



En bloc and two-lobe techniques for laser endoscopic enucleation of the prostate: retrospective comparative analysis of peri- and postoperative outcomes

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Abstract

Objectives Various techniques can be used for endoscopic enucleation of the prostate (EEP): removal of all nodes as a single unit (en bloc) or a step-by-step removal of adenomatous nodes (two- and three-lobe techniques). The objective of this study was to perform a comparative analysis of en bloc and two-lobe techniques for holmium laser enucleation of the prostate (HoLEP) and thulium fiber laser enucleation of the prostate (ThuFLEP).

Methods Retrospective assessment included patients with bladder outlet obstruction (IPSS > 20, Qmax < 10) secondary to BPH treated from January 2013 to December 2018. All the patients were assessed prior to surgery, as well as at 1, 3 and 6 months after surgery.

Results The data of 1115 patients who underwent HoLEP or ThuFLEP were analyzed. Two techniques were used: en bloc (406 patients) and two-lobe (709 patients). Mean prostate volumes were comparable between groups. Mean surgery times (68.8 ± 30.6 min vs 67.4 ± 30.1 min; $p = 0.604$) and enucleation rates (1.9 ± 0.74 g/min vs 1.9 ± 0.69 g/min; $p = 0.217$) were also comparable. Morcellation rate was lower in en bloc patients with prostate > 150 cc (2.8 ± 1.1 g/min vs 3.7 ± 2.3 g/min; $p < 0.001$). At 6 months, no differences in functional outcomes (IPSS, PVR, Qmax and QoL) were found.

Conclusions Outcomes and complication rates of en bloc and two-lobe EEP techniques were comparable. En bloc technique was found to have less favorable outcomes in morcellation rate for prostates > 150 cc. The choice of the technique should depend on surgeon's preferences.

Keywords BPH · Endoscopic enucleation of the prostate · EEP · En bloc · Two-lobe technique

Introduction

As of today, both the European Association of Urology (EAU) and American Urological Association (AUA) recommend endoscopic enucleation of the prostate (EEP) as a technique of choice for benign prostatic hyperplasia (BPH) of any size. It can be performed using different sources (electrosurgery or lasers) with similar functional outcomes [1].

Moreover, various techniques can be used for EEP: removal of all nodes as a single unit (en bloc) [2] or a step-by-step removal of adenomatous nodes (two- and three-lobe techniques) [3]. However, the comparative efficacy of these two approaches is poorly described in the available literature, and peri- and postoperative outcomes may differ.

The aim of the current trial was to compare the efficacy and safety of en bloc and two-lobe techniques of EEP: holmium laser enucleation of the prostate (HoLEP) and thulium fiber laser enucleation of the prostate (ThuFLEP).

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Materials and methods

This retrospective study included consecutive case series of patients with benign prostatic obstruction (IPSS > 20 or Qmax < 10) who underwent HoLEP or ThuFLEP from

January 2013 to December 2018. Patients with prior prostate surgery, prostate cancer, urethral strictures or bladder stones were excluded from the study. There were no specific inclusion criteria for HoLEP or ThuFLEP.

For HoLEP, a VersaPulse (Lumenis, Israel) with wavelength of 2100 nm and a 550 μm end-firing laser fiber was used. The power was set to 70 W and decreased to 40 W when incising distally at the verumontanum. For ThuFLEP, we used a thulium fiber (Tm-fiber) laser (NTO IRE-POLUS, Russia) with wavelength of 1940 nm and a 600- μm laser fiber. All procedure steps were performed at 60 W. However, at the verumontanum the power was decreased to 30 W. Both HoLEP and ThuFLEP were carried out using a 26 Ch resectoscope (Karl Storz, Germany) with continuous irrigation (0.9% saline), a 12° optical system and an endoscope camera.

All the procedures were performed by three surgeons experienced in EEP. Holmium and Tm-fiber enucleations were carried out with two-lobe and en bloc techniques. Choice between the technique was in surgeon's preference. During the en bloc technique, a bladder neck incision was created at 5 o'clock. The incision depth was limited to the circular fibers of the prostatic capsule. Left lobe enucleation started from 5 o'clock with the incision extended toward the bladder at 12 o'clock. At 12 o'clock, it was continued toward 7 o'clock, forming a horseshoe-like incision. After dissection, both lobes were not completely released from the prostatic capsule until dissection at 10 to 2 o'clock.

