17 Holmium Laser Enucleation of the Prostate (HoLEP)

John J. Knoedler and Amy E. Krambeck

Introduction

Transurethral resection of the prostate (TURP) is still considered the gold standard treatment for benign prostatic hyperplasia (BPH). However, its current use is limited to small- and medium-sized prostates due to an overall morbidity rate of 15–20 % [1] and blood transfusion rate ranging from 5 to 11 % [2]. Treatment of large-sized prostate glands has been deferred to the suprapubic prostatectomy approach, which is associated with significant immediate postoperative patient morbidity, even using a robotic approach. Patients currently undergoing treatment for BPH are progressively older with more comorbidities; thus, there is an increased need for more minimally invasive procedures in the current treatment era. In an attempt to limit the morbidity associated with standard TURP and or suprapubic prostatectomy, several laser therapies have been introduced for the treatment of BPH, including neodymium:yttrium aluminum garnet (Nd:YAG), the holmium:YAG, and the potassium-titanyl-phosphate (KTP) lasers [3]. These lasers have been used to coagulate, vaporize, and cut prostatic tissue overgrowth using a variety of techniques. The holmium laser has been further developed to allow for actual prostatic lobe enucleation with subsequent tissue removal.

Holmium laser enucleation of the prostate (HoLEP) has emerged as an effective transurethral treatment option for patients suffering from symptomatic BPH of any size [4]. By using the holmium laser to incise the prostate gland, the laser scope to manually enucleate, and the morcellator to remove a large bulk of tissue from the bladder, the suprapubic prostatectomy technique is recreated during the HoLEP procedure without any abdominal or bladder incision. A multitude of publications have supported the safety and efficacy of HoLEP for small- and large-gland BPH [4–20], even in the presence of bleeding diatheses and anticoagulation [17]. HoLEP has been found to be as effective as TURP [7–11, 19] and open suprapubic prostatectomy [5, 7, 16] for the treatment of obstructive BPH, with the benefit of less morbidity. Long-term studies of patients undergoing HoLEP demonstrate sustained relief from BPH symptoms from 4 to 10 years postoperative, with very low retreatment rates, ranging from 0 to 4 % [12, 16, 18, 21, 22].

The efficacy of HoLEP lies in its excellent tissue debulking capabilities. Large case series have shown that HoLEP produces a prostate volume and prostate-specific antigen reduction of 60–90 % [6, 13–15, 18]. Another benefit of HoLEP is the potential to be performed as an outpatient procedure with catheter removal within 24 h of surgery. When compared to contemporary

J.J. Knoedler, MD (✉) • A.E. Krambeck, MD
Department of Urology, Mayo Clinic,
200 First Street SW, Rochester, MN 55905, USA
e-mail: Knoedler.John@mayo.edu

S.L. Best, S.Y. Nakada (eds.), *Minimally Invasive Urology: An Essential Clinical Guide to Endourology, Laparoscopy, LESS and Robotics*,
DOI 10.1007/978-1-4939-1317-6_17, © Springer Science+Business Media New York 2015

ablative procedures, HoLEP has the advantage of actual tissue removal for pathologic specimen examination, greater prostate volume reduction, and durable long-term results, while maintaining low morbidity [23].

Since HoLEP is a laser-based procedure, it is performed using normal saline irrigant, thus eliminating the risk of dilutional hyponatremia, also known as TUR syndrome. Furthermore, since the laser not only incises but also coagulates, it can perform pinpoint control of bleeding vessels as they enter the capsule of the prostate. The precise control of bleeding vessels at the time of transection has nearly eliminated the need for blood transfusion after HoLEP in patients without bleeding diathesis. Evidence demonstrates the feasibility of radical prostatectomy after HoLEP; the concomitant treatment of bladder, ureteral, and renal stones at time of HoLEP; and the limited impact of HoLEP on erectile function [24]. Investigators have reported that once the initial investment for the laser is factored out, HoLEP is more cost-effective compared with TURP and open prostatectomy due to a shorter length of hospitalization and decreased need for ancillary interventions (i.e., blood transfusion and continuous bladder irrigation) [19]. One criticism of the HoLEP procedure is the steep learning curve, which has limited its incorporation into many general urologists' practices. Thus, the focus of the chapter will be to describe the current technique of HoLEP including available equipment, a step-by-step guide to the procedure, and anticipated postoperative recovery and complications.

