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ORIGINAL ARTICLE

Prostate Disease

Incidence of urinary incontinence following endoscopic laser enucleation of the prostate by *en-bloc* and non-*en-bloc* techniques: a multicenter, real-world experience of 5068 patients

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We aim to evaluate the incidence of incontinence following laser endoscopic enucleation of the prostate (EEP) comparing *en-bloc* (Group 1) versus 2-lobe/3-lobe techniques (Group 2). We performed a retrospective review of patients undergoing EEP for benign prostatic enlargement in 12 centers between January 2020 and January 2022. Data were presented as median and interquartile range (IQR). Univariable and multivariable logistic regression analysis was performed to evaluate factors associated with stress urinary incontinence (SUI) and mixed urinary incontinence (MUI). There were 1711 patients in Group 1 and 3357 patients in Group 2. Patients in Group 2 were significantly younger (68 [62–73] years *vs* 69 [63–74] years, $P = 0.002$). Median (interquartile range) prostate volume (PV) was similar between the groups (70 [52–92] ml in Group 1 *vs* 70 [54–90] ml in Group 2, $P = 0.774$). There was no difference in preoperative International Prostate Symptom Score, quality of life, or maximum flow rate. Enucleation, morcellation, and total surgical time were significantly shorter in Group 1. Within 1 month, overall incontinence rate was 6.3% in Group 1 versus 5.3% in Group 2 ($P = 0.12$), and urge incontinence was significantly higher in Group 1 (55.1% *vs* 37.3% in Group 2, $P < 0.001$). After 3 months, the overall rate of incontinence was 1.7% in Group 1 versus 2.3% in Group 2 ($P = 0.06$), and SUI was significantly higher in Group 2 (55.6% *vs* 24.1% in Group 1, $P = 0.002$). At multivariable analysis, PV and IPSS were factors significantly associated with higher odds of transient SUI/MUI. PV, surgical time, and no early apical release technique were factors associated with higher odds of persistent SUI/MUI.

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INTRODUCTION

After its introduction in 1983, endoscopic enucleation of the prostate (EEP) has been constantly evolving alongside energy devices. EEP has gained popularity and acceptance among urologists, primarily due to the use of bipolar energy and lasers and the introduction of morcellators.[1] Ever since the clarion call was made by Herrmann that "enucleation is enucleation is enucleation", the standardized acronym of EEP for all anatomical enucleating techniques should be used to serve for the transition from the age of transurethral resection of the prostate and open prostatectomy toward the age of EEP.[2]

EEP can achieve complete adenoma removal and excellent improvement in micturition parameters and urinary symptoms when

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causing significantly less morbidity than transurethral resection of the prostate.[3] Nevertheless, postoperative urinary incontinence is one of the most distressing complications, impacting patients' quality of life following benign prostatic enlargement (BPE) surgery.[4] The pooled incidence of 6-month stress urinary incontinence (SUI), urge urinary incontinence (UUI), and mixed urinary incontinence (MUI) after EEP has been reported to be 6.0%, 7.3%, and 0.8%, respectively,[5] with no difference among different energy sources.[6] Incontinence following EEP is commonly transient with most cases resolving within 1 month to 6 months and could be secondary to more complete tissue removal leading to partial weakening or stretching of the external sphincter.[7]

Conventionally, EEP has been performed as a 3-lobe enucleation procedure where the middle lobe is removed first, followed by the lateral lobes separately. Over the past decade, various technical modifications have been introduced to enhance the effectiveness of enucleation and preserve postoperative urinary continence. These modifications include *en-bloc* enucleation techniques and early apical release/preservation of the external sphincter mucosa.

The primary aim of this study is to investigate the incidence of urinary incontinence from a multicenter, real-world experience when different laser energies are used for EEP comparing *en-bloc* and non-*en-bloc* techniques. The secondary outcomes are to investigate factors affecting transient and persistent SUI/MUI and postoperative complications.

