KJU Korean Journal of Urology

www.kjurology.org
http://dx.doi.org/10.4111/kju.2011.52.11.752

Lasers in Urology

Initial Experiences with a 980 nm Diode Laser for Photoselective Vaporization of the Prostate for the Treatment of Benign Prostatic Hyperplasia

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Purpose: This study was conducted to analyze the efficacy of photoselective vaporization of the prostate (PVP) with the use of a 980 nm diode laser for benign prostatic hyperplasia (BPH) according to postoperative period.
Materials and Methods: Data were collected from 96 patients who were diagnosed with BPH and who underwent PVP with the 980 nm K2 diode laser. Postoperative parameters, including International Prostate Symptom Score (IPSS), quality of life (QoL) score, maximum urinary flow rate (Qmax), and post-void residual volume (PVR), were assessed and compared with preoperative baseline values.
Results: The mean prostate volume was 45.3±15.6 g, the mean operative time (lasing time) was 22.9±18.3 minutes, the total amount of energy was 126±84 kJ, and the Foley catheter maintenance period after PVP was 24.8±5.6 hours. At 1 month, significant improvements were noted in IPSS (11.7±6.6), QoL score (2.3±1.1), Qmax (12.7±6.1 ml/sec), and PVR (41.9±30.5 ml). After 3 months, all follow-up parameters showed significant improvements that were sustained throughout a period of 6 months after PVP.
Conclusions: PVP using a K2 diode laser is a minimally invasive and effective surgical method for improvement of BPH and is associated with minimal morbidity.

Key Words: *Lasers; Prostatic hyperplasia; Urodynamics*

Article History:
received 23 August, 2011
accepted 21 September, 2011

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INTRODUCTION

The prevalence of benign prostatic hyperplasia (BPH) has shown a progressive increase, owing much to an increase in the elderly population, advancement in diagnostic methods, economic growth, and desire for a better quality of life [1]. The initial treatment of BPH is mostly through medications, but some patients who show no improvements in their conditions with medication choose surgical treatment. Transurethral resection of the prostate (TURP) is the most standard surgical procedure performed for BPH to date [2]. However, complications such as bleeding, retrograde ejaculation, and transurethral resection (TUR) syndrome can occur after TURP [3-6]. Therefore, various lasers have been introduced as alternatives to TURP to minimize such complications. Recent photoselective vaporization of the prostate (PVP) procedures have used high-energy 80 W potassium-titanyl-phosphate (KTP) lasers and 120 W lithium-triborate lasers.

Numerous studies have shown that PVP shows surgical outcomes similar to those of TURP, but reduces the hospital stay and catheterization time dramatically and further reduces bleeding, thereby decreasing possible complications [7-9]. A recently introduced diode laser system operates on a wavelength of 980 nm. Because this wavelength offers a high simultaneous absorption in water and hemoglobin, it is postulated to combine high tissue ablative properties with good hemostasis. The aim of this study was to clinically evaluate the usefulness of the high-power 980 nm diode laser in the treatment of BPH.

TABLE 1. Characteristics of the patients

	Mean±SD	Range
Age (yr)	73.5±6.4	55-81
PSS	19.3±8.3	0-35
QoL score	4.2±1.1	1-6
Qmax	8.5±5.7	1.5-25.0
PVR	99.1±138.9	0-400
PSA	3.5±1.8	1-5
Prostate volume (g)	45.3±15.6	21-90

IPSS: International Prostate Symptom Score, QoL: quality of life, Qmax: maximum urinary flow rate, PVR: post-void residual volume, PSA: prostate-specific antigen

MATERIALS AND METHODS

A retrospective study was performed from March 2010 to December 2010. We treated 96 patients diagnosed with bladder outlet obstruction secondary to BPH. In all cases, pharmacological treatment had been tried, with minimal or null response.