Current Equipment Used for HoLEP

Equipment List

1. 100 W holmium laser unit
2. 550 μ end-fire laser fiber
3. 30° cystoscope lens
4. Video tower and a freely swinging camera head
5. Normal saline irrigation
6. Continuous flow resectoscope (26–28 F) with modified inner sheath with a stabilizer
7. 6 F stabilizing catheter
8. Van Buren sounds
9. Ellik evacuator
10. Offset rigid nephroscope
11. 5 mm tissue morcellator
12. Alligator grasper
13. 20 F catheter with mandarin guide

The holmium laser is a pulsed solid-state laser with a wavelength of 2.140 nm. Unlike other available laser systems, the holmium laser is a contact laser with a depth of penetration in prostatic tissue of only 0.4 mm. The laser is highly absorbed by water (absorption peak of water: 1.940 nm), which makes up 60–70 % of the prostate [24]. This water absorption produces an energy density that heats the prostatic tissue to greater than 100° Celsius [3]. With such high heats created, the tissue is vaporized without deep coagulation for a "what you see is what you get" effect, eliminating delayed tissue sloughing. The holmium laser produces very little char effect, which allows the laser to precisely cut and dissect tissue it is in direct contact with without obscuring surgical planes. When the laser is not in direct contact with the tissue, it can dissipate heat causing coagulation of vessels to a depth of 2–3 mm [3]. The holmium laser is a multipurpose laser and can be used not only for tissue cutting (as in the treatment of urinary strictures) and coagulation (treatment of urothelial tumors) but also for fracturing of stones [5, 25, 26]. To perform HoLEP in an efficient manner, a high-powered laser is necessary and, in general, the 100 W VersaPulse holmium laser (Lumenis, Santa Clara, CA) is used (Fig. 17.1).

The holmium laser energy can be transmitted along flexible quartz fibers of varying diameters, ranging from 200 to 100 μm. The ability to use multiple-sized fibers allows the holmium laser to be used with not only a cystoscope but also rigid and flexible ureteroscopes. In general, a larger laser fiber is necessary to perform HoLEP, and the 550 μm end-fire fiber is generally preferred (Fig. 17.2). Several different companies offer both disposable and reusable quartz laser fibers. The ability to sterilize and reuse the laser fibers up to 20–30 uses gives HoLEP a theoretical economical advantage over other prostate laser treatments [24]. When performing HoLEP, the laser fiber is routinely stripped of its protective cladding, over several inches, and then placed through a 6 Fr stabilizing catheter (Cook, Spencer, IN). The catheter is secured in place with a Luer-Lok injection port (Baxter, Deerfield, IL).

Fig. 17.1 The 100 W VersaPulse holmium laser used to perform HoLEP

Two different companies provide laser scopes that can be used to perform HoLEP. Olympus (Hamburg, Germany) has a 27 Fr continuous flow resectoscope with a modified inner sheath that incorporates a laser fiber channel and bridge (Fig. 17.3) (we utilize the Olympus scope), and Storz (Tuttlingen, Germany) manufactures two different-sized continuous flow laser scopes to perform HoLEP: a 26 Fr instrument with a dedicated inner sheath and stabilizing guide and a 28 Fr instrument with a dedicated inner sheath and stabilizing ring. Regardless of laser scope used to perform HoLEP, a 30° lens is necessary to adequately visualize the prostate and laser fiber. Due to the extreme hand movements necessary to perform HoLEP, an endoscopic camera with a swivel base is necessary, as direct use of the eyepiece is neither feasible nor safe. High-definition video systems such as those provided by Stryker (Kalamazoo, MI) and Olympus (Hamburg, Germany) make visualization of the plane between capsule and adenoma much easier, but are not necessary to perform the procedure. Since HoLEP is a laser-based therapy, normal saline irrigation is used in all cases.

Once enucleation of the prostate has been completed, the tissue must be removed using a tissue morcellator. To introduce the tissue morcellator, the inner working elements of the laser scope are removed leaving only the outer sheath and replaced with a modified offset long 26 Fr nephroscope with

