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Holmium laser enucleation of the prostate: a 3-year single-center experience of 173 cases

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Abstract

Background: Holmium laser enucleation of the prostate (Holep) is a safe, effective, and prostate size-independent procedure for benign prostatic hyperplasia treatment (BPH). Holep has demonstrated comparable long-term outcomes with historical BPH mainstay treatments, namely open prostatectomy or transurethral resection of the prostate, as well as straightforward evidence of its low morbidity. In this study, we aimed to report our 3-year Holep experience based on 173 patients.

Methods: We conducted a retrospective descriptive single center study utilizing medical charts of 173 patients who underwent Holep between 2017 and 2020. Peri and postoperative measures included prostate volume, peak urinary flow rate (Qmax), prostate specific antigen, catheterization time, hospital stay, and complications.

Results: The mean age and mean prostate weight at baseline were 71.3 ± 7.8 years and 64.2 g (17 and 380 g), respectively. Holep was associated with a short catheterization time and hospital stay (2.7 and 3 days, respectively). Qmax significantly improved after Holep (8.1 vs 20.4 ml/s, $p < 0.05$), and results sustained at 06 months postoperatively. Perioperative and postoperative complications were mainly represented by hematuria (29%). However, more than half of these patients were taking anticoagulation drug therapy at the time of surgery. Complications mostly occurred during the early years following Holep's introduction and tended to decrease with time and experience.

Conclusion: Holep remains a safe and effective procedure for BPH treatment, with durable long-term results even in clinical settings where the procedure is new. The rate of complications, which is associated with the learning curve, improves with time and experience.

Keywords: Holmium laser, Benign prostatic hyperplasia, Safety, Complications

1 Background

Benign prostatic hyperplasia (BPH) is the most common cause of lower urinary tract symptoms (LUTS) affecting men over the age of fifty, and BPH prevalence gradually increases as they age, reaching nearly 80% of men in the ninth decade of life [1, 2]. Remarkable progress has been made in the surgical treatment of BPH in the past decades, with the emergence of cutting-edge laser techniques such as photoselective laser vaporization prostatectomy (PVP) or Holmium laser enucleation of the prostate (Holep) [3]. Today, Holep is widely considered a viable alternative to the conventional surgical techniques [4], namely open prostatectomy and transurethral resection of the prostate (TURP), and is highly recommended by both the American Urology Association (AUA) and the European Association of Urology (EAU) for men with larger prostate volumes than 80 cc [5–7]. As for bladder outlet obstruction (BOO) and long-term functional results, Holep provides comparable symptoms improvements with the previous surgical techniques but has clearly demonstrated its superiority in reducing

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blood loss and hospital stay length [5, 8]. However, the learning curve of this technique represents a real impediment to its widespread use, despite clear evidence of its low morbidity [9–11]. Herein, we report the results of three years' experience with Holep following the introduction of this technique in our institution. The aim of this study was to analyze our results and compare them with the existing literature.

2 Methods

This study is reported according to the strengthening and the reporting of observational studies in epidemiology guidelines (STROBE) [12].

2.1 Study design and period

We retrospectively reviewed medical charts of patients admitted to our institution between March 2017 and February 2020.

2.2 Study population and inclusion criteria

All male patients who underwent BPH surgery utilizing Holep during the study period in our institution were included.

2.3 Equipment and Operative technique

Holep procedure was performed with a 26 Fr resectoscope sheath and a 500 micron laser fiber connected to a Holmium generator (Lumenis). The parameters for prostate enucleation were 100 watts, 50 Hz, and 2 J, while those for hemostasis were 56 watts, 35 Hz, and 1.6 J. The Holep enucleation technique is fully described elsewhere [13]. Enucleated prostate was then morcellated using the Wolf Morcellator. At completion of each procedure, we inserted a double lumen catheter into the bladder. Patients were discharged after catheter removal along with a satisfactory voiding of the bladder. A catheter was reinserted if postoperative urination was not possible, and the removal attempt was conducted by a trained nurse at home or during the postoperative follow-up visit.

2.4 Pre, intra, and postoperative measures

We described pre, intra and postoperative measures including prostate volume (PV), peak urinary flow rate (Qmax), postvoid-residual urine volume (PVR), voiding volume (VV), prostate specific antigen (PSA), catheterization time, hospital stay length, complications rate and incidental of prostate cancer (iPCa). Complications that occurred within the first month of the procedure or after were classified as early and late complications, respectively. All study outcomes were evaluated at 3 and 6 months following the procedure through clinical interviews, uroflowmetry, and post-void residual measurements. A successful procedure consisted of the following: complete prostate enucleation and morcellation, a satisfactory bladder voiding after catheter removal and absence of complications including hematuria, urinary tract infection and urinary incontinence [7]. After three months of satisfactory postoperative outcomes, patients were no longer systematically examined.

