Holmium Laser Enucleation of the Prostate With Tissue Morcellation: Initial United States Experience

JEFFREY A. MOODY, M.D., and JAMES E. LINGEMAN, M.D.

INTRODUCTION

BENIGN PROSTATIC HYPERPLASIA (BPH) affects 70% of men over age 70 and is a significant cause of morbidity in this population. Endoscopic surgery for BPH has evolved over the past decade with technological advances that offer significant advantages in perioperative and postoperative morbidity and hospital stay. One of the technological advances has been the holmium laser, a multifunction tool in urology that can be used for intracorporeal lithotripsy, stricture and ureteropelvic junction incision, excision and ablation of urothelial tumors or condylomata, and resection/vaporization of prostatic adenomatous tissue. We report the initial use in the United States of the holmium laser with transurethral tissue morcellation for the endoscopic treatment of BPH.

The surgical technique for the use of the holmium laser in the treatment of BPH has evolved over the past 5 years, due in large part to the work of Gilling and associates. Initially, the holmium laser energy was used in concert with Nd: YAG energy to vaporize and coagulate tissue, and the procedure was termed "combination endoscopic laser ablation of the prostate" or CELAP. Unfortunately, many of the irritative voiding symptoms experienced by patients undergoing visual laser ablation of the prostate (VLAP) with the Nd: YAG laser were also seen using the dual-laser technique. Vaporization alone was next used with holmium energy (holmium laser ablation of the prostate, or HoLAP) with excellent voiding results and low rates of transfusion, but the time required to vaporize significant volumes of adenoma was excessive. Using the holmium laser to resect the prostate into its anatomic lobes (HoLRP) was the next step in the development of the technique. This method also provided excellent results, but the issue of how to remove the large adenomas from the bladder after resection was unresolved. Development of a transurethral tissue morcellator now allows efficient removal of adenomatous tissue of any size. The technique has progressed to a true anatomic enucleation, similar to an endoscopic open prostatectomy, abbreviated HoLEP (holmium laser enucleation of prostate), which is the procedure on which this work is based.

The surgical advantages of HoLEP compared with standard transurethral electrosection (TURP) are in the areas of blood loss and electrolytic effects of irrigant. The laser technique is hemostatic, allowing operation in a virtually bloodless field, and decreases or eliminates the need for postoperative bladder irrigation. Consequently, catheters may be removed earlier, length of stay is decreased, and return to normal activity is hastened. The reported blood transfusion rate is 1 per 1000 procedures. Additionally, patients with altered coagulation profiles from therapeutic or pathologic etiologies may undergo HoLEP without increased bleeding complications.

Because thermal energy is the mechanism through which the holmium laser works, physiologic irrigants, such as normal saline, may be used for HoLEP. The use of normal saline eliminates the risk of dilutional hyponatremia and potential TUR syndrome. The combination of the hemostatic capabilities of the holmium laser and transurethral tissue morcellation allow enucleated adenoma of very large size to be removed effectively from the bladder, offering a possible alternative to open prostatectomy. In this work, we review the first 61 HoLEPs with tissue morcellation performed at our institution.

PATIENTS AND METHODS

The surgical technique for HoLEP used in this work is as follows (Fig. 1). The holmium laser is set for an energy level of 2 J and a 40 Hz rate for a total power of 80 W. Initial incisions are made at the 5 and 7 o'clock positions lateral to the median lobe, from the bladder neck to the verumontanum (VM), with the 550-μm end-firing laser fiber (Fig. 1A, B). Once this is completed, the distal ends of the incisions are connected at the VM, and median lobe enucleation is achieved in retrograde fashion to the bladder neck (Fig. 1C). To enucleate the lateral lobes, an incision is made at the 12 o'clock position from the bladder neck to the VM. Enucleation of the lateral lobes is accomplished by joining the superior (12 o'clock) and inferior incisions distally and continuing retrograde to the bladder neck (Fig. 1D). The large adenomatous lobes are then removed by morcellation. The tissue morcellator is a handle-based set of hollow reciprocating blades attached to a vacuum pump system and activated by a foot pedal, used through a standard 27F nephroscope (Fig. 2). Enucleated tissue is first drawn toward the blades by suction, where it is morcellated and removed to a specimen container. At the end of the procedure, 20 mg of
FIG. 1. HoLEP technique. (A) Initial right median lobe incision, lateral to lobe (7 o'clock position). (B) Completed median lobe incisions (5 and 7 o'clock positions). (C) Enucleated median lobe floating into bladder. (D) Right lateral lobe enucleation, with right inferior apical dissection completed underneath right lateral lobe. Note superior (12 o'clock) incision. Distal connection of superior and inferior incisions just proximal to urinary sphincter allows retrograde enucleation of right lateral lobe.

FIG. 2. Tissue morcellator placed through modified Olympus holmium resectoscope. A 27F nephroscope may also be used.
furosemide is given intravenously, and a standard two-way 20F catheter is placed.

