Rapid Communication

Holmium Laser Ablation of Large Prostate Glands: An Endourologic Alternative to Open Prostatectomy

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ABSTRACT

Purpose: To assess the efficacy and safety of holmium laser ablation of the prostate (HoLAP) to treat patients with large glands who would otherwise be recommended for open prostatectomy.

Patients and Methods: A series of 17 patients aged 54 to 79 years (mean 68.2 years) with lower urinary tract symptoms (LUTS) secondary to benign prostatic hyperplasia (BPH) (n = 14) or prostate carcinoma (n = 3) and a transurethral ultrasonography-assessed prostate volume of >80 cc were treated with a 100 W holmium laser. The endpoint of treatment was complete vaporization of obstructing prostate tissue down to the capsular fibers with an adequate prostate cavity.

Results: The mean laser time was 77 minutes (range 43–203 minutes), the catheter time 2.12 days (range 1–5 days), and the length of stay 1.34 days (range 1–3 days). None of the patients required continuous bladder irrigation. Prostate volume decreased from 121.82 ± 42.10 cc to 54.58 ± 20.65 cc (55%; P < 0.01). The American Urological Association Symptom Score decreased from 20.41 ± 5.35 to 5.70 ± 2.20 (70%; P < 0.01). The peak urinary flow rate (Q_max) increased from 6.92 ± 5.71 to 15.06 ± 7.57 (217%; P < 0.01). Serum sodium changed from 138.53 ± 2.50 mEq/L to 138.00 ± 3.29 mEq/L (P = 0.4). Hemoglobin changed from 14.4 ± 1.15 g/dL to 13.58 ± 1.29 g/dL (-5%). No patient had postoperative stress incontinence.

Conclusion: The HoLAP technique is effective in the treatment of patients with LUTS secondary to BPH and for some patients with prostate carcinoma. Because of the excellent hemostatic properties of the holmium laser wavelength, large glands can be vaporized safely with minimal morbidity and a short hospital stay. The clinical advantages over open prostatectomy include clinically insignificant perioperative blood loss, no stress incontinence, short duration of catheterization, and no skin incision.

INTRODUCTION

Men with obstructive urinary symptoms secondary to benign prostatic hyperplasia (BPH) who have prostate gland volumes in excess of 80 to 100 cc generally are advised to have an open prostatectomy, which is associated with significant morbidity, including a perioperative transfusion rate of 27%, stress incontinence in 6%, a hospital stay of 4 or 5 days, and an indwelling catheter for 5 to 7 days. Transurethral holmium ablation of the prostate (HoLAP) for glands up to 60 cc with a 60 W holmium laser has been reported to be effective and safe. The purpose of this study was to assess the clinical efficacy and safety of HoLAP to treat patients with prostate gland volume of ≥80 cc with a 100-W holmium laser.

PATIENTS AND METHODS

Seventeen consecutive patients age 54 to 79 years (mean 68 years) with lower urinary-tract symptoms (LUTS) secondary to
BPH (N = 14) or prostate carcinoma (N = 3) and transurethral ultrasound (TRUS)-assessed prostate volume of \( \geq 80 \) cc (mean 121.82 cc; range 80–203 cc) were treated with HoLAP using a 100 W laser from March 2004 to December 2005. Preoperatively, all patients had a thorough medical history and physical examination, digital rectal examination, urinalysis, urine culture, serum prostate specific antigen assay, blood chemistry studies, TRUS, and, if indicated, TRUS-guided prostate biopsies. The size and the appearance of the prostate, as well as the status of the bladder and the morphology of the urethra, were determined by cystoscopy prior to the procedure.

Patients were included in the study if they presented with moderate to severe LUTS, as determined by a standardized American Urological Association (AUA) Symptom Score of >10 and uroflowmetry analysis showing a peak flow rate of <15 mL/sec with a voided volume of 125 mL. Six patients were in urinary retention. The lasing parameters and catheter and hospital times were recorded. Blood hemoglobin and sodium concentration were checked in the recovery room. Postoperative follow-up included prostate volume determination by TRUS, uroflowmetry, and assessment of AUA score.

All patients were surgical candidates for transurethral resection (TURP) on the basis of their preoperative medical assessment. Patients with prostate carcinoma undergoing HoLAP had elected external-beam radiation or brachytherapy, and their preoperative and postoperative TRUS prostate volume determinations were made prior to radiation therapy or androgen blockade if given.

The HoLAP technique has been described. All patients were treated with a 100 W holmium laser with a sidefiring 550-\( \mu \)m fiber under spinal anesthesia. A 27F continuous-flow resectoscope with a revolving laser bridge with sterile water as irrigant was used. The endpoint of treatment was complete removal of the median lobe and vaporization of the lateral lobes as far as the circular capsular fibers to the extent possible, with the final appearance of an open TURP-like cavity. Three patients required electroresection of the median lobe because of its size (n = 1) or excessive vascularity (n = 2) to obtain complete removal. The volume of resected tissue was added to the postoperative TRUS-assessed prostate volume for analysis so that the reported postoperative TRUS prostate volume in these three patients reflects the amount of tissue removed by laser vaporization alone.

