KTP/LBO Laser Vaporization of the Prostate

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• BPH • GreenLight laser
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Laser-based treatments have been developed in the past 15 years as an alternative to transurethral resection of the prostate (TURP) for treatment of symptomatic benign prostatic hyperplasia (BPH). Increasing demand for a minimally invasive procedure to alleviate lower urinary tract symptoms (LUTS) with greater efficacy and fewer side effects has led to the introduction of various lasers, including photoselective vaporization of the prostate (PVP) using "GreenLight PV" KTP (potassium-titanyl-phosphate) laser, or most recently, the "GreenLight High Performance System (HPS)" LBO (lithium triborate) laser. Laser prostatectomies may be performed with coagulative lasers such as neodymium:yttrium-aluminium-garnet (Nd:YAG) and diode lasers, cutting lasers such as holmium:YAG, (Ho:YAG) and thulium:YAG (Tm:YAG), or vaporization lasers such as Nd:YAG, Ho:YAG, diode, KTP, and lithium triborate (LBO) lasers. The search for an ideal minimally invasive treatment option for BPH to reduce morbidity and expense is constantly evolving. Many earlier modalities using various delivery systems did not result in consistent and durable outcomes compared with the reference standard, TURP. Since its introduction in 1998 by Malek and colleagues, the excellent clinical outcomes, low morbidity, technical simplicity, and cost-effectiveness of GreenLight laser photoselective vaporization (American Medical Systems, Minnetonka, MN) have made this technology a valid and efficacious clinical alternative to TURP.

Most early data on laser treatment of BPH were based on an Nd:YAG laser using visual laser ablation of the prostate (VLAP), as initially introduced by Costello and colleagues.[1] Limitations included prolonged operative time because of the lack of a continuously emitting laser beam, significant dysuria, and extended postoperative catheterization time secondary to massive sloughing of necrotic tissue.[2] The key determinant of efficacy with laser vaporization is based on the interaction between the laser beam and target tissue. The laser energy (collimated coherent light emitted from an energized source at a single wavelength) can produce either coagulation, when tissue is heated to below the boiling/vaporization temperature but above that required to denature protein, or vaporization, in which the tissue is evaporated by being heated to above the vaporization/boiling temperature. The wavelength of Nd:YAG (1064 nm) is double the wavelength (532 nm) and half of the frequency of KTP or LBO lasers. The KTP and LBO lasers produce the same 532-nm light beam within the visible green region of the electromagnetic spectrum with different maximal average power (80 W vs 120 W, respectively).[3,4] Unlike the 1064 nm wavelength of the Nd:YAG laser, which is found within the infrared portion of the electromagnetic spectrum, the KTP or LBO lasers are selectively absorbed by hemoglobin within prostatic tissue, thus permitting photoselective vaporization and removal of prostatic tissue by rapid photothermal vaporization of heated intracellular water.[5] With a short optical penetration of 0.8 mm because of the shorter wavelength and absorption by hemoglobin, the resulting coagulation zone is limited to 1 to 2 mm, which leads to

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a more focused and effective vaporization when compared with the 4 to 7 mm coagulation zone of Nd:YAG.[6] Unlike KTP or LBO lasers, Nd:YAG laser treatment often leads to severe postoperative dysuria and delayed sloughing, resulting in prolonged obstruction.[7]

The GreenLight HPS (120-W LBO laser), which is currently used at our institution, permits more rapid and effective tissue vaporization, greater maximum average power, and improved collimation of the laser beam than the older GreenLight PV (KTP laser) system (**Fig. 1**). For these reasons, the GreenLight HPS laser can be used to treat larger prostate glands with up to 3-mm working distance between the laser fiber and the tissue compared with the required “near contact” of tissue (0.5 mm distance) for vaporization with the older GreenLight PV system (**Fig. 2**). Increased working distance with the older PV system results in coagulation rather than vaporization. By contrast, the GreenLight HPS uses separate footswitches for vaporization and coagulation (default 20 W) (**Figs. 3** and **4**). With either system, hemostasis is gained by the inherent superficial coagulative effect of the KTP or LBO laser beam,

Fig. 1. GreenLight HPS system (AMS, Minnetonka, MN).

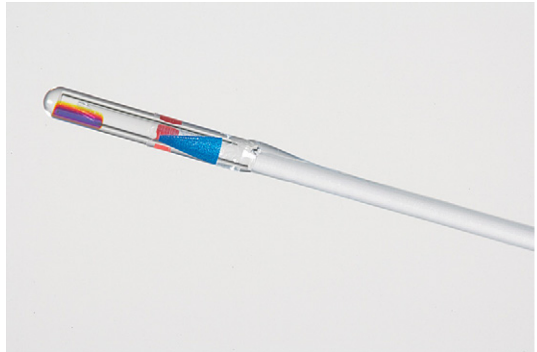

Fig. 2. GreenLight HPS laser fiber (532 nm).

which permits a nearly bloodless procedure. In the first study of pure KTP, bleeding hemostasis was successfully obtained by defocusing the laser beam (3–4 mm) without the need to switch to Nd:YAG laser for coagulation.[8] Specific studies establishing the efficacy of GreenLight PV and GreenLight HPS laser are discussed later in this review.

Preoperative evaluation may include accurate transrectal ultrasound (TRUS) prostate volume assessment to properly gauge required vaporization energy and operative time. Preoperative evaluation is surgeon-dependent and may include uroflowmetry, postvoid residual (PVR) measurement, cystoscopy, and urodynamic evaluation. In contrast to TURP, no tissue specimen is provided by photovaporization of the prostate (PVP). Therefore histopathologic abnormalities, including high-grade prostatic intraepithelial neoplasia (HGPIN), atypical small cell acinar proliferation (ASAP), and cancer cannot be diagnosed. With preoperative elevated prostate-specific antigen (PSA) or suspicious digital rectal examination (DRE), a TRUS-guided biopsy should be performed. The clinical significance of cancers not identified preoperatively as a result of normal PSA and DRE is not clear. Patients may in the future develop prostate cancer, and should be followed postoperatively by DRE and PSA surveillance in specific circumstances when a proactive follow-up is agreed on by urologist and patient. The procedure may be performed on patients taking 5α-reductase inhibitors for more than 6 months without compromising efficiency or efficacy as described by Araki and colleagues[9] in a prospective nonrandomized trial. GreenLight laser photovaporization has a high absorption affinity for hemoglobin, making prostate tissue a good candidate target tissue. Because 5α-reductase inhibitors reduce angiogenesis and blood vessel formation in prostate tissue, it had