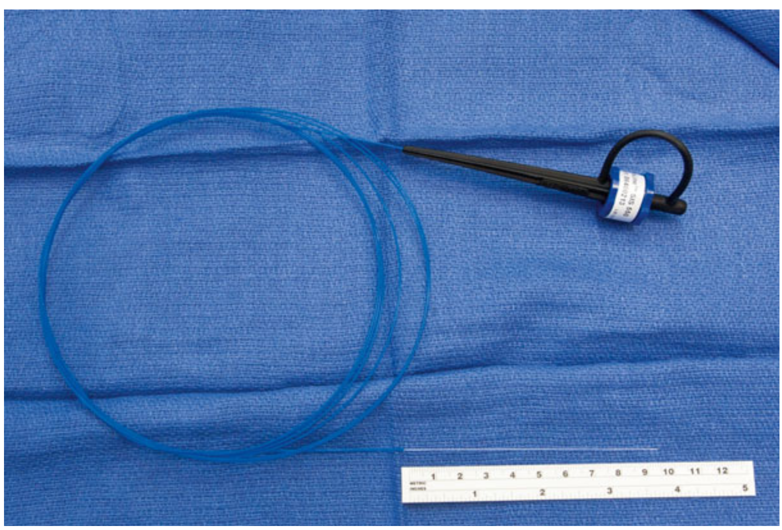

Fig. 17.2 The 550 µm quartz laser fiber used to perform HoLEP

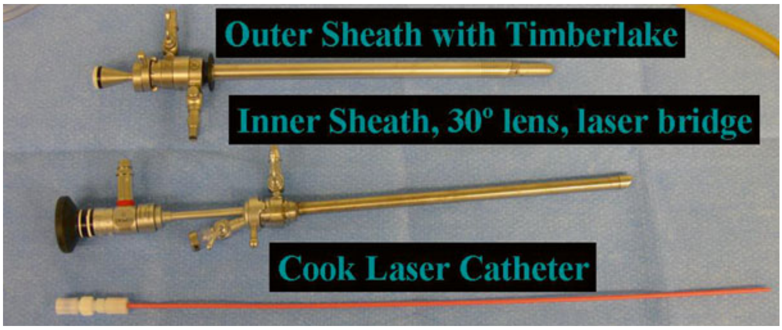

Fig. 17.3 The disassembled laser scope and protective laser catheter. The device shown is the Storz 28 Fr set consisting of a 28 Fr outer sheath, inner sheath with stabilizing ring, and 30° telescope lens. The laser catheter fits through the working element of the scope and is held in place by the stabilizing ring

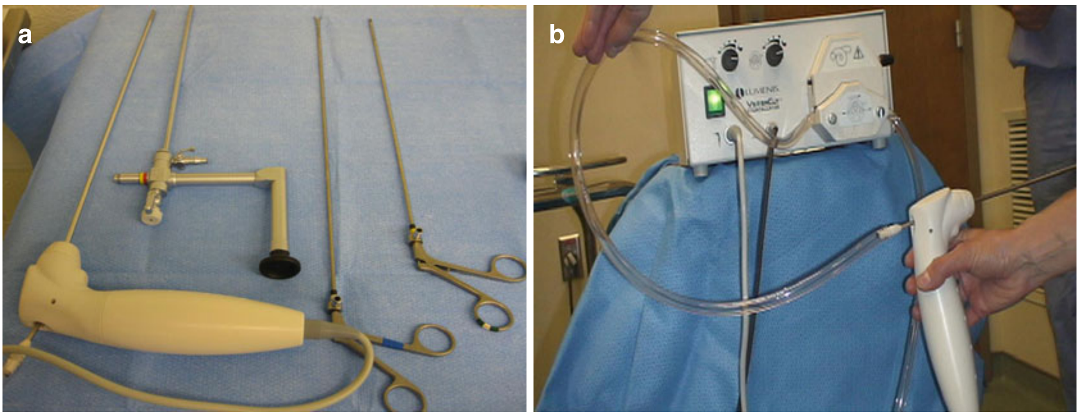

Fig. 17.4 (**a**) The long nephroscope shown here has a 5 mm working channel which permits passage of the morcellator as well as grasping forceps. The grasping forceps can be used to remove small fragments rather than morcellating. (**b**) The Lumenis VersaCut morcellator has a pump suction device which allows for simultaneous removal of the prostate tissue at time of morcellation

a 5 mm working channel (Olympus or Storz). The tissue morcellator is then introduced through the 5 mm working channel (Fig. 17.4a). The VersaCut morcellator (Lumenis) consists of a hand piece with reciprocating blades and controller box with suction pump and is operated solely by a foot pedal (Fig. 17.4b). Partial depression of the foot pedal produces suction only, and complete depression allows for movement of the morcellator blades with suction. Due to the intense suction produced by the morcellator, it is important to have two water inflows through the nephroscope to keep the bladder distended, preventing inadvertent damage by the morcellator. The Richard Wolf company (Vernon Hills, IL) has also developed a morcellator, the Piranha. This morcellator has separate controls for suction and morcellation and is run by a trigger handpiece. Comparison of the two morcellators has demonstrated excellent tissue removal; however, in ex vivo testing, the Lumenis morcellator was more efficient at tissue removal [27]. After all the tissue is removed, a standard urethral catheter is placed for at least 6 h or until hematuria has decreased to an acceptable amount.

HoLEP: Step By Step

Preoperative Evaluation

Prior to undergoing HoLEP, patients should have an appropriate preoperative evaluation. Though work-up may be tailored to the individual patient, this should typically include a patient history, AUA symptom score (or appropriate validated metric), and urinary flow with post-void residual. Laboratory evaluation including complete blood count (CBC), electrolytes with creatinine, and serum PSA should be obtained. In general, patients should undergo a preoperative cystoscopy and prostate ultrasound for operative planning. The cystoscopy is particularly important to rule out other causes of urinary obstruction such as urethral stricture disease and also assess for other pathology such as bladder calculi or tumor. The prostate ultrasound is beneficial for operating room planning time since size of the prostate dictates case duration. If the patient suffers from severe urgency frequency or has other neurologic comorbidities, a full urodynamic study can be beneficial in differentiating between significant detrusor instability and bladder outlet obstruction.

As with any surgical procedure, a detailed informed consent is mandatory. Though the risk of clinically significant bleeding is relatively low, even in the setting of anticoagulation or bleeding diathesis [17], the possibility of transfusion should be discussed. Patients should be informed of the risks, both short term and long term of both stress and urge urinary incontinence, and the possibility of ongoing urinary retention particularly in those patients who presented with preoperative urinary retention [21]. Patients should also be counseled on the small but real risk of urethral and bladder injury which can occur at time of dilation or morcellation. The series by Krambeck et al. notes frequent inconsequential bladder mucosal injury, but only one full-thickness injury requiring repair out of 1,065.