PATIENTS AND METHODS

Patients

We performed a retrospective analysis of all patients who underwent laser-guided EEP in 12 centers (**Box 1**) between January 2020 and January 2022. Inclusion criteria were lower urinary tract symptoms not responding to or worsening despite medical therapy and absolute indication for surgery, namely acute urinary retention, recurrent hematuria due to BPE, recurrent urinary tract infections, and bilateral hydronephrosis with renal impairment. Exclusion criteria were concomitant lower urinary tract surgery (*i.e.*, endoscopic urethrotomy, lithotripsy, or transurethral resection of bladder tumor), prostate cancer, previous prostate/urethral surgery, or pelvic radiotherapy. Prostate cancer was ruled out before EEP in patients with elevated PSA or when clinically suspected by performing a prostate biopsy. At baseline, the following data were gathered: age, American Society of Anesthesiologists (ASA) score, presence of a preoperative indwelling catheter, International Prostate Symptom Score (IPSS) with quality of life (QoL) item, PSA, postvoid residual urine (PVR), and maximum flow rate (Qmax) at uroflowmetry. Prostate volume was measured by transrectal ultrasonography. Complications were considered early if they occurred within 30 days of surgery and graded according to the modified Clavien–Dindo classification. Complications occurred between 30 days and 1 year following surgery were considered late. The maximum follow-up was 1 year. Institutional board review approval was obtained by the leading center (Asian Institute of Nephrology and Urology, Hyderabad, India; Approval No. AINU #11/2022), and the remaining centers had approvals from their Institutional boards. The study followed the principles of the Helsinki Declaration. All patients signed informed consent to collect their anonymized data.

Box 1: Centers where surgery was performed

- IRCCS INRCA, Ancona, Italy
- Ng Teng Fong General Hospital, Singapore, Singapore
- Tel Aviv Sourasky Medical Center, Affiliated to the Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel
- ICUA-Clínica CEMTRO, Madrid, Spain
- AkfaMedline Hospital, Tashkent, Uzbekistan.
- Gleneagles Hospital, Singapore, Singapore
- National University Hospital, Singapore, Singapore
- Mahatma Gandhi Mission's Medical College and Hospital, Aurangabad, India
- Sechenov University, Moscow, Russian Federation
- Sarvodaya Hospital and Research Centre, Faridabad, Haryana, India
- Saint-Petersburg State University Hospital, Saint-Petersburg, Russian Federation
- Asian Institute of Nephrology and Urology, Hyderabad, India

Surgical procedures

Thirteen surgeons with previous experience in more than 200 laser EEP were involved in all procedures. Antibiotic prophylaxis was administered to all patients according to local protocols. Laser choice and EEP technique were at the surgeon's discretion based on their experience and available resources. Morcellation was performed in all cases after enucleation. At the end of the procedure, a 20-Ch or 22-Ch catheter was inserted into the bladder and left in place with continuous irrigation until the urine became clear. Enucleation time was measured as the time from the beginning of the enucleation until the start of morcellation. Surgical time was defined as the time from cystoscopy to catheter placement. Patients were assessed postsurgery according to the local standard of care.

Patients were divided into two groups based on the type of enucleation technique employed. Surgeons were informed to provide data specifically only for those patients where there was only one technique deployed to avoid confounding results. Group 1 consisted of patients who underwent *en-bloc* enucleation, while Group 2 included patients who had either 2-lobe or traditional 3-lobe enucleation.

Definition of incontinence

Urinary incontinence was defined as any complaint of urine leakage as reported by patients and categorized into three types: (i) UUI, involuntary loss of urine associated with urgency; (ii) SUI, involuntary loss of urine on effort or physical exertion including sporting activities, or on sneezing or coughing; and (iii) MUI, both stress and urgency urinary incontinence.[8] To assess the duration of incontinence, we divided it into three categories based on the period between catheter removal and patient-reported cessation of incontinence: up to 1 month, from 1 month to 3 months, and longer than 3 months.

