360.

15. Siroky MB, Olsson CA, Krane RJ. The flow rate nomogram: I. Development. J Urol. 1979; 122:665-668.

16. Huang SW, Tsai CY, Tseng CS, et al. Comparative efficacy and safety of new surgical treatments for benign prostatic hyperplasia: Systematic review and network meta-analysis. BMJ. 2019; 367:l5919.

17. Mourmouris P, Tzelves L, Feretzakis G, et al. The use and applicability of machine learning algorithms in predicting the surgical outcome for patients with benign prostatic enlargement. Which model to use? Arch Ital di Urol e Androl. 2021; 93:418-424.

18. Itoh H, Kojima M, Okihara K, et al. Significant relationship of time-dependent uroflowmetric parameters to lower urinary tract symptoms as measured by the International Prostate Symptom Score. Int J Urol. 2006; 13:1058-1065.

19. Drake MJ, Doumouchtsis SK, Hashim H, Gammie A. Fundamentals of urodynamic practice, based on International Continence Society good urodynamic practices recommendations. Neurourol Urodyn. 2018; 37:S50-S60.

20. Schäfer W. Analysis of bladder-outlet function with the linearized passive urethral resistance relation, linPURR, and a disease-specific approach for grading obstruction: from complex to simple. World J Urol. 1995; 13:47-58.

21. D'Ancona C, Haylen B, Oelke M, et al. The International Continence Society (ICS) report on the terminology for adult male lower urinary tract and pelvic floor symptoms and dysfunction. Neurourol Urodyn. 2019; 38:433-477.

22. Boci R, Fall M, Waldén M, et al. Home uroflowmetry: Improved accuracy in outflow assessment. Neurourol Urodyn. 1999; 18:25-32.

23. Chan CK, Yip SKH, Wu IPH, et al. Evaluation of the clinical value of a simple flowmeter in the management of male lower urinary tract symptoms. BJU Int. 2012; 109:1690-1696.

24. Lukacs S, Vale J, Mazaris E. Difference between actual vs. pathology prostate weight in TURP and radical robotic-assisted prostatectomy specimen. Int Braz J Urol. 2014; 4:823-827.

Correspondence

Filipe Lopes, MD (Corresponding Author)
filopes94@gmail.com

Ricardo Pereira e Silva, MD
ricardomanuelsilva7@gmail.com

Miguel Fernandes, MD
mivafer@gmail.com

Tito Palmela Leitão, MD
titopleitao@gmail.com

José Palma dos Reis, MD
jpalmareis@campus.ul.pt

Serviço de Urologia, Hospital de Santa Maria
Avenida Professor Egas Moniz
1649-035 Lisboa, Portugal