Operative Preparation

Patients are positioned in the dorsal lithotomy position and induced with general endotracheal anesthesia. The urethra is calibrated to 28 or 30 F depending on the cystoscope set used, taking care to dilate only the anterior urethra and not disrupt the prostatic urethra. The continuous flow resectoscope sheath is placed with the Timberlake obturator, and then the operating laser scope with 6 F laser stabilizing catheter is placed. A 550 μ laser fiber is stripped of its most distal cladding over 2–3 in. and placed through the laser stabilizing catheter. Normal saline irrigation is used, thus preventing TUR syndrome, and the outflow tract of the continuous flow resectoscope is attached to tubing that drains to gravity over the trap.

Assessment of Anatomy and Creation of Posterior Plane

Once the resectoscope is placed, the anatomy of the patient is assessed. Ideally, the surgeon should be aware of any important variations, such as a large median lobe preoperatively. Attempt is made to visualize the ureteral orifices; however, these may be obscured by prostatic intrusion into the bladder, particularly with a large median lobe. The surgeon must then decide whether bilobar or trilobar hypertrophy exists and whether a median lobe must be enucleated separately.

If a significant median lobe is present, the surgeon begins by incising at the 5 or 7 o'clock positions at the bladder neck and carrying the incision towards the apex, stopping before the verumontanum (Fig. 17.5). The laser is set at 2

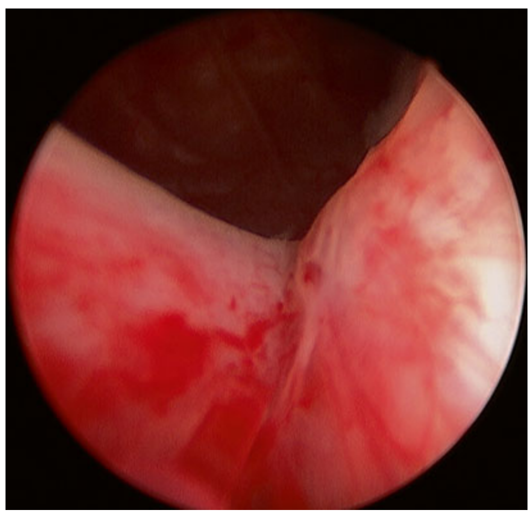

Fig. 17.5 View of the initial posterior incision, starting at the 6 or 5 and 7 o'clock position depending on the presence of a median lobe

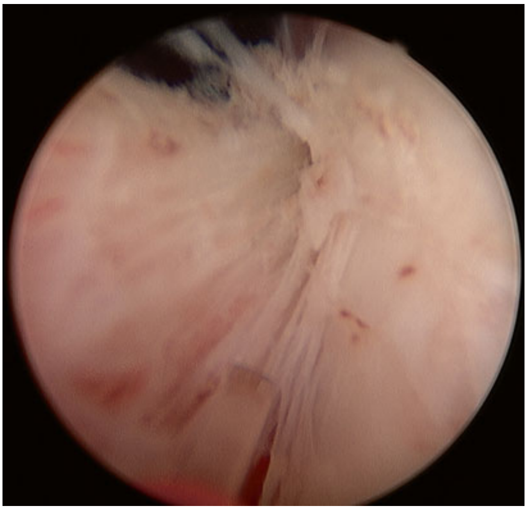

Fig. 17.6 Circular fibers at the bladder neck, identifying the capsule

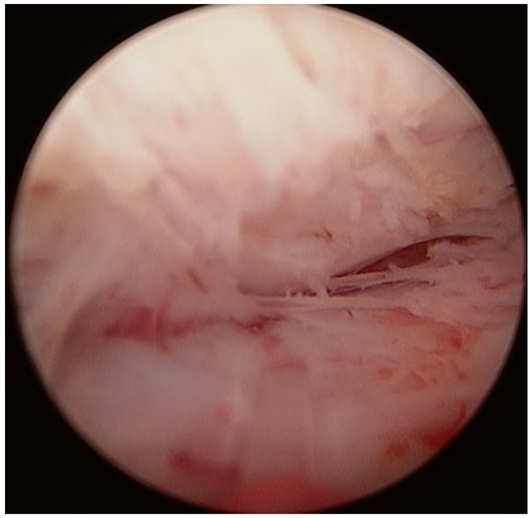

Fig. 17.7 The cobweb appearance with separation of the adenoma from the prostatic capsule