2.5 Statistical analysis

Appropriate descriptive statistics were used to describe all variables related to baseline characteristics, intra and postoperative measures of patients who underwent Holep. Continuous variables are expressed as means (SD) and medians (IQR), and categorical variables as numbers and percentages. Pre and postoperative measures were compared using paired samples t-test, with the level of significance accepted as $p<0.05$. Data analysis was performed using Epi-Ifo version 7. Because the purpose of this study was purely descriptive, no further multivariable analysis was performed.

2.6 Ethical considerations

This study was approved by Département d'Information Médicale (DIM), and the Ethics review board of our institution. Given the anonymized nature of the data, the need for individual consent was waived.

3 Results

3.1 Preoperative baseline characteristics

We analyzed medical charts of 173 patients who underwent Holep during the study period. The mean age of the included patients was 71.3 ± 7.8 years, with extremes of 51 and 93 years. A total of 79.8% ($n=138$) of patients were between the ages of 60 and 79. There were 3.5% of patients ($n=6$) with prostate surgery history, including transurethral prostate resection ($n=5$, 2.9%) and greenlight laser prostatic vaporization ($n=1$, 0.6%). Seventy-two (41.6%) patients were taking anticoagulation drug therapy at the time of the surgery. Medical treatment failure and acute urinary retention following first trial without catheter (TWOC) represented the main indication of BPH surgery. Table 1 displays preoperative baseline characteristics of study participants.

3.2 Intra and postoperative measures

Table 2 presents the intra and postoperative measures of study participants. The mean prostate volume before Holep and the mean PSA were 64.2 g (17–380 g) and 4.1 ng/ml (0.1–32.6 ng/ml), respectively. Qmax significantly improved after Holep procedure at 3 months, and results sustained at 06 months postoperatively (8.1 vs 20.6 ml/s, $p<0.05$). Catheterization time lasted between one and two days in 67% of patients ($n=116$). One

Table 1 Preoperative baseline characteristics

Total number of included patients, *N*	173
Age, mean (SD)	71.3 (7.83)
Age categories	
50–59	10 (5.8)
60–79	138 (79.8)
80+	25 (14.4)
History of prostatic surgery	6 (3.5)
Diabetes	19 (11)
Hypertension	58 (33.5)
Anticoagulation drug therapy	72 (41.6)
Smoking	35 (20.7)
PSA before procedure, mean (SD)	4.1 (0.1–32.6)
Holep indications	
Medical treatment failure	79 (45.7)
Acute urinary retention after TWOC	48 (22.7)
Obstructive acute kidney injury	22 (12.7)
Bladder stone	07 (4)
Persistent hematuria	06 (3.5)
Recurrent prostatitis	03 (1.7)
Holep preceding radiotherapy for prostate cancer	07 (4)
Pelviuereteric lithiasis	01 (0.6)

Unless stated otherwise, numbers in table are n, %

Baseline characteristics were defined at study inclusion

SD: Standard deviation

PSA was done prior surgery and is expressed in ng/ml. Numbers in Brackets represent minimum and maximum

Table 2 Intra and postoperative measurements

	Intraoperative	Postoperative
Qmax*	8.1 (2 and 17)	20.4 (3.5 and 38)
PVR	278.7 (0 et 2000)	98.7(0 et 450)
PSA	4.1	1.9
Hemoglobin	13.5	12.3
Prostate volume**	64.2 (17 and 380)	NA
Enucleated prostate volume**	NA	44.8 (7 and 330)
Catheterization time	NA	2.7
Hospital stay	NA	3

Unless stated otherwise, the numbers in the table are mean, (minimum and maximum values)

SD: Standard deviation

NA:Not applicable

Uroflowmetry Qmax unit is ml/s

Post voiding residual PVR is expressed in ml

Prostate specific antigen PSA unit is ng/ml

Hemoglobin unit is g/dl

Prostate volume unit is gram

Catherization post Holep is expressed in days

Hospital stay is expressed is expressed in days

*Intra and postoperative Qmax difference was statistically significant ($p < 0.05$)

**Intra and Postoperative prostate volume corresponds to the volume of prostate before and after enucleation, respectively

patient (0.6%) with only the prostatic median lobe enucleated experienced postoperative voiding failure. Three months following the initial surgery, the latter underwent a second enucleation of his remaining lateral lobes. In total, one hundred thirty-four patients (77.5%) were discharged from the hospital within one to three days. We observed a prolonged postoperative hospital stay beyond three days in twenty-three (59%) patients with hematuria, eleven (28%) patients with bladder retention, four (10%) patients with infectious complications, and one (2.6%) patient with transient ischemic attack. Fourteen patients (8%) were readmitted at the hospital within the first month following surgery, mainly for bladder retention ($n=3$, 1.7%), hematuria ($n=4$, 2.3%) and urogenital infection ($n=7$, 4%).