Statistical analyses

Continuous variables were assessed for their normal distribution with the Shapiro–Wilk test, and were reported as median and interquartile range (IQR). Categorical variables were reported as absolute frequency and percentage. Comparison between groups was performed by the Mann–Whitney U test for continuous variables and/or Fisher's exact test for categorical parameters. Univariable logistic regression analysis was performed to evaluate factors associated with SUI and MUI which were considered together because postoperative incontinence is often a mixed condition in patients undergoing EEP.[7] Variables significantly associated with the outcome in univariable analysis were entered into a multivariable model to assess their significance as independent predictors. Two separate analyses were performed, one for incontinence lasting up to 3 months after surgery, and the second one for incontinence lasting longer than 3 months after surgery. Data were presented as odds ratios (ORs), 95% confidence intervals (CIs), and *P*-values. A two-tailed $P < 0.05$ was considered statistically significant. All statistical tests were performed using R Statistical language, version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

During the study period, 5068 patients met the inclusion criteria and were included in the analysis. Among them, there were 1711 patients in Group 1 and 3357 patients in Group 2. **Table 1** shows patient baseline characteristics. Median prostate volume was similar between the groups (70 [IQR: 52–92] ml in Group 1 *vs* 70 [IQR: 54–90] ml in Group 2, $P = 0.774$). Patients in Group 2 were significantly younger (median [IQR]: 68 [62–73] *vs* 69 [63–74] years in Group 1, $P = 0.002$), had higher PSA (median [IQR]: 4.1 [2.3–6.7] ng ml^{-1} *vs* 4.0 [2.2–6.2] ng ml^{-1} in Group 1, $P = 0.009$), and had lower PVR (median [IQR]: 70 [50–100] ml *vs* 80 [60–120] ml in Group 1, $P < 0.001$). Conversely, there was no difference in preoperative IPSS, QoL, and Qmax between groups (all $P > 0.05$). There were a significantly higher number of patients with a preoperative indwelling catheter in Group 1 (35.7%) compared with Group 2 (15.2%, $P < 0.001$).

Table 2 shows intraoperative outcomes and early and late complications. Enucleation, morcellation, and total surgical time were significantly shorter in Group 1 (all $P < 0.05$). There was a significantly higher usage of the early apical release technique in Group 1 (63.9% *vs* 29.8% in Group 2, $P < 0.001$). Most of the early postoperative complications were Clavien grade 2 with no significant difference between the groups for acute urinary retention requiring catheterization (4.0% in Group 1 *vs* 3.2% in Group 2, $P = 0.171$) and hematuria requiring a blood transfusion (0.8% in Group 1 *vs* 0.7% in Group 2, $P = 0.8$). There were a significantly higher number of urinary tract infections requiring antibiotics in Group 2 (4.7% *vs* 2.3% in Group 1, $P < 0.001$). Surgical hemostasis of delayed secondary bleeding (Clavien grade 3) was significantly higher in Group 2 (1.1% *vs* 0.4% in Group 1, $P = 0.019$). Late complications were noted in 32 (1.9%) patients in Group 1 and 72 (2.1%) patients in Group 2, with no difference in reoperation rate for BPE and transurethral incision for bladder neck contracture. However, there was a significantly higher rate of urethral stricture requiring either dilatation or urethrotomy in Group 2. No difference was noted in the diagnosis of incidental prostate cancer.

Table 3 shows the postoperative incontinence rate and duration. Within 1 month after EEP, the overall incontinence rate was 6.3% in Group 1 *vs* 5.3% in Group 2 ($P = 0.12$). The rate of UUI among incontinent patients was significantly higher in Group 1 (55.1% *vs* 37.3% in Group 2, $P < 0.001$) with no difference in SUI and MUI. Between 1 month and 3 months, the overall incontinence rate was 4.6% in Group 1 *vs* 4.1% in Group 2 ($P = 0.62$). MUI was significantly higher in Group 1 (31.6% *vs* 23.0% in Group 2, $P = 0.022$). After 3 months, the overall rate of incontinence was 1.7% in Group 1 versus 2.3% in Group 2 ($P = 0.06$). Among these patients, SUI was significantly higher in Group 2 (55.6% *vs* 24.1% in Group 1, $P = 0.002$).

At multivariable analysis, prostate volume (OR: 1.009, 95% CI: 1.003–1.015, $P = 0.004$) and preoperative IPSS (OR: 1.060, 95% CI: 1.024–1.098, $P = 0.001$) were factors significantly associated with higher odds of 3-month SUI/MUI (**Table 4**). Prostate volume (OR: 2.178, 95% CI: 2.176–2.201, $P = 0.006$), surgical time (OR: 1.010, 95% CI: 1.005–1.015, $P < 0.001$), and no early apical release technique (OR: 2.915, 95% CI: 1.540–5.826, $P = 0.002$) were factors associated with higher odds of long-lasting SUI/MUI (**Table 4**). Among the four lasers used in our study, the thulium fiber laser was associated with less early and late SUI/MUI (OR: 0.126, 95% CI: 0.060–0.241, $P < 0.001$).