Joules (J) and 40 or 50 Hertz (Hz). The initial groove created by the incision is deepened until the capsule is reached, which can be identified most readily by circular fibers near the bladder neck (Fig. 17.6). This depth near the bladder neck should be familiar to surgeons with experience with TURP or photoselective vaporization of the prostate and serves as a landmark to establish depth. By gently moving the nose of the scope in the horizontal plane, the groove can be widened to help identify the capsule. A second identical incision is then made at either the 5 or 7 o'clock position of the bladder neck, on the opposite side of the median lobe. Once both bladder neck incisions are developed, the surgeon then begins to undermine the median lobe. The laser is moved transversely to connect the plane between the two lateral groves along the apex of the median lobe. The resection is then gradually carried proximally, using the beak of the scope to lift the adenoma upward into the lumen of the prostatic urethra, establishing tissue traction and working space for the laser to cut underneath. The proper plane should demonstrate a cobweb appearance with separation of the adenoma from the prostatic capsule (Fig. 17.7). The plane of this resection gradually slopes upward as the resection is carried towards the bladder neck. Once arrived proximally, the adenoma of the median lobe is separated and pushed into the bladder. When separating the adenoma from the bladder neck, the surgeon must take care to dissect closely to the bladder neck fibers. If the plane is too superficial, the dissection will track up the back of the adenoma leaving a large piece of tissue at the bladder neck, and if the dissection is too deep, the trigone can be undermined. Furthermore, care should be taken to avoid inadvertent injury to the ureteral orifices or back wall of the bladder as the adenoma is separated from the bladder neck. This can be accomplished by insuring the adenoma is not pushed back against the bladder wall, but is rather balanced in an upright position in the bladder.

If the median lobe is small or moderately sized, it does not need to be enucleated separately. A single posterior groove can be made at either the 5, 6, or 7 o'clock position depending on the anatomy of the prostate. The median lobe or posterior tissue is then enucleated with the lateral lobe tissue.

Enucleation of Lateral Lobes

After enucleation of the median lobe, or the single posterior incision if a formal median lobe enucleation is not performed, attention is then

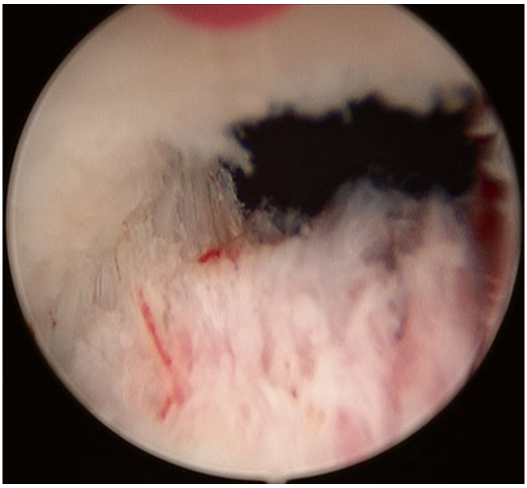

Fig. 17.8 The anterior plane of dissection carried from the 10 to 2 o'clock position through the bladder mucosa so that the scope enters the lumen of the bladder, note the laser fiber and capsule superiorly and the adenoma inferiorly

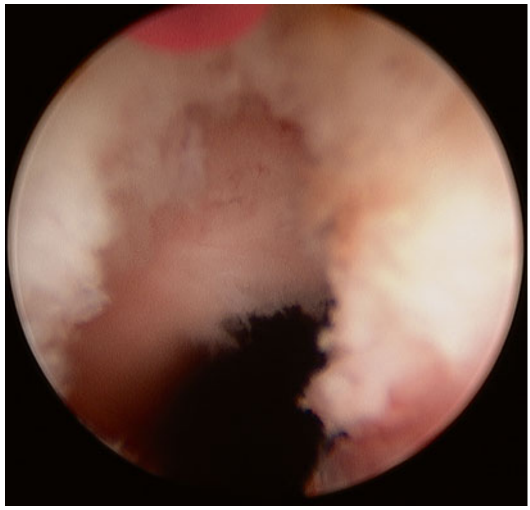

Fig. 17.9 The two lobes are divided by repositioning the scope in the prostatic urethra and dividing the anterior commissure at the 12 o'clock position

turned to the lateral lobe tissue. The lateral lobes are enucleated individually, beginning at the apex just proximal and lateral to the verumontanum, to avoid injury to the sphincter. A superficial incision of the mucosa is created by making a short horizontal cut, just enough to allow entrance of the beak of the scope. The laser energy can then be decreased to 2 J and 20 Hz to limit potential collateral damage to the sphincter. The scope is then gently rotated around the apex of the adenoma using mainly blunt dissection and limited lasering until the scope is positioned in the 12 o'clock position, with capsule residing above the scope and adenoma below. The laser energy is then increased to the initial starting settings of 2 J and 40 or 50 Hz. The anterior plane of dissection is then carried towards the bladder neck, utilizing the scope to push down the adenoma separating it from the capsule above. The laser is used to separate attachments and control any bleeding vessels. The anterior plane of dissection is carried from the 10 to 2 o'clock position through the bladder mucosa so that the scope enters the lumen of the bladder (Fig. 17.8).

The two lobes are then divided by repositioning the scope in the prostatic urethra and dividing the anterior commissure at the 12 o'clock position (Fig. 17.9). The incision is carried from the bladder neck to the apex into the space previously created by the anterior dissection, checking to ensure that this does not carry into the sphincter.