The equipment necessary for HoLEP (Table 1) includes a holmium laser of sufficient energy to vaporize adenoma (60 W minimum; 80 W preferred) with 550-μm end-firing fibers, which provide adequate energy density for dissection and hemostasis. A stabilizing 7F laser catheter is commercially available (Cook Urological, Spencer, IN). A continuous-flow resectoscope with a tip-modified laser sheath allows good visibility, dissipation of any heat generated, and stabilization of the laser fiber. The tissue morcellator is used to remove enucleated adenoma through a nephroscope (offset) or other specially designed endoscope. A video camera system is recommended for optical safety at the 2 J energy setting.

From June 1998 until March 1999, we performed 61 HoLEPs with tissue morcellation. We retrospectively reviewed patient data.

The mean patient age was 71.3 (range 55–96) years. The indications for surgical intervention were failed medical therapy, high AUA Symptom Score or both (40 patients); urinary retention (15 patients); bladder calculi (6 patients); recurrent hematuria (4 patients); azotemia (3 patients); and urinary tract infection (1 patient). The preoperative AUA Symptom Score averaged 20.4 (range 14–33). The mean preoperative uroflow was 7.7 mL/sec (range 0–18 mL/sec.). The preoperative postvoiding residual volume averaged 276 mL (range 60–1050 mL). Results are means with range, and p values are given where comparisons were made.

Operative data

The mean operative times were as follows: total 117 minutes (range 45–315 minutes); laser enucleation time 77 minutes (range 32–230 minutes); and morcellation time 21 minutes (range 4–85 minutes). Morcellation efficiency was, on average, 2.3 g/min with a prototype morcellator. The commercial morcellator has only recently become available and was not used for any of these procedures. The mean decrease in hemoglobin after HoLEP was 0.6 g/dL (range 0–4 g/dL decrease; P = NS). No patient receive autologous or allogenic blood transfusions. Serum sodium decreased by an average of 1 mEq/L after HoLEP (Range – 8 mEq/L to +9 mEq/L; P = NS). No patient manifested any symptoms of dilutional hyponatremia or of hypernatremia.

Postoperative course and complications

Postoperative AUA symptom scores were significantly decreased, to an average of 6.7 (range 1–21) (P < 0.001). Postoperative uroflowmetry and postvoiding residual determinations were performed in only a small number of patients, because most had been referred from outside centers. The average resected weight was 48 g (range 0.8–228 g). In comparison, the average weight of TURP specimen during the same time period at our institution was 13 g (N = 32; data not shown). A pathologic diagnosis by histological examination was able to be made in 100% of patients. Pathology was BPH in 54 patients and prostate cancer in 7 patients (T1a in 3, T1b in 4).

The average length of stay (LOS) for all patients was 1.2 days (range 0–5 days). Four patients (6.5%) had the procedure performed on an outpatient basis. Thirty-six patients (59%) were discharged in 23 hours or less. Eighteen patients (29%) stayed longer than 24 hours for a variety of reasons (inability to void, hematuria, bladder mucosal injury). Three patients (5%) remained in the hospital for medical reasons unrelated to the procedure.

Thirteen patients (21%) had stress urinary incontinence, which resolved in all of them in <3 months (Table 2). No patient had urge incontinence postoperatively. Seven patients were discharged with catheters indwelling, but five of them had the catheter removed in less than 1 week and are voiding. Two patients were unable to void postoperatively and were placed on intermittent self-catheterization.

Complications occurred in eight patients (13%) (Table 3). There were bladder neck contractures in two patients, both at 4 months postoperatively. The contractures were able to be dilated in the office with local anesthesia and have not recur during follow-up. A prostatic perforation with extraperitoneal extravasation was noted on cystogram in one patient who complained of pain on voiding after catheter removal. The extravasation resolved with catheter replacement for 5 days. Five

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**Table 1. HoLEP EQUIPMENT**

<table>
<thead>
<tr>
<th>Equipment</th>
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<tbody>
<tr>
<td>80 W holmium laser</td>
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<tr>
<td>550-μm fiber (end-firing)</td>
<td></td>
</tr>
<tr>
<td>7F. laser catheter (Cook)</td>
<td></td>
</tr>
<tr>
<td>Continuous-flow resectoscope</td>
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<tr>
<td>Laser bridge-modified resectoscope sheath</td>
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<tr>
<td>Tissue morcellator</td>
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<tr>
<td>Nephroscope (offset)</td>
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<td>Video system</td>
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**Table 2. Treatment Course in 61 Patients**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Patients</th>
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<tbody>
<tr>
<td>Stress incontinence</td>
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</tr>
<tr>
<td>Urge incontinence</td>
<td>0</td>
</tr>
<tr>
<td>Catheter at discharge</td>
<td>7b</td>
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<tr>
<td>Retention; on ISC</td>
<td>2</td>
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*aResolved in all patients by 3 months. 
*bFive had catheter removed in <1 week and are voiding.