**RESULTS**

The mean laser time was 77 minutes (range 43–203 minutes), the mean duration of catheterization was 2.12 days (range 1–5 days), and the mean hospital stay was 1.35 days (range 1–3 days). None of the patients required continuous bladder irrigation. One patient, who was taking clopidogrel, experienced clot urinary retention postoperatively and was returned to the operating room for clot evacuation with transfusion of 2 units of whole blood for clinically significant blood loss, followed by platelet transfusions to restore hemostasis. There were no instances of febrile urinary-tract infection. No patient experienced stress incontinence after catheter removal. There were no instances of delayed clot retention.

Minor hematuria was noted in 2 patients (11%). Two patients reported minor dysuria. There were no major complications and no instances of urethral stricture. One patient had a vesical-neck contracture 5 months postoperatively that was treated with transurethral incision with a good response.

Table 1 shows changes in clinical parameters after HoLAP. Of the seven patients in urinary retention preoperatively, one patient with severe diabetes mellitus and a large postvoiding residual volume continues to be on intermittent self-catheterization (ISC). One patient who was on ISC prior to HoLAP was able to void on his own and discontinued ISC 2 months after his procedure. The other five patients have been voiding without difficulty. Four patients experienced brief episodes of urinary retention postoperatively and were treated with catheterization and bethanechol and after catheter removal were voiding spontaneously at 4 weeks. One patient had a persistent urinary-tract infection for about 6 weeks; he had been treated for infection and had an indwelling catheter for several weeks preoperatively. Follow-up ranged from 2 months to 22 months with a mean of 3.3 months.

**DISCUSSION**

Although any laser wavelength can ablate prostate tissue given high enough power density, the holmium laser, with a beam in the near-infrared portion of the electromagnetic spectrum (wavelength 2140 nm), its pulsed nature, and shallow tissue penetration of only 0.4 mm is unique in its ability to vaporize prostate tissue rapidly without leaving much coagulated tissue behind. The wavelength can be transmitted through quartz optical fibers, thereby allowing its use for endoscopic surgery. The holmium laser has a high absorption quotient in water and is absorbed by hemoglobin to a lesser extent. Experimental studies have shown soft-tissue ablation through saline and blood by the holmium laser in a noncontact mode.

High water absorption and its pulsed nature result in shallow penetration into prostate tissue, producing controlled ablation with good hemostasis and minimal damage to adjacent tissue.

![Table 1. Clinical Parameter Changes after HoLAP](image)

<table>
<thead>
<tr>
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<th>Preop.</th>
<th>Postop.</th>
<th>Change (%)</th>
<th>P value</th>
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<tbody>
<tr>
<td>Volume (cc)</td>
<td>121.82 ± 42.10</td>
<td>54.58 ± 20.65</td>
<td>67.24 ± 28.53 (−55)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>AUA Score</td>
<td>20.41 ± 5.35</td>
<td>5.70 ± 2.20</td>
<td>14.70 ± 5.78 (−70)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Q(_{\text{max}}) (mL/sec)</td>
<td>6.92 ± 5.71</td>
<td>15.06 ± 7.57</td>
<td>8.14 ± 8.81 (217%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Serum sodium</td>
<td>138.53 ± 2.50</td>
<td>138.00 ± 3.29</td>
<td>−0.53 ± 2.57 (−0.38)</td>
<td>0.4</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>14.40 ± 1.15</td>
<td>13.58 ± 1.29</td>
<td>−0.81 ± 0.96 (5)</td>
<td>&lt;0.01</td>
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The holmium laser has been used for the surgical treatment of BPH for more than 10 years. Holmium laser ablation using a sidefiring fiber was first performed in 1994 with a 60 W laser. Mottett and associates reported a randomized comparison of TURP and HoLAP for symptomatic BPH in patients with prostate volumes <60 cc using a 60 W or an 80 W laser. The International Prostate Symptom Score and Madsen symptom scores and Q_{max} were similar in the two groups at 12 months postoperatively. The TURP group showed a significant reduction in prostate volume (47%), whereas the change was statistically insignificant in the HoLAP group, at 39% from the preoperative volume. The mean operating time was 75 minutes for HoLAP and 40 minutes for TURP. The slow ablation rate was considered a disadvantage.

Because the speed of tissue ablation depends on the power output of the laser machine, the recent introduction of a 100 W holmium laser can be expected to improve the efficiency and efficacy of the procedure by vaporizing prostate tissue more rapidly. The present study indeed shows that even in large prostate glands, significant improvement in Q_{max} and AUA Scores equivalent to those seen after TURP can be achieved. It is generally accepted that a Q_{max} of 15 mL/sec is considered unobstructed. Scores greater than 32 are urodynamically obstructed. A significant reduction in prostate volume (55%) was obtained. This large reduction is related to the high energy output of the 100 W holmium laser, the use of better instrumentation, and attention to details of the surgical technique. A 27F continuous-flow resectoscope with a revolving laser bridge is essential for efficient vaporization of large prostate glands. Continuous-flow irrigation with wall suction applied to the egress port of the resectoscope also is helpful. It is important to use the laser tip in a near-contact mode and to avoid overheating it during the procedure. Overheating can degrade the fiber tip and reduce the energy output, thereby slowing vaporization. A severely degraded fiber, depending on the energy output, may cause only coagulation of the tissue and no vaporization.