DISCUSSION

In this study, we evaluated complications and postoperative incontinence rates of EEP with different laser energies comparing *en-bloc* versus non-*en-bloc* enucleation techniques in a large, real-world multicenter series of men with clinical BPE. We found that both enucleation approaches showed a similar safety profile with a low rate of low-grade complications and postoperative urinary incontinence.

The *en-bloc* technique is characterized by a single incision during enucleation. Current evidence shows that *en-bloc* enucleation provides some advantages over the traditional 3-lobe or 2-lobe approaches such as easier recognition of the surgical plane, better preservation of the external sphincter's mucosa, and shorter surgical time.[9] In addition, the *en-bloc* with early apical release technique during the initial learning curve allows for a faster and more efficient operation.[10] Despite all surgeons involved in our study being experienced in EEP, we also found that enucleation and surgical time were significantly shorter in Group 1. Yet, morcellation time was in favor of Group 1. Considering that median prostate volume was similar in both the groups, we speculate that this could be multifactorial like a faster ability to morcellate 1 whole adenoma than 2 or 3 separate pieces. Moreover, the type of morcellator used may also make the efficiency of the procedure better. However, we are unable to verify this because morcellator type was not gathered and we acknowledge that this is a limitation of the retrospective design of our study.

Another key observation in our study is that the overall rate of any type of postoperative incontinence steadily decreased after surgery in

Table 1: Patient's baseline characteristics

Characteristic	*Group 1 (en-bloc enucleation; n=1711)*	*Group 2 (non-en-bloc enucleation; n=3357)*	*P*
Age (year), median (IQR)	69 (63–74)	68 (62–73)	0.002*
PV (ml), median (IQR)	70 (52–92)	70 (54–90)	0.774
Preoperative IDC, *n* (%)	610 (35.7)	511 (15.2)	<0.001*
ASA score (*n*)	1132	1967	<0.001*
1, *n* (%)	229 (20.2)	851 (43.3)	
2, *n* (%)	611 (54.0)	708 (36.0)	
3, *n* (%)	288 (25.4)	405 (20.6)	
4, *n* (%)	4 (0.4)	3 (0.2)	
Preoperative IPSS, median (IQR)	23 (21–26)	23 (21–26)	0.788
Preoperative QoL, median (IQR)	5.0 (4.0–5.0)	5.0 (4.0–5.0)	0.511
Preoperative Qmax (ml s^{-1}), median (IQR)	8.0 (6.0–10.7)	8.2 (6.2–10.4)	0.776
Preoperative PVR (ml), median (IQR)	80 (60–120)	70 (50–100)	<0.001*
Preoperative PSA (ng ml^{-1}), median (IQR)	4.0 (2.2–6.2)	4.1 (2.3–6.7)	0.009*

*P <0.05, statistically significant. IQR: interquartile range; IPSS: International Prostate Symptom Score; QoL: quality of life; Qmax: maximum flow rate; PVR: postvoiding residual of urine; PSA: prostate-specific antigen; IDC: indwelling catheter; ASA: American Society of Anesthesiologists; PV: prostate volume