The two-lobe technique was employed as previously described [4]. The surgery began with a 6 o'clock incision (or 7 o'clock in case the median lobe was present) on the bladder neck toward the verumontanum until the circular capsular fibers were visualized. At the verumontanum, the incision was continued counterclockwise, laterally to the 5 o'clock position, toward the neck of the urinary bladder. Then, at 12 o'clock, an incision was made from the neck of the bladder toward the verumontanum. Following that, the incisions at 5 and 12 o'clock were connected and the enucleated left lobe was displaced into the bladder. The same technique was used for right lobe enucleation.

During both techniques, the enucleated prostate tissue was removed with a Piranha mechanical morcellator (Richard Wolf, Germany). The surgery was finished with coagulation of bleeding vessels with a standard loop if necessary. After surgery, a 21F three-way Foley catheter was inserted for continuous bladder irrigation with normal saline. Bladder irrigation was finished on the first postoperative day provided no postoperative bleeding was found. The follow-up period was 6 months. At 1, 3 and 6 months, PSA, prostate volume on TRUS, IPSS, Qmax and QoL were evaluated.

The primary endpoint of our study was efficacy (enucleation rate and surgery time) of each of the enucleation techniques (en bloc and two-lobe). The secondary endpoint

was safety, i.e., number of complications, especially with regard to urinary incontinence.

For statistical analysis, we used IBM SPSS Statistics 23.0. Patient data were expressed as mean \pm standard deviation. For comparison of the means, analysis of variance (ANOVA) was used. Nonparametric variables were compared with Kolmogorov–Smirnov test. Post hoc analysis was performed with Mann–Whitney U Test. The Chi square test was used to determine the significance of frequency difference. A *p* value of 0.05 was chosen as threshold for statistical significance.

Results

The data of 1115 patients who underwent HoLEP or ThuFLEP were analyzed. Two techniques were used: en bloc (406 patients) and two-lobe (709 patients). Preoperative mean prostate volumes were comparable between the two groups (86.11 cc and 87.70 cc, respectively; *p*=0.944), with minimal volume of 30 cc and maximum of 320 cc. Mean age was 67 years in the en bloc group and 66 years in the two-lobe group (*p*=0.609). There were no intergroup differences in any of the preoperative parameters (IPSS, QoL, Qmax) (Table 1).

Mean surgery time was 68.82 ± 30.58 min in the en bloc group and 67.41 ± 30.08 min in the two-lobe group (*p*=0.604). The mass of enucleated tissue (69.50 ± 32.32 g vs 71.09 ± 33.60 g; *p*=0.588) and postoperative prostate volumes (16.11 ± 7.49 cc vs 16.40 ± 7.39 cc; *p*=0.355) was comparable in the en bloc and two-lobe groups. To assess possible differences in enucleation or morcellation rates, patients were divided into the following volume groups: <80 cc; 80–150 cc and >150 cc. Enucleation rates were getting higher with volume growth: en bloc—from 1.63 to 2.1 g/min and two-lobe—from 1.58 to 2.2 g/min. No differences were found in mean enucleation rates (1.9 ± 0.74 g/min vs 1.9 ± 0.69 g/min; *p*=0.217). During assessment of morcellation rate, we found out that the mean rates were comparable between the techniques; however, the rate was lower in en bloc patients with prostate >150 cc comparable to smaller volumes (2.6 ± 1.1 g/min vs 3.4 ± 2.0 g/min; *p*<0.001) and to rate of morcellation in two-lobe technique (2.6 ± 1.1 g/min vs 3.5 ± 1.0 g/min; *p*<0.001). But en bloc technique morcellation rate was superior at volumes from 80 to 150 cc (3.4 ± 2.0 g/min vs 2.9 ± 2.4 g/min; *p*=0.008). After separate assessment, no differences were found between en bloc and two-lobe techniques efficiency in ThuFLEP group; it was also fair for HoLEP. At 6 months of follow-up, there were no differences in functional outcomes (IPSS, PVR, Qmax and QoL). All the groups showed statistically significant improvement after surgery.