The mean laser time in this study was 77 minutes for a mean prostate-volume reduction of 67 cc, amounting to approximately 0.87 g of tissue removal per minute. This time compares favorably with operative times for TURP and holmium enucleation (HoLEP) for large prostate glands reported by Tan et al, who described a mean tissue-removal rate of 0.61 g/min for HoLEP and 0.8 g/min for TURP. The current study also confirms the absence of significant intraoperative bleeding and irrigant absorption during HoLAP for large glands, as evidenced by normal postoperative blood hemoglobin and serum sodium concentrations. There was minimal postoperative discomfort, a short duration of catheterization (2.12 days), and brief hospitalization (1.35 days). The only patient with significant postoperative bleeding was receiving clopidogrel bisulfate because of recent placement of a coronary-artery stent, and he had taken the last dose a few hours prior to his procedure. His bleeding was controlled only after platelet transfusions were given and clopidogrel was discontinued. There were no further bleeding complications. Strong caution is advised while treating anticoagulated patients with HoLAP, particularly for a large gland.

None of the patients required continuous bladder irrigation. No patient reported stress incontinence after catheter removal. At 1-month office follow-up, all but two patients were voiding well. One has continued to perform ISC because of a decompensated bladder, and the other patient on ISC preoperatively was able to discontinue it 2 months after HoLAP. Two patients (11%) experienced minor hematuria, and two patients had mild dysuria for 1 week not necessitating any medications. No narcotic medications were needed in the postoperative period. One patient (5%) was returned to the operating room for relief of a bladder-neck contracture. No urethral strictures have occurred. These patients need long-term follow-up to assess the durability of their symptomatic improvement.

The 80 W KTP laser also has been used for the treatment of patients with large BPH. Sandhu et al reported 64 patients with large prostate glands, defined as a volume >60 cc, with a mean volume of 101 cc. Two patients required staged procedures. The mean operative time was 123 minutes. With no postoperative prostate volume measurements available, it is not possible to know the amount of tissue removed.

There was no clinically significant change in serum sodium or hematocrit values postoperatively. The increase in the mean maximum urinary flow rate over the preoperative value was statistically significant at 1, 3, 6, and 12 months with no significant difference between the values at the four observation points. The considerably longer operative time reported in this study is probably related to the physical properties of the KTP laser, which is highly efficient in vaporizing vascular tissue; for example, prostate tissue close to the urethral mucosa. However, the KTP acts more like an Nd:YAG laser in relatively avascular tissue, as would be seen at deeper levels in large prostate glands, where it would penetrate deeply and result predominantly in tissue coagulation and less vaporization. Coagulated tissue in turn is much harder to vaporize. A 23F continuous-flow cystoscope, as used in this study, will also slow down the procedure overall. The HoLAP procedure with the instrument set-up discussed in the current report should be able to take care of a 100-cc gland in approximately 1 hour with about 55% of the prostate tissue being removed.

This series, although relatively small, is the first report of transurethral laser vaporization of large prostate glands with a 100 W holmium laser and documents a significant improvement over currently prevalent alternatives, including open prostatectomy or a long TURP. Holmium laser enucleation of prostate, although proved safe and effective and reported for several years, has not found widespread acceptance in the United States for various reasons. With the currently available technology of a 100 W holmium laser, it now is possible to treat patients with large prostate glands with significantly less morbidity, including clinically insignificant blood loss, absence of dilutional hyponatremia, minimal postoperative discomfort, no stress incontinence, and a short duration of catheterization and hospital stay. The HoLAP procedure is easy to learn by urologists who already know how to do a good TURP.

The economic benefits of HoLAP for large prostate glands compared with open prostatectomy, although not documented in this study, can be assumed given the shorter hospital stay, absence of blood transfusions, and short duration of catheterization. Although HoLAP is a safer and more cost-effective procedure than open prostatectomy and TURP, it is reimbursed at
CONCLUSION

A HoLAP with a 100 W laser is effective in the treatment of patients with LUTS secondary to BPH and some patients with prostate carcinoma. Because of the excellent ablative and hemostatic properties of the holmium laser wavelength, large prostate glands can be vaporized safely with minimal morbidity and a short hospital stay. The clinical advantages over open prostatectomy, as seen in this study, include clinically insignificant perioperative blood loss, short duration of catheterization, minimal postoperative discomfort, no need for postoperative narcotics, short hospital stay, no skin incision, and no postoperative stress incontinence.

REFERENCES


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ABBREVIATIONS USED

BPH = benign prostatic hyperplasia; HoLAP = holmium laser ablation of the prostate; HoLEP = holmium laser enucleation of the prostate; ISC = intermittent self-catheterization; KTP = potassium-titanyl-phosphate laser; Nd:YAG = neodymium:yttrium-aluminum-garnet laser; TRUS = transrectal ultrasonography; TURP = transurethral resection of the prostate.