Table 2: Intraoperative outcomes and complications

Outcomes and complications	*Group 1 (en-bloc enucleation; n=1711)*	*Group 2 (non-en-bloc enucleation; n=3357)*	*P*
Energy source, *n* (%)			<0.001*
High power holmium laser	974 (56.9)	980 (29.2)	
Holmium laser with MOSES technology	83 (4.9)	93 (2.8)	
Thulium fiber laser	450 (26.3)	1812 (54.0)	
Thulium-YAG laser	204 (11.9)	472 (14.1)	
Enucleation subtype, *n* (%)			
3 lobes	0 (0)	529 (15.8)	
2 lobes	0 (0)	2828 (84.2)	
En-bloc	1711 (100.0)	0 (0)	
Early apical release, *n* (%)	1093 (63.9)	1001 (29.8)	<0.001*
Surgical time (min), median (IQR)	65 (50–85)	70 (50–95)	<0.001*
Enucleation time (min), median (IQR)	40 (25–55)	55 (40–80)	<0.001*
Morcellation time (min), median (IQR)	11 (7.0–18)	20 (15–35)	<0.001*
30-day postoperative complications, *n* (%)			
Acute urinary retention (Clavien 2)	68 (4.0)	107 (3.2)	0.171
Hematuria requiring blood transfusion (Clavien 2)	12 (0.8)	23 (0.7)	0.80
Urinary tract infection (Clavien 2)	39 (2.3)	158 (4.7)	<0.001*
Delayed secondary bleeding needing surgical control of hemostasis (Clavien 3)	7 (0.4)	37 (1.1)	0.019*
Sepsis (Clavien 4)	1 (0.1)	5 (0.1)	0.650
Delayed complications, *n* (%)			
Urethral stricture requiring dilation	9 (0.5)	42 (1.3)	0.022*
Urethral stricture requiring urethrotomy	11 (0.6)	8 (0.2)	0.047*
Bladder neck contracture requiring transurethral incision	10 (0.6)	26 (0.8)	0.559
Redo surgery for BPH	2 (0.1)	6 (0.2)	0.881
Histology (*n*)	1381	3278	0.078
BPH, *n* (%)	1320 (95.6)	3153 (96.2)	
Incidental prostate cancer, *n* (%)	59 (4.3)	122 (3.7)	
Urothelial carcinoma, *n* (%)	2 (0.1)	0 (0)	
Others, *n* (%)	0 (0)	3 (0.1)	

**P* <0.05, statistically significant. BPH: benign prostatic hyperplasia; IQR: interquartile range; YAG: yttrium–aluminum–garnet

Table 3: Incontinence rate and duration following surgery

Duration of incontinence	*Group 1 (en-bloc enucleation; n=1711)*	*Group 2 (non-en-bloc enucleation; n=3357)*	*P*
<1 month, *n* (%)	107 (6.3)	177 (5.3)	0.12
Urge	59 (55.1)	66 (37.3)	<0.001*
Stress	25 (23.4)	71 (40.1)	0.04*
Mixed	23 (21.5)	40 (22.6)	0.261
1–3 months, *n* (%)	79 (4.6)	139 (4.1)	0.62
Urge	27 (34.2)	40 (28.8)	0.063
Stress	27 (34.2)	67 (48.2)	0.182
Mixed	25 (31.6)	32 (23.0)	0.022*
>3 months, *n* (%)	29 (1.7)	77 (2.3)	0.06
Urge	11 (37.9)	24 (31.2)	0.953
Stress	7 (24.1)	43 (55.6)	0.002*
Mixed	11 (37.9)	10 (13.0)	0.037

**P* <0.05, statistically significant

both groups, from 6.3% to 1.7% in Group 1 and from 5.3% to 2.3% in Group 2. This result is in line with a recent study by Capogrosso *et al.*,[11] where, in a series of a single and highly experienced surgeon, the continence rate following holmium laser enucleation of the prostate increased steadily from 68% at 1 month up to 94% at 1 year. However, the rate of continence at 1 month was lower in the study of Capogrosso *et al.*[11] than that in ours, but this difference can be partially explained by the larger median prostate volume in that study (87 [IQR: 60–115] ml).

The rate of incontinence was similar among the two groups in our study at each follow-up period, but patients in Group 2 had a significantly higher rate of SUI within 1 month and after 3 months of surgery. This may partially be explained by the easier recognition of the surgical plane during *en-bloc* enucleation. This could provide less bleeding in the surgical field with better observation, reducing the risk of capsular perforation which has been shown to be associated with a higher risk of SUI.[12] In fact, patients in Group 2 in our study had a significantly higher rate of delayed secondary bleeding needing surgical hemostasis and this could in part explain why these patients showed a significantly higher rate of SUI. Recently, another modification from the traditional 3-lobe enucleation came out, the so-called top-down holmium laser enucleation of the prostate. In this approach, the incision is meticulously carried out just above the external sphincter and is then deepened to create a division between the right and left adenomas, ultimately reaching the surgical capsule.[13] Once the surgical plane between the adenoma and the capsule is established, a top-down lateral lobe dissection is performed, extending from front to back toward the apical adenoma located at the 6-o'clock position. This technique showed an excellent continence rate of 97.8% at 1-year follow-up.[13]