Table 1 Peri- and postoperative parameters

	En bloc	Two-lobe	<i>p</i>
Number of patients (<i>n</i>)	406	709	
Age (years)	66.8 ± 7.7 (49–80)	66.6 ± 7.72 (46–89)	0.609
PSA (ng/ml)	4.7 ± 3.9 (0.2–24.0)	4.8 ± 4.2 (0.1–21.1)	0.545
Prostate volume (ml)	87.1 ± 40.6 (35–250)	87.7 ± 42.0 (30–330)	0.944
PVR (ml)	73.5 ± 21.7 (20–120)	72.9 ± 22.7 (20–130)	0.647
Qmax (ml/s)	9.5 ± 2.7 (2.4–13)	9.3 ± 2.7 (2.9–14)	0.461
IPSS, score	22.8 ± 1.8 (20–33)	22.7 ± 1.7 (20–35)	0.465
QoL, score	4.0 ± 0.8 (3–6)	4.0 ± 0.8 (3–6)	0.989
Surgery time (min)	68.8 ± 30.6 (24–188)	67.4 ± 30.1 (31–211)	0.604
Enucleation time (min)	40.5 ± 24.9 (14–110)	39.3 ± 23.1 (21–145)	0.686
Morcellation time (min)	28.4 ± 11.4 (10–78)	28.3 ± 12.1 (10–76)	0.791
Removed tissue (g)	69.5 ± 32.3 (20–198)	71.1 ± 33.6 (18–258)	0.688
Mean enucleation rate (g/min)	1.9 ± 0.7 (0.6–3.9)	1.9 ± 0.7 (0.5–4.1)	0.217
Mean morcellation rate (g/min)	2.7 ± 1.3 (0.6–6.9)	2.8 ± 1.8 (0.6–7.1)	0.620
Morcellation rate < 80 cc (g/min)	2.1 ± 0.8 (0.6–2.9)	2.0 ± 1.0 (0.6–2.5)	0.180
Morcellation rate 80–150 cc (g/min)	3.4 ± 2.0 (1.9–6.9)	2.9 ± 2.4 (2.1–7.0)	0.008
Morcellation rate > 150 cc (g/min)	2.6 ± 1.1 (1.9–4.8)	3.5 ± 1.0 (2.5–6.0)	<i>p</i> < 0.001
Catheterization time (days)	1.7 ± 0.8 (1–3)	1.6 ± 0.7 (1–3)	0.620
Hospital stay (days)	3.7 ± 0.9 (2–6)	3.6 ± 1.0 (3–5)	0.511
Postop PSA (ng/ml)	0.9 ± 0.3 (0.6–1.5)	0.9 ± 0.3 (0.5–1.6)	0.767
Postop prostate volume (ml)	16.1 ± 7.5 (5.0–35)	16.4 ± 7.4 (5–33)	0.355
Postop PVR (ml)	13.4 ± 10.4 (0–35)	13.2 ± 10.2 (0–40)	0.98
Postop Qmax (ml/s)	21.9 ± 3.6 (14–28)	21.5 ± 3.8 (16–28)	0.116
Postop IPSS, score	5.1 ± 1.9 (2–8)	4.9 ± 2.0 (0–7)	0.341
Postop QoL, score	1.6 ± 0.6 (1–3)	1.6 ± 0.6 (1–4)	0.436

Values expressed as mean ± SD

The bolded part means a statistical significance. A *p* value of 0.05 was chosen as the threshold for statistical significance

Complications are summarized in Table 2. There were no statistically significant differences in the number of postoperative complications between the groups. De novo transient stress urinary incontinence after catheter removal was observed in 34 (8.37%) patients in the en bloc group and in 59 (8.32%) patients in the two-lobe group (*p* = 0.529). At

6 months after surgery, mild stress urinary incontinence (1 pad per day) was reported by 6 (1.47%) patients of the en bloc group and 12 (1.69%) patients of the two-lobe group (*p* = 0.606). Clot retention that did not require repeat endoscopic intervention and hemostasis was observed in 44 (10.84%) and 69 (9.73%) patients after en bloc and two-lobe