Once the lobes are divided, the mucosal strip of tissue attaching the adenoma to the area of the sphincter must be divided. The encircle technique is performed by positioning the scope inverted at the 12 o'clock position near the bladder neck. The scope is then rotated around the outer edge of the adenoma while hugging the capsule until it is oriented appropriately in the 6 o'clock position. The mucosal strip is now positioned to one side of the scope and the sphincter on the other. The scope is then pulled distally to allow the strip to fall in front of the scope where it can be transected safely without concern for sphincter injury.

After the division of the mucosal strip, the remainder of the lobe is enucleated by joining the lateral and posterior planes working distally towards the bladder neck. Once the adenoma is nearly completely detached, the adenoma is pushed into the bladder using the beak of the scope. The final attachments at the bladder neck are severed, and the adenoma is freed into the bladder (Fig. 17.10). Attention is then turned

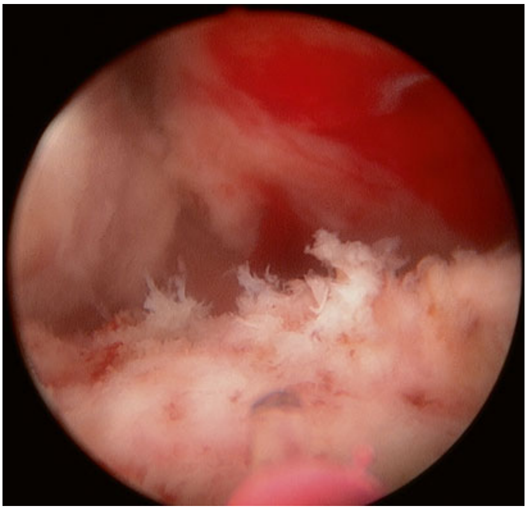

Fig. 17.10 View of the enucleated lateral lobes pushed into the bladder

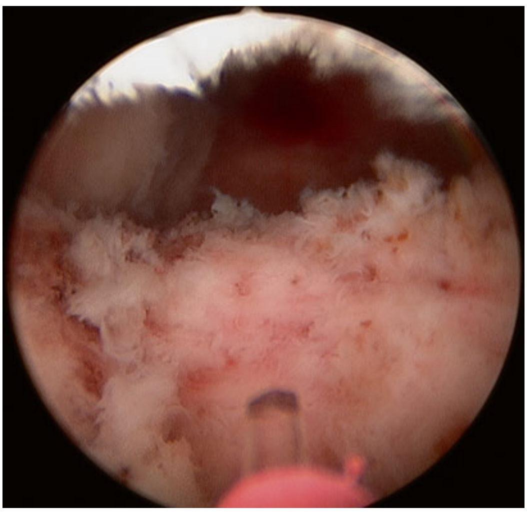

Fig. 17.11 View of the widely opened prostatic fossa

to the contralateral lobe, which is dissected in a similar fashion. At the conclusion, a widely patent prostatic fossa can be visualized (Fig. 17.11).

Once the enucleation is completed, hemostasis must be achieved. Though the holmium laser does an excellent job at sealing small vessels during enucleation, it is typically necessary to control small bleeders. This is accomplished by pulling the tip of the laser fibers a few millimeters away from the tissue, to provide a more coagulative effect. Taking time to achieve adequate hemostasis will improve visualization during morcellation.

Following enucleation, the resected tissue is removed using a tissue morcellator. As mentioned earlier, the inner working elements of the laser scope are removed and replaced with a modified offset long 26 Fr nephroscope with a 5 mm working channel. The tissue morcellator is then introduced through the 5 mm working channel. The morcellator uses a combination of suction and cutting blades to remove the tissue; therefore, care must be taken to have high fluid flow through the scope, as the suction can rapidly deflate the bladder and rapidly bring the bladder wall into the proximity of the morcellator, causing serious injury. Once the bulk of the tissue is removed, any small residual fragments can be grasped with an alligator forceps or flushed from the bladder using an Ellik.

Finally, a 20 F catheter is placed over a mandarin catheter guide. Continuous bladder irrigation may be necessary depending on the degree of hematuria noted. To improve bladder neck hemostasis, some tension may need to be applied to the catheter for a brief period of time. The catheter is typically maintained overnight and removed the following day. Patients must be able to void after catheter removal, and post-void residual volume checked to ensure there is no urinary retention.

Anticipate Post-op Results

Since the HoLEP procedure is a complete debulking of the prostate, it is of little surprise that durable long-term outcomes are possible. Naspro and colleagues recently reviewed the literature for HoLEP and reported durable results at a mean follow-up of 43.5 months. They found a mean post-procedure Qmax of 21.9 ml/s and mean reoperative rate of 4.3 % (range 0–14.1 %) [24]. The authors also noted a significant mean decrease in serum PSA levels from baseline (mean 63–1.63 ng/dl, postoperatively) and transrectal ultrasound prostate volume (mean: from 68 to 27.2 ml, postoperatively). At longest follow-up, the overall re-intervention rate was low at 0–5.4 %.