3.3 Intra, early and late postoperative complications

Table 3 presents complications following Holep surgery. Hematuria was the most frequent complication reported. In 16.8% ($n=29$) of patients with hematuria, more than half ($n=17$) were on anticoagulation drug therapy. As a result, eight patients (4.6%) had to be readmitted to the operating room for hemostasis control and six patients (3.5%) required blood transfusions. Overall, complications mostly occurred at the initiation of Holep in our institution in 2017, and greatly decreased through the years, as showed by the evolution of intraoperative complications represented in Fig. 1.

Thirteen patients (7.5%) reported stress urinary incontinence three months after Holep, which persisted at six and 12 months in eleven patients (6.4%) and six patients (3.5%), respectively. These patients with persistent stress urinary incontinence had a mean age of 69.4 years (63 and 79 years) and mean prostate volume of 70.4 g (22 and 120 g, with larger volume in four patients). Although most of them were treated with anticholinergics along with pelvic-floor rehabilitation ($n=17$, 9.8%), two patients had suburethral slings implantation surgery (four Virtue arms) at 18 and 23 months following HoLEP and display good functional long-term results.

Postoperative dysuria was reported in one patient (Qmax 3.5 ml/s) due to the presence of a free prostatic lobule trapped in the membranous urethra, which was removed 3 months after the procedure. Urethral stricture was observed in six patients (3.5%), primarily located in the bulbar urethra ($n=5$) and in the urethral meatus ($n=1$). These patients were treated with endoscopic internal urethrotomy ($n=3$) and urethral calibration ($n=3$).

One patient had developed a 30° ventral penile curvature during the first three months postoperatively. Two patients underwent TURP for obstructive residual adenomatous lobule at 24 and 41 months. Bladder neck

Table 3 Intra and postoperative complications

*Intraoperative complications**	
Capsular perforation	21 (12.1)
Bladder trigone detachment	4 (2.3)
Superficial bladder mucosal injury	3 (1.7)
Conversion	
Morcellator device malfunction	2 (1.1)
High density of enucleated prostatic tissue	4 (2.3)
Lateral lobules adherent to the prostatic capsular	2 (1.1)
Prostate cavity hemostasis	3 (1.7)
Bulky prostatic tissue retrieved by cystotomy	1 (0.6)
*Early postoperative complications**	
Postoperative Hematuria with clot retention	29 (16.8)
Blood transfusion	6 (3.5)
Extraperitoneal extravasation of irrigation liquid	1 (0.6)
Infectious complications	
Prostatitis	8 (4.6)
Orchiepididymitis	3 (1.7)
Stroke	1 (0.6)
Late postoperative complications	
Persistent urinary incontinence**	13 (7.5)
Urethral stricture	2 (1.1)
Bladder neck sclerosis	4 (2.3)
Ventral penile curvature	1 (0.6)
Reoperation***	6 (3.5)

*Intra and early postoperative complications occurred within 01 month following Holep, while late postoperative complications occurred after 01 month

**Transient urinary incontinence within 03 months post Holep was observed in 23 patients (13.3%) whereas persistent urinary incontinence at 6 and 12 months following Holep was observed in in 11 (6.4%) and 06 (3.5%) patients, respectively. Stress urinary incontinence was the most predominant type: 17 (9.9%), 08 (4.6%) and 4 (2.3%) patients at 3, 6 and 12 months, respectively

***Reoperation included Holep enucleation for remaining lateral lobes 3 months following median lobe enucleation (01 patient, 0.6%), residual prostatic tissue obstructing the membranous urethra (01 patient, 0.6%), recurrent BPH at 24 and 41 months treated by TURP (2 patients, 1.2%) and suburethral sling surgery (2 patients, 1.2%)

sclerosis was observed in four patients (2.3%) between 9 and 36 months and they had undergone a cervico-prostatic incision. The anatomopathological analysis of the morcellation chips made it possible to diagnose twenty iPCa (12%).

