Laser Resection of the Prostate: Implications for Anesthesia

Richard A. Hanson, MD*

Mark H. Zornow, MD*

Michael J. Conlin, MD†

Ansgar M. Brambrink, MD, PhD*

Holmium:yttrium-aluminum-garnet and potassium-titanyl-phosphate lasers make it possible to perform transurethral prostate resection with almost no absorption of irrigant and minimal blood loss. Subarachnoid block is usually administered for classical transurethral resection of the prostate, so that the patient can be monitored for the onset of transurethral resection of the prostate syndrome secondary to irrigant absorption. New laser resection techniques may allow the patient and anesthesiologist to choose options most appropriate for the patient's medical conditions and preference.

In this study, we review the urologic literature to provide an overview of current laser technology for prostate reduction surgery. We also screened this literature for evidence of potential effects on anesthesia care for special patient groups as well as for overall perioperative management.

Our findings suggest that the anesthesiologist may now safely offer general anesthesia for endourologic laser surgery, even on an ambulatory basis. This includes patients with cardiovascular disease or receiving continuous anticoagulation therapy.

We found no studies specifically aimed at evaluating best anesthetic practices for patients undergoing laser procedures. Therefore, clinical research is needed to better define the risks and benefits of the various anesthetic alternatives.

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It is generally accepted that the anesthetic of choice for classical transurethral resection of the prostate (TURP) is a subarachnoid block (SAB). This technique is favored because it is effective and efficient. However, the primary motivation is that a regional anesthetic permits early detection of mental status changes associated with absorption of large amounts of irrigating solution, typically called "TURP syndrome." TURP syndrome has been extensively described in a number of articles and texts (1,2). The recent introduction of laser technology for endoscopic resection of prostate tissue has nearly eliminated the risk of TURP syndrome (3). Laser resection of the prostate has been exhaustively reviewed in recent urologic literature (4–6). The purpose of this review is to evaluate the anticipated impact of this new resection technique on anesthesia care in patients with benign prostate hypertrophy (BPH).

From the Departments of *Anesthesiology and Peri-Operative Medicine, and †Surgery, Division of Urology, Oregon Health and Science University, Portland, Oregon.

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Address correspondence and reprint requests to Ansgar M. Brambrink, MD, PhD, Department of Anesthesiology and Peri-Operative Medicine, Oregon Health and Science University, 3181 SW Sam Jackson Park Road, UHS-2, Portland, OR 97239. Address e-mail to brambrin@ohsu.edu.

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LASER RESECTION OF THE PROSTATE

In an effort to reduce perioperative morbidity, the urologic community has explored a number of alternatives to conventional electrocautery TURP including transurethral contact vaporization, interstitial laser coagulation, laser resection, and laser enucleation of the prostate. Transurethral contact vaporization (7) and interstitial laser coagulation (8) have not matched the efficacy of the "gold standard" electrocautery approach, and their use seems to be in decline (3). Laser resection of the prostate initially showed the most promise, but was limited to small and medium-sized prostates.

Advancing technology has abandoned the Neodynium (Nd) lasers in favor of the more precise Holmium:yttrium-aluminum-garnet (YAG) lasers (www.surgical.lumenis.com) and "photoselective" high-powered potassium-titanyl-phosphate (KTP) lasers (www.laserscope.com). Holmium lasers were initially used in conjunction with Nd:YAG lasers to combine their cutting and coagulation properties, respectively. However, since Holmium lasers were found to provide adequate hemostasis, Nd:YAG lasers are no longer considered beneficial.

This newer clinical approach to treating BPH is termed "Holmium laser resection of the prostate" (9); and uses a high-powered (60–80 W), pulsed, solid-state Holmium laser with a wavelength of 2140 nm. This wavelength is highly absorbed by water, limiting tissue penetration to 0.4 mm. This property creates a laser with precise cutting abilities. Tissue is heated above 100°C, and the resulting heat dissipation coagulates small and medium-sized vessels to a depth of 2–3 mm (4). Large pieces of prostatic tissue are resected in a retrograde direction and left suspended by a small tissue tether near the bladder neck. When adequate tissue dissection is complete, the large pieces are lased into smaller ones that release into the bladder where they are endoscopically retrieved.