The group from Methodist Hospital in Indianapolis, Indiana, evaluated their experience with over 1,000 HoLEP procedures performed [21]. The mean preoperative transrectal ultrasound prostate volume was 99.3 g (range 9–391), American Urological Association (AUA) symptom score 20.3 (1–35), and Qmax 8.4 cc/s (1.1–39.3). Overall complication rates were low, occurring in only 2.3 % of the cohort. Mean follow-up was 287 days, ranging from 6 days to 10 years. At most recent follow-up, the mean AUA symptom score was 5.3, and Qmax was 22.7 cc/s. Only 3 (0.3 %) of patients were in urinary retention and the authors site that all three patients had findings consistent with an atonic bladder, not obstruction. Only one patient underwent a second HoLEP procedure for bleeding prostatic regrowth, not obstruction. Urethral stricture and bladder neck contractures occurred in less than 2 % of the cohort. Similarly, Elmansy et al. report rates of stricture and bladder neck contracture at 10-year follow-up of 0.8 and 1.6 %, respectively [22].

Despite durable long-term results, immediately postoperatively patients undergoing HoLEP can experience mild to moderate storage symptoms in the form of urgency and even urge incontinence. By 1 month postoperatively, the symptoms are present in approximately 30 % of patients and by 3 months only 10 % [24]. The symptoms respond well to anticholinergic therapies and pelvic floor exercises, and in general are self-limiting. The series of over 1,000 HoLEP procedures reports a less than 5 % overall incontinence rate at long term [21]. Elmansy et al., in a review of 949 patients over 10 years, found that presence of diabetes mellitus, larger volume prostate gland, and a greater reduction in postoperative PSA were all predictive of postoperative stress urinary incontinence [28]. Other potential complications that can occur at the time of surgery or in the immediate postoperative period are hematuria, clot retention, bladder or urethral injury, and any complication that can occur from general anesthesia (Table 17.1).

Table 17.1 Complications of HoLEP among a series with 10-year follow-up [21]

Complication	Occurrence (%)
Bladder perforation	0.1
Clinically significant hematuria	0.7
Urethral stricture	2.3
Bladder neck contracture	1.5
Significant short-term stress incontinence	12.5
Significant short-term urge incontinence	11.5
Significant long-term stress incontinence	1.8
Significant long-term urge incontinence	1.5
Re-resection due to adenoma regrowth	0.1
Persistent urinary retention[a]	0.03

[a]Three total patients, including two with documented atonic bladder and 1 who developed neurogenic bladder following HoLEP due to spinal cord injury

HoLEP appears to have limited impact on sexual function, similar to TURP and open suprapubic prostatectomy [24]. No difference in IIEF erectile function domain scores has been observed pre to 2 years postoperatively. However, patients should be counseled on the development of retrograde ejaculation, which has been noted in over 75 % of patients followed over 6 years and can affect patient sexual satisfaction [12].

Summary

This chapter has outlined the utility of holmium laser enucleation of the prostate as supported by the literature, provided a guide to performing HoLEP including the standard required equipment, and reviewed the anticipated postoperative results of the procedure. HoLEP is a safe, effective, minimally invasive surgical treatment of BPH. It has demonstrated durable results, with such a significant degree of de-obstruction that subsequent surgical revision is rare. With a relatively low morbidity compared to standard TURP and the ability to resect large volumes of tissue, HoLEP continues to evolve into a new gold standard for the treatment of BPH.

References

1. Mebust WK, Holtgrewe HL, Cockett AT, Peters PC. Transurethral prostatectomy: immediate and postoperative complications. a cooperative study of