**Table 3. Complications of HoLEP**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Patients</th>
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<tbody>
<tr>
<td>Bladder neck contracture</td>
<td>2a</td>
</tr>
<tr>
<td>Prostate perforation</td>
<td>1</td>
</tr>
<tr>
<td>Bladder mucosal injury</td>
<td>5b</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>0</td>
</tr>
<tr>
<td>Reoperation</td>
<td>0</td>
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*aBoth at 4 months; dilated in office without operative intervention. 
*bNo bladder perforations; all resolved with catheter drainage.
FIG. 3. Results for various BPH treatment options represented by % change from baseline. Note that HoLEP approximates results of TURP. Data from Campbell’s Urology, ed 7, and references 5 and 6.

bladder mucosal injuries occurred during morcellation. All were noted immediately. No bladder perforations resulted, as documented by cystogram. As a precaution, catheter drainage was continued for 3 to 5 days postoperatively. There were no reoperations.

It should be noted that a subset of 10 patients on whom we have performed HoLEP had >100 g of resected tissue. Traditionally, these patients would have undergone open prostatectomies, with hospital stays of 3 to 7 days and increased blood loss and risk of transfusion and would have been discharged with an indwelling catheter. These 10 patients had an average resected weight of adenoma of 151 g, blood loss of 1.3 g of hemoglobin, and LOS of 2.1 days. None was discharged with a catheter indwelling. Four patients had stress urinary incontinence, which resolved in <3 months. One patient had a prostatic perforation, as detailed above. There were no other complications, reoperations, or transfusions.

DISCUSSION

Urology as a specialty continues to be at the forefront of technological advancement for the minimally invasive treatment of many diseases, especially BPH. As newer technology is introduced, it undergoes evaluation for safety and efficacy, with subsequent training of practitioners in the procedure or the use of the technology. If the new technology is safe and equally or more efficacious with fewer side effects or complications, the technology should replace existing procedures and technology for appropriate surgical indications. The HoLEP method is currently being evaluated according to the above criteria.

The past decade has seen a veritable explosion in the options for medical and surgical treatment of BPH. The development and widespread use of alpha-adrenergic blockage in the bladder neck and prostatic smooth muscle has provided a large number of patients with significant improvement of symptoms related to BPH.7 Technological advances in a wide variety of areas, including balloon dilation, radiofrequency or microwave heating of the prostate, resecting loop modifications allowing vaporization of adenomatous tissue with electrocautery, as well as interstitial and contact laser energies for coagulation, vaporization, or resection of adenomatous tissue, have provided the patient and clinician with a diverse, and sometimes confusing, array of choices, with varying results. Figure 3 presents the published results of various treatment options as measured by AUA Symptom Score and Uroflowmetry. The HoLEP approximates the results of TURP in published data and also in our results. Other therapies have advantages and disadvantages, which are beyond the scope of this article, but are undergoing the same process of evaluation by clinicians for safety, efficacy, and ease of use. The essential question is whether and where HoLEP stands among the various treatment options for BPH.

In the process of evaluation, we address the safety issues associated with HoLEP first. The effective depth of penetration in fluid or tissue of the holmium laser energy is 0.5 mm, so the effect of the laser depends on tissue contact by the fiber. Tissue effects do not occur beyond the visible range of the endoscope. With proper training in the safe use of the holmium laser, it can be used with the same caution and precision as any other
HoLEP WITH TISSUE MORCELLATION

surgical instrument. In the clinical setting, the complications of HoLEP are similar to those of TURP, with the notable exceptions related to bleeding and the need for transfusion.\textsuperscript{5,6} Next, the efficacy of HoLEP can be evaluated with qualitative and quantitative methods. Qualitatively, AUA Symptom Scores have shown declines similar to those of patients after TURP in randomized trials.\textsuperscript{6} Quantitatively, uroflowmetry is significantly and equally affected after HoLEP, with results comparable to those of TURP. Our preliminary data (not shown) compare favorably with published results.

Finally, the ease of use or training for the procedure of HoLEP will be facilitated by a familiarity with the holmium laser, a video camera system for endoscopic surgery, and observing several procedures. Ideally, performing the first several procedures in a proctored environment with continuous feedback from a surgeon experienced in HoLEP will enhance the pace at which the procedure is learned.

The HoLEP method of BPH treatment must be evaluated critically by many clinicians for safety, efficacy, and ease of use and be held to the same standards as other new technology, as well as the traditional techniques. The advantages for the patient relative to morbidity and the surgeon relative to successful treatment of a common disease make HoLEP a procedure that deserves serious consideration for use in the future.

CONCLUSIONS

Holmium laser enucleation of the prostate with tissue morcellation is a new technique to remove prostatic adenoma in a safe, efficacious manner. Perioperative bleeding was reduced relative to the reported results for TURP. We were able to perform HoLEP for a wide range of prostate size. The data for the subset of >100 g HoLEPs suggest that the advantages of HoLEP for the patient (decreased bleeding, LOS, and morbidity) increase as prostate size increases. Operative time will decrease as surgeon experience and morcellation efficiency improve. Duration of catheterization and hospital LOS were reduced, and complications were not increased, compared with TURP. Stress incontinence was seen relatively frequently after HoLEP but was short-term and self-limited and is probably secondary to the completeness of the enucleation procedure. The significant benefits for both the patient and surgeon should provide motivation for further training and expansion of the use of HoLEP.

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REFERENCES


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