Continence in men involves a complex mechanism where the external (striated) sphincter's activity is not the sole factor responsible. Indeed, urinary continence can still be preserved even when the striated sphincter is paralyzed.[14] The muscular and elastic tissues located in the distal third of the prostatic urethra might have a crucial

Table 4: Univariable and multivariable analysis of factors affecting early (≤3 months) and late (>3 months) stress and mixed incontinence

Variable	*Univariable analysis*		*Multivariable analysis*	
	OR (95% CI)	*P*	*OR (95% CI)*	*P*
Early stress and mixed incontinence (≤3 months)				
Age	0.999 (0.984–1.013)	0.836		
Non-*en-bloc* enucleation (reference *en bloc* enucleation)	1.075 (0.843–1.379)	0.564		
PV	1.004 (1.001–1.007)	0.004*	1.009 (1.003–1.015)	0.004*
Surgical time	1.005 (1.003–1.008)	<0.001*	0.993 (0.986–1.010)	0.054
Preoperative IPSS	1.029 (1.005–1.054)	0.019*	1.060 (1.024–1.098)	0.001*
Preoperative PVR	1.001 (1.000–1.002)	0.002*	1.000 (0.999–1.001)	0.684
Preoperative IDC	0.747 (0.549–0.999)	0.056		
Holmium laser with MOSES technology (reference high power holmium laser)	1.074 (0.593–1.81)	0.801	0.308 (0.205–0.458)	<0.001*
Thulium fiber laser (reference high power holmium laser)	0.489 (0.374–0.635)	<0.001*		
Thulium-YAG laser (reference high power holmium laser)	0.861 (0.608–1.198)	0.387		
No early apical release (reference early apical release)	1.107 (0.876–1.403)	0.399		
Late stress and mixed incontinence (>3 months)				
Age	1.509 (0.899–2.654)	0.134		
Non-*en bloc* enucleation (reference *en bloc* enucleation)	0.995 (0.967–1.024)	0.744		
PV	1.988 (1.979–1.996)	0.008*	2.178 (2.176–2.201)	0.006*
Surgical time	1.010 (1.005–1.015)	<0.001*	1.010 (1.005–1.016)	<0.001*
Preoperative IPSS	1.049 (0.989–1.106)	0.104		
Preoperative PVR	0.998 (0.994–1.000)	0.185		
Preoperative IDCs	0.787 (0.411–1.394)	0.437		
Holmium laser with MOSES technology (reference high power holmium laser)	0.689 (0.166–1.902)	0.534	0.126 (0.060–0.241)	<0.001*
Thulium fiber laser (reference high power holmium laser)	0.176 (0.084–0.335)	<0.001*		
Thulium-YAG laser (reference high power holmium laser)	0.596 (0.283–1.135)	0.140		
No early apical release (reference early apical release)	2.447 (1.433–4.423)	0.002*	2.915 (1.540–5.826)	0.002*

*P <0.05, statistically significant. IPSS: International Prostate Symptom Score; PVR: postvoiding residual of urine; IDC: indwelling catheter; OR: odds ratio; CI: confidence interval; PV: prostate volume; YAG: yttrium–aluminum–garnet

role in sustaining continence.[15] Damage to this specific segment of the urethra could potentially contribute to SUI following surgery for BPE. As a consequence, the preservation of the distal prostatic urethra seems to play an important role in maintaining continence after EEP, as demonstrated by the application of the early apical release technique. A key observation in our study is that patients who did not have early apical release technique demonstrated an almost three-fold higher risk of persistent SUI/MUI regardless of the type of enucleation approach. This could simply be because the classical *en-bloc* technique always incorporated early apical release as standard, whereas using the latter in 2- and 3-lobe enucleation reflects a surgeon's preference to minimize SUI.[16]