4 Discussion

In this descriptive study of 173 patients who underwent HoLEP, we found that this technique was associated with significant Qmax improvement, short bladder catheterization, hospital stay, and could be used independently of prostate size. The rate of complications was relatively high in our study in the first two years following the introduction to our institution and further decreased as much as experience was gained.

Holep is a mini invasive surgical technique indicated in men with moderate to severe LUTS due to benign prostatic hyperplasia, unresponsive to conventional medical treatment [14]. Several lines of evidence have established that Holep is a safe and effective procedure, enabling complete removal of the prostatic adenoma as with prostatectomy, in patients with voluminous prostate size [5–7]. Similarly, it is equally effective as TURP for smaller prostates with the lowest complications rates [10, 15, 16]. Holep significantly improves Qmax and reduces LUTS, all of which have been proven in many reports [17–19]. As a result of the learning curve, Holep-associated complications such as prostate capsular perforation or bladder mucosal damage are likely to occur more frequently when the procedure is newly implemented, but decrease with time and experience [7, 16]. For example, bladder injury and bladder trigone detachment occurred within the first two years of Holep commencement in our institution (Fig. 1), and became less common in the subsequent years. There have been instances in which Holep had to be converted to TURP (1.1% in our study) to complete the surgery, due to the inability to obtain a good cleavage plane between the adenoma and the prostate shell, although Holep conversion to TURP remains a rare occurrence.

One patient (0.58%) underwent an open cystotomy in order to remove a bulky prostate tissue weighing 330 g that had been enucleated in one piece. In that particular situation, open cystotomy is not only faster but also reduces the risk of morcellation injury since, after enucleation, the bulky prostate tissues that have been released into the bladder completely occlude the bladder lumen, challenging the vision and ultimately not allowing a safe fragmentation of the enucleated prostate. Therefore, an open cystotomy is sometimes necessary to facilitate the retrieval of the enucleated tissue, because the morcellation of enucleated adenoma could be unsafe if performed under impaired vision [16].

Bladder injury during morcellation is one of the most feared intraoperative complications, with cumulative incidence ranging from 2.9 to 3.6% [7]. In our study, bladder injury appeared superficial and distant from ureteral meatus. It is well known that superficial bladder injuries display a better prognostic compared to bladder rupture which requires open surgical repair [7]. One of the key elements to prevent bladder injury remains effective and careful hemostasis and fully distended bladder [20], all of which provide a clear vision during enucleation/morcellation, and allow a minimally continuous bladder irrigation postoperatively [10]. It is apparent, however, that a hyperinflated bladder required during morcellation may have been a contributing factor to the extra peritoneal extravasation of the irrigation liquid that we encountered