Continued refinement of the Holmium laser resection technique has led to the development of "Holmium laser *enucleation* of the prostate." The precision of the Holmium laser allows it to resect the intact median and lateral lobes of the prostate from the prostatic capsule, reducing the lengthy tissue retrieval time associated with more conventional laser resection. Studies have shown that enucleation is as effective as classical TURP in relieving symptoms of BPH up to 4 yr postoperatively with a decrease in perioperative morbidity, hospital stay, and catheterization times (5,9–13). In addition, enucleation is comparable to open prostatectomy in relieving obstructive symptoms and improving urine flow rates up to 18 mo postoperatively. Improvements in enucleation have resulted in a reduction in blood loss, transfusions, hospital stay, catheterization time, and complications (10,14). Kuntz et al. (13) reported significant relief in obstructive symptoms in a randomized trial comparing 100 Holmium laser enucleation patients to 100 TURP patients. Naspro et al. (15) have shown that enucleation preserves histologic prostate architecture, allowing detection of incidental prostate cancer.

From the anesthesiologist's point of view, the advantages of Holmium laser technique are apparent. The decreased amount of irrigation solution required, the decreased bladder pressures, and the improved hemostasis result in less absorption of irrigant (16). Furthermore, it is irrelevant whether the irrigant can conduct electricity, and so normal saline may be used. This avoids the osmotic complications of absorbing large quantities of glycine, mannitol, or sorbitol. These benefits are offset, but only slightly, by the longer procedure times for Holmium laser resection and enucleation compared to traditional TURP (4). Holmium laser prostate surgery is also technically demanding and requires a long learning curve (20–30 cases of structured training or up to 50 cases when self-taught) (3).

The KTP laser is the most recent advancement in laser technology for the treatment of BPH. KTP laser resection involves passing a high-powered (60–80 W) Nd:YAG, solid-state laser through a KTP crystal to vaporize prostate tissue. The passage of the Nd:YAG laser through the KTP crystal halves the wavelength to 532 nm and doubles the frequency, producing a visibly green laser. (Thus, the KTP laser has been trademarked "Green Light™".) This wavelength is highly absorbed by oxyhemoglobin and blood-rich tissue. The direct heating of blood yields an almost bloodless procedure. The green KTP laser is poorly absorbed by water, allowing for a noncontact application that creates an immediately evident cavity with minimal dissipation of energy to the surrounding tissue. Sparing the surrounding tissue significantly reduces scarring and postoperative contracture, which have led to a narrowing of the urethra 6–12 mo after earlier ablation techniques (3). KTP laser is often described as "photoselective laser vaporization of the prostate" (17). The KTP laser is administered through a side-firing fiber. Prostate tissue can be removed at a rate of 0.3–0.5 g/min (4). Two-year follow-up in a series of patients treated with the 60-W laser suggests that its efficacy is equal to a classic TURP procedure (18). The 80-W KTP laser provides the power to treat even larger prostates (17). This modality is relatively new. In a 2006 review, Kuntz (4) found that only 1 of 7 published case series on the 80-W KTP laser had more than 1-yr follow-up. Results in all studies suggest significant increase in urinary peak flow rate and decrease in obstructive symptoms. Malek et al. (19) reported the only study with up to a 5-yr follow-up that provides evidence of decreased symptoms and increased flow rates for the duration of the study; however, there was no comparison to conventional TURP in that study.

There are additional advantages of the KTP laser. The hemostatic properties of the KTP laser result in significantly less bleeding, fewer blood transfusions, less absorption of the irrigant, and shorter hospital stays (17,20,21). Bladder catheterization times, when required, average between 18 and 24 h (17,20–22). The required irrigation pressures are much less than a classical TURP. There is no need for a nonconductive irrigant, and so saline can be used. Barber et al. (23) monitored irrigant absorption during KTP laser vaporization via end-tidal ethanol concentrations in 40 patients and found no detectable absorption during an average 47 min of lasing. Barber and Muir (20) reviewed studies that also reported no significant change in serum sodium when using sterile water as an irrigant.