13 participating institutions evaluating 3,885 patients. 1989. J Urol. 2002;167(2 Pt 2):999–1003.
2. AUA Practice Guidelines Committee. AUA guideline on management of benign prostatic hyperplasia (2003). Chapter 1: diagnosis and treatment recommendations. J Urol. 2003;170(2 Pt 1):530–47.
3. Kuntz RM. Current role of lasers in the treatment of benign prostatic hyperplasia (BPH). Eur Urol. 2006;49(6):961–9.
4. Tooher R, Sutherland P, Costello A, Gilling P, Rees G, Maddern G. A systematic review of holmium laser prostatectomy for benign prostatic hyperplasia. J Urol. 2004;171(5):1773–81.
5. Kuntz RM, Lehrich K. Transurethral holmium laser enucleation versus transvesical open enucleation for prostate adenoma greater than 100 gm.:: a randomized prospective trial of 120 patients. J Urol. 2002;168(4 Pt 1):1465–9.
6. Matlaga BR, Miller NL, Lingeman JE. Holmium laser treatment of benign prostatic hyperplasia: an update. Curr Opin Urol. 2007;17(1):27–31.
7. Kuntz RM, Ahyai S, Lehrich K, Fayad A. Transurethral holmium laser enucleation of the prostate versus transurethral electrocautery resection of the prostate: a randomized prospective trial in 200 patients. J Urol. 2004;172(3):1012–6.
8. Ahyai SA, Lehrich K, Kuntz RM. Holmium laser enucleation versus transurethral resection of the prostate: 3-year follow-up results of a randomized clinical trial. Eur Urol. 2007;52(5):1456–63.
9. Montorsi F, Naspro R, Salonia A, Suardi N, Briganti A, Zanoni M, et al. Holmium laser enucleation versus transurethral resection of the prostate: results from a 2-center, prospective, randomized trial in patients with obstructive benign prostatic hyperplasia. J Urol. 2004;172(5 Pt 1):1926–9.
10. Gilling PJ, Mackey M, Cresswell M, Kennett K, Kabalin JN, Fraundorfer MR. Holmium laser versus transurethral resection of the prostate: a randomized prospective trial with 1-year followup. J Urol. 1999;162(5):1640–4.
11. Wilson LC, Gilling PJ, Williams A, Kennett KM, Frampton CM, Westenberg AM, et al. A randomised trial comparing holmium laser enucleation versus transurethral resection in the treatment of prostates larger than 40 grams: results at 2 years. Eur Urol. 2006;50(3):569–73.
12. Gilling PJ, Aho TF, Frampton CM, King CJ, Fraundorfer MR. Holmium laser enucleation of the prostate: results at 6 years. Eur Urol. 2008;53(4):744–9.
13. Kuo RL, Kim SC, Lingeman JE, Paterson RF, Watkins SL, Simmons GR, et al. Holmium laser enucleation of prostate (HoLEP): the Methodist Hospital experience with greater than 75 gram enucleations. J Urol. 2003;170(1):149–52.
14. Elzayat EA, Habib EI, Elhilali MM. Holmium laser enucleation of the prostate: a size-independent new "gold standard". Urology. 2005;66(5 Suppl):108–13.
15. Elzayat EA, Elhilali MM. Holmium laser enucleation of the prostate (HoLEP): the endourologic alternative to open prostatectomy. Eur Urol. 2006;49(1):87–91.
16. Kuntz RM, Lehrich K, Ahyai SA. Holmium laser enucleation of the prostate versus open prostatectomy for prostates greater than 100 grams: 5-year follow-up results of a randomised clinical trial. Eur Urol. 2008;53(1):160–6.
17. Elzayat E, Habib E, Elhilali M. Holmium laser enucleation of the prostate in patients on anticoagulant therapy or with bleeding disorders. J Urol. 2006;175(4):1428–32.
18. Elzayat EA, Elhilali MM. Holmium laser enucleation of the prostate (HoLEP): long-term results, reoperation rate, and possible impact of the learning curve. Eur Urol. 2007;52(5):1465–71.
19. Fraundorfer MR, Gilling PJ, Kennett KM, Dunton NG. Holmium laser resection of the prostate is more cost effective than transurethral resection of the prostate: results of a randomized prospective study. Urology. 2001;57(3):454–8.
20. Kuo RL, Paterson RF, Kim SC, Siqueira Jr TM, Elhilali MM, Lingeman JE. Holmium Laser Enucleation of the Prostate (HoLEP): A Technical Update. World J Surg Oncol. 2003;1(1):6.
21. Krambeck AE, Handa SE, Lingeman JE. Experience with more than 1,000 holmium laser prostate enucleations for benign prostatic hyperplasia. J Urol. 2013;189(1 Suppl):027.
22. Elmansy HM, Kotb A, Elhilali MM. Holmium laser enucleation of the prostate: long-term durability of clinical outcomes and complication rates during 10 years of followup. J Urol. 2011;186(5):1972–6.
23. Aho TF, Gilling PJ. Current techniques for laser prostatectomy–PVP and HoLEP. Arch Esp Urol. 2008;61(9):1005–13.
24. Naspro R, Bachmann A, Gilling P, Kuntz R, Madersbacher S, Montorsi F, et al. A review of the recent evidence (2006–2008) for 532-nm photoselective laser vaporisation and holmium laser enucleation of the prostate. Eur Urol. 2009;55(6):1345–57.
25. Wheelahan J, Scott NA, Cartmill R, Marshall V, Morton RP, Nacey J, et al. Minimally invasive laser techniques for prostatectomy: a systematic review. The ASERNIP-S review group. Australian Safety and Efficacy Register of New Interventional Procedures–Surgical. BJU Int. 2000;86(7):805–15.
26. Wilson LC, Gilling PJ. From coagulation to enucleation: the use of lasers in surgery for benign prostatic hyperplasia. Nat Clin Pract Urol. 2005;2(9):443–8.
27. Cornu JN, Terrasa JB, Lukacs B. Ex-vivo comparison of available morcellation devices during Holmium laser enucleation of the prostate through objective parameters. J Endourol. 2012; Epub ahead of print.
28. Elmansy HM, Kotb A, Elhilali MM. Is there a way to predict stress urinary incontinence after holmium laser enucleation of the prostate? J Urol. 2011;186(5):1977–81.