Table 2 Early and late postoperative complications

	En bloc (%)	Two-lobe (%)	<i>p</i>
Number of patients (<i>n</i>)	406	709	
Repeated morcellation <i>n</i> (%)	5 (1.23)	12 (1.69)	0.371
Short-term stress urinary incontinence <i>n</i> (%)	34 (8.37)	59 (8.32)	0.529
Stress urinary incontinence at 3 months <i>n</i> (%)	12 (2.96)	30 (4.23)	0.181
Stress urinary incontinence at 6 months <i>n</i> (%)	6 (1.47)	12 (1.69)	0.606
Clot retention <i>n</i> (%)	44 (10.84)	69 (9.73)	0.312
Ureteral orifice injury <i>n</i> (%)	2 (0.49)	3 (0.42)	0.599
Hyperthermia <i>n</i> (%)	13 (3.20)	14 (1.97)	0.140
Urinary retention <i>n</i> (%)	15 (3.69)	19 (2.68)	0.220
Urethral stricture <i>n</i> (%)	2 (0.49)	5 (0.70)	0.499
Bladder neck contracture <i>n</i> (%)	3 (0.74)	7 (0.99)	0.475

techniques, respectively ($p=0.312$). No TURP syndrome, bladder wall injury or blood loss necessitating blood transfusion was encountered in any of the groups.

Discussion

As endoscopic enucleation was spreading, novel surgical techniques were constantly being proposed. All of them were developed to resemble or mimic the enucleation of adenoma along the surgical capsule during open prostatectomy as the most anatomically correct procedure [5]. The first endoscopic enucleation (with monopolar electrocautery) was performed by Hiraoka et al. in 1986 [6]. However, its technical imperfection hindered the spread of the technique. The Hiraoka technique implied the use of the loop to resect the lobes which was rather time consuming. Enucleation of the prostate only became well known in 1998 when Gilling et al. reported on the first HoLEP procedure with a morcellator to cut and evacuate the lobes [3]. It is the Gilling technique (or the three-lobe technique) which is the most spread nowadays. A decade after, Baazeem et al. [7] described a two-lobe technique to simplify EEP and facilitate learning. However, the learning curve of EEP was still subject to dispute with the longest learning curve of 50 procedures or even more [8]. In 2015, Scoffone et al. proposed the en bloc no-touch HoLEP technique in hopes of easing the learning process [2]. The main difference was initial identification of the enucleation plane at the verumontanum and continuous horseshoe enucleation of all lobes at once. Scoffone et al. argued that it could improve surgery time and facilitate learning because one of the most troublesome parts of surgery—plane identification—needed to be completed only once [2]. However, during the current trial, we did not find any differences in the mean enucleation time: it was 68.82 ± 30.58 min in the en bloc group and 67.41 ± 30.08 min in the two-lobe group ($p=0.604$).

In 2009, Bach et al. introduced the Tm:YAG laser for BPH surgery and presented the so-called Thulium VapoEnucleation (ThuVEP) [9]. Tm:YAG laser energy was characterized by better absorption in intracellular water and continuous operation making it an efficient tool for tissue vaporization. During vapoenucleation, the prostatic tissue was partially evaporated, and some surgeons even evaporated the median lobe. The main goal of novel techniques was time reduction and functional outcomes comparable to HoLEP. Becker et al. mentioned that there was a significant difference in enucleation time between ThuVEP and HoLEP in favor of the first (27.03 min vs 40 min; $p \leq 0.004$), yet postoperative outcomes were comparable between HoLEP and ThuVEP [10]. However, extensive energy consumption led to substantial carbonization during surgery which could

complicate surgical plane identification and even lead to thermal injury of the capsule [11].

To decrease the risk of thermal damage, in 2010 Hermann et al. [11] developed a modified version of ThuVEP which became free of the vapo- prefix and was named thulium laser enucleation of the prostate (ThuLEP). The difference was a mostly mechanical approach to enucleation with laser energy only used for initial tissue incision and dissection of adhesions. The lobes themselves were enucleated with the resectoscope beak. This allowed for anatomically correct enucleation, leaving little to no residual adenoma tissue [11].