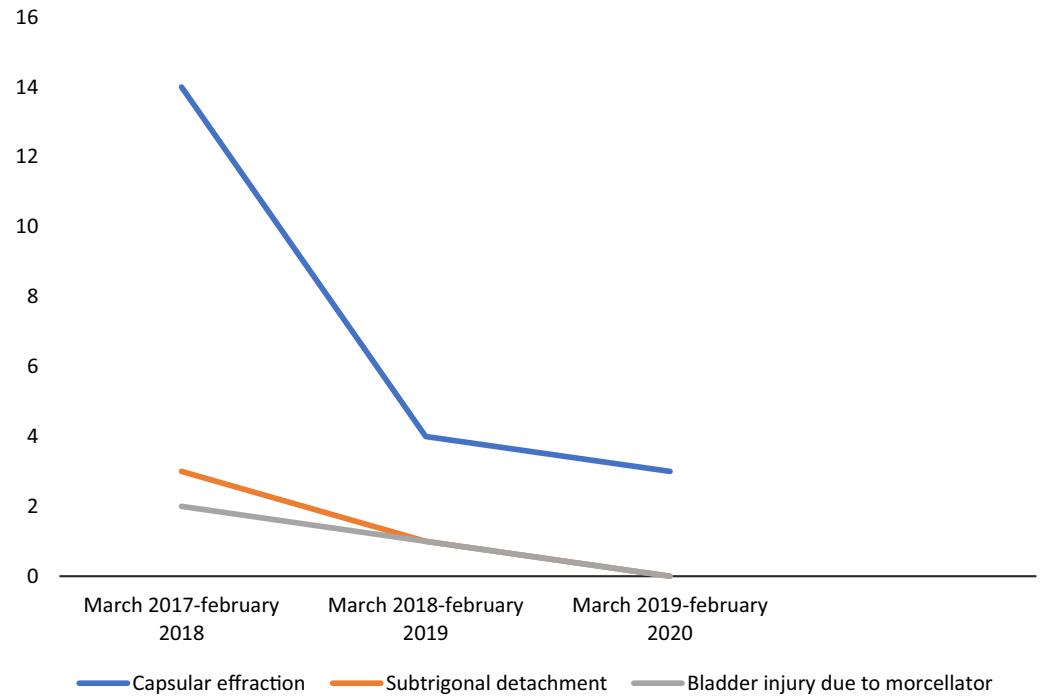

Fig. 1 Evolution of intraoperative complications through years

in this series. While it is often challenging to identify this complication intraoperatively [21], the diagnosis was made afterward in our series, as patients experienced abdominal discomfort, meteorism, and had ultrasound signs. Bladder injury as well as capsular perforation didn't prolong the duration of catheterization.

The blood transfusion rate in our series (3.5%) is comparable to that of the rates reported during TURP in the literature [7]. Post-Holep hematuria increases the length of catheterization and hospital stay, as it requires more frequent irrigations, blood transfusion, and often reoperations. Patients taking anticoagulation medication seemed to be more at risk of this complication during Holep surgery, and therefore represent a dilemma for clinicians [22, 23]. In fact, clinicians may be able to benefit from discontinuing anticoagulation medications prior to Holep, since this ensures better control over hemorrhagic complications. However, it is often impossible to do in real practice, especially in patients with heart valves replacement, as doing so greatly increases the risk of thromboembolic complications [23]. In addition to anticoagulation medication, Prostate volume is another contributing factor to the risk of hemorrhagic complications because surgery for large adenomas increases the time for enucleation and hemostasis [10].

Transient urinary incontinence is common within the first 3 months following Holep, and numerous factors have been implicated, including advanced age, large prostate volume, obesity, traction of the urethral sphincter during the enucleation procedure or tissue damaged by laser energy near the prostatic apex [7, 24, 25]. A meta-analysis reported that the rate of persistent urinary incontinence (after 3 months) is comparable to that of TURP and roughly ranged between 1.5 and 2% [7, 26]. Furthermore, the rate of persistent urinary incontinence despite bladder and pelvic floor rehabilitation in our series (3.5%) is similar to that reported by Ye et al. (3.2%) [27].

Urethral strictures and bladder neck sclerosis are complications associated with prostate surgery, and not specific to HoLEP [7]. The postoperative decrease in the PSA level confirms almost complete elimination of the adenoma after surgery [16, 28].

This study presents several limitations that should be highlighted. Given its descriptive nature, numerous variables were not accounted for in the assessment of Holep safety and effectiveness, including concurrent comorbidities, Holep indications, or sexual function post Holep. While we found a higher rate of hemorrhagic complications in patients who did not

discontinue their anticoagulation treatment, we didn't compare these findings to patients who did. In addition, the absence of control group further limits the interpretation of these findings.

5 Conclusion

Even in clinical settings where it is newly implemented, Holep displays a favorable safety and effectiveness profile, resulting in a significant Qmax improvement, short catheterization time and hospital stay, low complications rate as well as durable long-term results. The rate of complications, which is associated with the learning curve significantly improves with time and experience. Urological surgeons should pay attention to patients with concomitant anticoagulation drug therapy, as they displayed a higher rate of hemorrhagic complications.

Abbreviations

AUA: American association of urology; BPH: Begnin prostatic hyperplasia; BOO: Bladder outlet obstruction; EAU: European association of urology; LUTS: Low urinary tract symptoms; IPCA: Incidental prostate cancer; Holep: Holmium laser enucleation of the prostate; PSA: Prostate specific antigen; PV: Prostate volume; PVR: Post residual urine volume; Qmax: Peak urinary flow rate; Strobe: Strengthening and the reporting of observational studies in epidemiology; TWOC: Trial without catheter; VV: Voiding volume.

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Author contributions

RBM, RB initiated the project. RBM developed and conducted the search. RBM developed the outline and refined the summaries of results, which was revised by RB, JJD, AP, AO, TC, HR, EA, CP and CO. JJD reviewed the appropriateness of the statistical analysis and the whole manuscript. All authors reviewed and provided intellectual contributions to the draft manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

This study was approved by the ethics review board of Centre Hospitalier Saint Louis de La Rochelle.

Consent for publication

Not applicable.

Competing interests

Authors have no conflicts of interest to declare.

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