Procedure times for enucleation of the prostate are longer for both the KTP laser and the Holmium laser compared to classic TURP (21). However, the KTP laser procedure is less technically demanding and easier to learn than the Holmium laser technique, and satisfactory results can be achieved within the course of fewer cases (17). Since the tissue is vaporized, no pathologic specimen is obtained. This limits the use of KTP laser to treating BPH, rather than resection of malignancy. Earlier vaporization techniques (transurethral vaporization of the prostate) failed due to excessive laser dissipation into surrounding tissue. This caused abundant scarring and tissue contracture and ultimately led to a more frequent recurrence of obstructive symptoms compared to TURP in long-term follow-up (3). More data must be collected to determine the long-term efficacy of photoselective vaporization of the prostate with the KTP laser, particularly when compared to Holmium laser techniques and conventional TURP (6).

At this time, advanced laser technology for resection of the prostate appears to be at least as effective as TURP in 2–4-yr outcomes. This fact, coupled with a reduction in perioperative morbidity and mortality, suggests that Holmium and KTP laser prostate surgery could become more prominent. Most importantly for the anesthesiologist, these emerging techniques have the potential to significantly influence our anesthetic practice during the endoscopic treatment of BPH.

PERIOPERATIVE ANESTHETIC CONSIDERATIONS

There are a few studies devoted to anesthesia care for BPH patients treated using new laser techniques. Therefore, our perioperative considerations are currently based on indirect evidence from urologic literature, which focuses on new surgical techniques rather than on opportunities for advances in anesthesia. This review emphasizes the need for clinical studies to investigate the implications for anesthesia care.

The risk of TURP syndrome has led anesthesiologists to prefer SAB for TURP. A regional technique allows the anesthesiologist to monitor the neurologic status of the patient throughout the procedure. Most patients affected by obstructive symptoms due to BPH are elderly and often present with additional comorbidities that result in increased risks such as cardiovascular or pulmonary complications during the perioperative period. Some may also be taking anticoagulation medications or have degenerative changes in the spine that prevent regional anesthesia or make it technically difficult. Several characteristics of the new laser techniques, i.e., reduced risk for bleeding, ability to use saline as an irrigant, profound reduction in fluid absorption, and reduced local tissue swelling, may offer specific advantages for elderly or debilitated patients and allow a more patient-oriented approach to their anesthetic management.

Anticoagulation therapy is not uncommon in this patient population, which often has comorbidities from chronic atrial fibrillation, mechanical heart valves, and recurrent deep vein thrombosis. The withdrawal of anticoagulation therapy without appropriate substitution presents a significant thromboembolic risk in association with prostate surgery (24,25). Reich et al. (21) studied 66 high-risk patients with ASA assessment scores of three or more who underwent photoselective vaporization of the prostate with the KTP laser. Twenty-six of these subjects were receiving concurrent anticoagulation therapy with warfarin. There were no intra- or postoperative complications, and no subjects required blood transfusion. All patients continued their anticoagulation regimen throughout the study. Hai and Malek (22) demonstrated successful treatment of this patient subset on an outpatient basis. Sandhu et al. (26) published a case series of 24 patients taking some form of anticoagulation (warfarin, clopidigrel, or acetylsalicylic acid). None experienced significant blood loss or clot retention, and all had reduction in symptoms with improvement in peak flow rate up to 1 yr of follow-up.

Therefore, patients may be able to continue anticoagulation therapy when they undergo transurethral laser resection of the prostate. It is important to note, however, that discoveries in this area are rapidly evolving. For example, in a well-designed follow-up study, Elzayat et al. (27) recently found that bleeding can occur and require treatment after laser surgery. Thus, adequate preparation and long-term monitoring for bleeding complications are still important. Further studies should be conducted to determine if patients receiving anticoagulation therapy or with bleeding disorders benefit from laser-assisted prostate reduction.

The postoperative requirement for traditional TURP is several days of urethral catheterization (average 44–85 h) and bladder irrigation, resulting in a hospital stay of 3–5 days. In contrast, Holmium laser techniques require an average of 18–27 h of postprocedure catheterization and hospital stays of 1–2 days (3,10). For KTP laser therapy, the majority of patients are treated in an outpatient setting and do not even require an indwelling catheter postoperatively (20). These data suggest that, in the future, many of these procedures may be performed in an ambulatory setting. Thus, the anesthetic could be one of rapid recovery and minimal interference with postoperative urinary voiding.