Nowadays, there are a lot of modifications of each of these techniques. For example, in 2015 Kim et al. presented an All-in-One one lobe technique [12] resembling en bloc enucleation proposed by Scoffone et al. [2]. In 2018, Castellani et al. compared two en bloc EEP techniques with separate and joint enucleation of median and lateral lobes [13]. No differences in surgery length or complication rates were found [13].

Thulium fiber laser enucleation was first described in 2018 as another possible option for EEP [1]. Among its main differences is the use of new generation thulium fiber laser with wavelength of 1940 nm. Fiber technology allowed combining the advantages of Ho:YAG and Tm:YAG lasers. Novel Tm-fiber is a pulsed laser with great energy absorption properties, better than that of Tm:YAG. It allows for precise tissue cutting and, at the same time, decreases carbonization and limits vaporization [14]. However, no differences in postoperative outcomes, surgery length and complication rates were found between ThuFLEP and HoLEP [1]. Previously, only the two-lobe technique for ThuFLEP was described. However, in the current trial we retrospectively assessed both Ho:YAG and Tm-fiber surgeries performed in our institution both in en bloc and two-lobes techniques.

One of the main driving forces behind the development of new EEP techniques was the search for ways to facilitate learning. In our practice, we first use step-by-step techniques for grasping the fundamentals of EEP [4]. However, Castellani et al. stressed that en bloc EEP may also be proposed even for laser-naïve urologists as an alternative to the original three-lobe technique [13]. Scoffone et al. also mentioned that the en bloc no-touch technique could ease the learning curve of EEP [2]. However, no comparative data are available on this topic. We believe that the en bloc technique requires more careful understanding of prostate anatomy which potentially makes the technique more difficult at the first steps of learning, yet this point needs to be confirmed in future studies.

One popular opinion is that en bloc may quicken morcellation because there is no need to follow every lobe, and they can be morcellated in one piece. However, in our study morcellation time was comparable between the groups

(28.45 ± 11.41 min for en bloc and 28.25 ± 12.10 min for two-lobe; $p=0.791$). Yet, during statistical assessment we found out that morcellation rate of en bloc technique was higher in case of 80 to 150 cc prostates than those of two-lobe technique. As for higher volumes—more than 150 cc, surprisingly we found decrease in morcellation rate of en bloc group comparing both to patients with lower volumes of the prostate and two-lobe group. One of the possible reasons for such difference could be encounter of dense nodes during morcellation, leading to loss of grasp of morcellator.

Less morcellator movement during en bloc morcellation may decrease the rate of bladder mucosa injury, but again no such complications were observed in either of the groups.

Our findings suggest that the surgeon's skill is the main attribute of successful surgery. It is not only the device that could be secondary [5], but the technique of enucleation itself. If you are experienced, follow the correct enucleation plane and be able to deal with intraoperative complications; the enucleation technique is not of great importance.

Limitations

The first main limitation was the retrospective and non-randomized nature of the study. Second, we did not include the first 100 patients of each surgeon in the study to rule out the effects of the learning process. That is the reason why the three-lobe technique was not included in our study. It was mostly used as the initial step of EEP learning. Third, short follow-up (6 months) prevented assessment of possible late complications, e.g., strictures, bladder neck contracture or BPH recurrence. Fourth, as it was previously shown, all EEP techniques share comparable outcomes [1, 5]; therefore, we suggested that it is possible to include patients who underwent both HoLEP and ThuFLEP in the study.

Conclusions

Both en bloc and two-lobe techniques of EEP can be effective and safe treatment options for BPH. Its peri- and post-operative outcomes as well as complication rates are comparable. Therefore, the primary choice of the technique should depend on surgeon's preferences.

Compliance with ethical standards

Conflict of interest All authors state that they have no conflict of interest that might potentially bias their work.

Ethical approval The study was approved by the Sechenov University (Moscow, Russia) Institutional Review Board.

Informed consent Informed consent was obtained from all individual participants included in the study.

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