When compared to the traditional 3-lobe technique, the early apical and *en-bloc* approach demonstrated a significantly lower occurrence of temporary SUI (13.5% *vs* 4.5%, $P = 0.03$) in a series of 168 patients, although the difference was not statistically significant at the 6-month follow-up (4.9% *vs* 2.3%).[17] This technique encompasses the preservation of the external sphincter mucosa separating it from the striated sphincter by fully demarcating the prostatic apex from the sphincter itself.[18] Yet, the prolonged stretching and traction applied at the apex level during anterior and lateral enucleation could potentially harm the so-called musculus sphincter urethrae glaber, which runs beneath the striated sphincter and close to the mucosa.[18] The striated muscle fibers of the external sphincter and the smooth muscle fibers of the prostatic urethra are interconnected and cannot be separated.[19] Nevertheless, results in this field are still not convincing since Press *et al*.[10] showed no differences in continence rates at 3 months, 6 months, and 1 year after surgery in a series of 95 men undergoing either *en-bloc* holmium laser enucleation of the prostate with early apical release or standard approach.

A further observation in our study is that the larger the prostate the higher the odds of late SUI/MUI. This result can be justified by the common finding of a wide prostatic fossa after EEP due to the more complete adenoma removal compared with transurethral resection of the prostate. Indeed, transition zone prostate volume was found to be associated with five folds of persistent SUI after holmium laser enucleation of the prostate.[20] In addition, a large prostatic fossa can lead to the entrapping of urine and leakage not only with stress maneuvers but also after detrusor contractions correlated to the change in bladder response to filling as an effect of distorted feedback from the prostatic fossa itself.[21] This also explains why a nonnegligent number of patients complained of MUI in our cohort.

In our multivariable analyses, thulium fiber laser proved to be an independent variable with much promise when it comes to minimizing incontinence. Considering in our series, its utility was higher in Group 2, which had overall inferior results, it could be that laser energy alone does not necessarily be the deciding factor.

Our study has some limitations, starting from its retrospective nature. Second, even though different proficiencies in EEP and multiple surgeons cannot be controlled in the analytic phase, all involved urologists were highly experienced in EEP. We also acknowledge that postoperative patient management was not standardized. Yet, we did not collect data on pad test; hence, a quantification of different urine leakages between the two groups cannot be established. Furthermore, the findings of our study, being based on data from high-volume centers, may have limitations when it comes to generalizing the results to centers with less experience or lower patient volumes. Finally, our study has bias of including non-*en-bloc* techniques in the hands of different surgeons who might be modifying the way they perform surgery based on their own experience, skills acquisition, and training, making it difficult to draw absolute conclusions.

In conclusion, from our multicenter, real-world study comparing *en-bloc* versus non-*en-bloc* EEP performed with different lasers, the thulium fiber laser performs better in minimizing early and late SUI/MUI. Yet, we found that the overall rate of postoperative incontinence was similar between the two cohorts, with a significantly higher incidence of SUI within 1 month and after 3 months of surgery in the non-*en-bloc* enucleation group. Large prostate volume and nonearly apical release technique were factors significantly associated with persistent SUI/MUI. We acknowledge that these findings need to be validated by prospective randomized trials.

AUTHOR CONTRIBUTIONS

VG and DC developed the project and edited the manuscript. MD, SB, SNI, TPB, ANT, LKY, MRS, AM, MTB, MT, NG, MS, HYT, and JYCT participated in data acquisition and analysis. KYF performed statistics. BKS, D Elterman, FGS, D Enikeev, and TRWH revised the manuscript for important intellectual content and participated in critical revision of the manuscript. All authors read and approved the final manuscript.

COMPETING INTERESTS

Dean Elterman is a consultant for Boston Scientific (Marlborough, MA, USA), Procept Biorobotics (San Jose, CA, USA), Olympus, (Tokyo, Japan), Urotronic (Plymouth, MN, USA), and Prodeon (Sunnyvale, CA, USA). Fernando Gomez-Sancha is a consultant for Quanta System (Varese, Italy) and Lumenis (Petah Tikva, Israel). Thomas RW Herrmann is a consultant for, has received honoraria from, and is involved in research collaboration with Karl Storz (Tuttlingen, Germany). The remaining authors declare no competing interests.

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