Today, spinal anesthesia is used routinely for day surgery (28), but in some patients it can lead to urinary retention due to blockade of the parasympathetic fibers (S2–4) that control detrusor contraction and bladder neck relaxation (29). This may delay discharge to home, especially in the elderly, after prostate surgery. Reducing the spinal dose or using short-acting local anesthetics may be reasonable, but incomplete spread or premature resolution of the regional anesthesia can occur. Alternatively, modified regional techniques such as combined spinal epidural anesthesia may be offered to the patient.

Based on our review of the literature, there is early evidence that patients undergoing laser-assisted transurethral prostate surgery may, in fact, have more choices. For example, a general anesthetic with short-acting inhaled anesthetic gases or even IV sedation only may be used because the systemic complications of classical TURP are diminished. Sandhu et al. (17) reported 80-W KTP laser ablation on 64 patients, and 28 of these patients received IV sedation only. This suggests that laser-assisted prostate surgery patients could even bypass phase 1 recovery and be discharged to home faster.

Although regional anesthesia as well as general anesthesia and monitored anesthesia care have specific risk-benefit profiles, we believe that the decision for anesthesia care for transurethral laser surgery may, in the future, be more likely based on the condition and the preference of the patient and the experience of the provider, rather than on the risk profile of the procedure itself. However, studies are needed to verify these assumptions.

Elderly patients frequently have cardiac disease, such as diastolic dysfunction, valvular dysfunction, heart failure, arrhythmias, and coronary artery disease. Significant intravascular volume shifts are poorly tolerated in this population. The new laser techniques may provide advantages over traditional TURP in patients with cardiac disease. Changes in hematocrit and serum sodium have been shown to be clinically insignificant with both Holmium laser resection and KTP laser vaporization, suggesting that the risk of excessive intravascular volume due to irrigation fluid absorption is minimal (16,21,30).

Minimal fluid absorption would eliminate the risk of classical TURP syndrome, negating the need for continuous neurologic monitoring via SAB. Without a spinal anesthetic, patients maintain their sympathetic tone (stable hemodynamics) and avoid the risk of large intravascular volume shifts due to venous dilation. This will ultimately improve the anesthesia management of myocardial- and cardiovascular-compromised patients. However, clinical studies are required to confirm this hypothesis.

Regardless of the resection technique used, SAB provides documented benefits, and regional anesthesia may simply be preferred by the patient. For example, approximately one in 20 Americans suffers from chronic obstructive pulmonary disease (31), and these individuals may best be served by using a regional technique. There is an increased risk of postoperative pulmonary complications when a general anesthetic is used in patients with severe chronic obstructive pulmonary disease; therefore, general anesthesia should be avoided in these patients (30). In contrast, minimal effects on respiratory mechanics have been demonstrated using even high levels of neuraxial blockade, i.e., spinal or epidural anesthetic (32). Laser prostatectomy can be safely and easily performed using either a neuraxial or local block with sedation, thereby avoiding the pulmonary complications associated with a general anesthetic.

CONCLUSIONS

As the average age of our population increases, the number of individuals requiring prostate reduction for bladder outlet obstruction will also increase. Patients of advanced age frequently present with an array of comorbidities, and the relative number of candidates for a traditional TURP will most likely decline accordingly. Advancing technology in urologic lasers offers new options for the anesthetic care of these patients. The new laser techniques for resection of the prostate have several clear advantages, including 1) minimal fluid absorption, reducing the incidence of excessive intravascular volume and minimizing the risk of electrolyte abnormalities and TURP syndrome; 2) the potential to perform the procedure on an anticoagulated patient; 3) a lower incidence of a postoperative indwelling urinary catheter; and 4) the broader choice of anesthetic options, including general, neuroaxial, and local/monitored anesthesia care.

The current urologic literature necessarily focuses on the surgical benefits of laser technology. The advancement of state-of-the-art laser technology in urologic practice is a good example that progress outside our specialty can enhance our ability to provide more choices for anesthesia care. The evidence for anesthesia benefits is, at best, indirect. The benefits of having more anesthetic options must be documented through appropriate clinical research.

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