Patients were evaluated by means of anamnesis (the symptoms being evaluated through the International Prostate Symptom Score (IPSS), the quality of life (QoL) score, physical examination including digital rectal examination (DRE), prostate-specific antigen (PSA), transrectal ultrasonography, and uroflowmetry. Inclusion criteria were moderate to severe urinary symptoms, as determined by IPSS (score$\geq$8) and Qmax of less than 15 ml/s with or without post-void residual volume (PVR). Exclusion criteria were urethral stricture, previous prostatic surgery, prostate cancer, and obvious manifested neurogenic bladder dysfunction.

Spinal anesthesia was used in all cases, and surgery was performed by a single surgeon. Prostate vaporization was carried out with a diode laser at 980 nm (K2 diode laser system, Huentek, Seoul, Korea) delivering 120 W of maximum output power with a 600 nm side-fire fiber endowed within a spot of 1 mm in diameter. In all cases, saline solution was used for irrigation through a 23 F cystoscope. Vaporization was started at the bladder neck in a clockwise manner, pulling the resectoscope further out and rotating the laser fiber simultaneously with the power set at 80 to 120 W. All prostate tissue causing obstruction was removed until a fine surgical cavity was formed, as in TURP. In all cases, an 18 F three-way catheter was placed despite obtaining clear urine or minimal hematuria. A urethral catheter was placed after the operation and was removed the next day, taking into consideration the degree of hematuria.

Postoperative Qmax, PVR, and IPSS with QoL score were obtained at 1, 3, and 6 months after surgery. Operation time, applied energy, and duration of catheterization were obtained. For statistical analysis, we used SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA). Postoperative Qmax, PVR, IPSS, and QoL score were compared with preoperative values by using the Student t-test (paired); p-values of less than 0.05 were defined as statistically significant.

TABLE 2. Perioperative outcomes

	Mean±SD	Range
Operation time (lasing time, min)	22.9±18.3	10-60
Applied energy (kJ)	126±84	5-250
Catheterization time (hr)	24.8±5.6	20-48

RESULTS

A total of 96 patients met the inclusion criteria. The patients' mean age was 73.5±6.4 years (range, 55 to 81 years), and the mean follow-up period was 7.2 months (range, 6 to 9 months). Preoperative parameters were as follows: IPSS, 19.3±8.3; QoL, 4.2±1.1; Qmax, 8.5±5.7 ml/s; PVR, 99.1±138.9 ml; PSA, 3.5±1.8 ng/ml; and prostate volume, 45.3±15.6 g (Table 1).

Mean operation time (lasing time) was 22.9±18.3 minutes, and mean applied energy was 126±84 kJ. Mean catheterization duration was 24.8±5.6 hours (Table 2). One month after surgery, subjective and objective follow-up parameters were assessed and statistical analysis was performed. Compared with the preoperative data, statistically significant improvements were observed in total IPSS (11.7±6.6, $p<0.05$), QoL score (2.3±1.1, $p<0.05$), Qmax (12.8±6.1, $p<0.05$), and PVR (41.9±30.5, $p<0.05$).

Three months after the operation, all parameters were reassessed, and the statistical analysis was performed again. Compared with the preoperative data, significant improvements were observed in total IPSS (8.2± 5.4, $p<0.05$), the QoL score (1.8±0.8, $p<0.05$), Qmax (15.1±5.4, $p<0.05$), and PVR (34.8±31.2, $p<0.05$). All postoperative follow-up parameters were assessed again at 6 months after surgery. The 6 month total IPSS was 7.4±2.1, the QoL score was 1.4±0.6, Qmax was 16.7±4.91 ml/s, and PVR was 23.0±23.4 ml. All of the above 1, 3, and 6 month postoperative values were statistically significant when compared with baseline values and were sustained throughout the follow-up period (Fig. 1).

The only major postoperative complication in our study was mild dysuria (n=16, 16.7%), which improved with conservative care. There were no complications such as delayed hematuria or obstructive retention with blood clot.

DISCUSSION

Although TUR of the prostate is considered to be the gold standard of care in the treatment of BPH [2], its perioperative morbidity (hemorrhage, urethral stenosis, reabsorption syndrome, and catheterization times) has encouraged the search for alternatives than can reduce complications and offer at least similar clinical results [3-6]. In an attempt to minimize the morbidity of TURP, alternative techniques for prostate ablation are being developed.

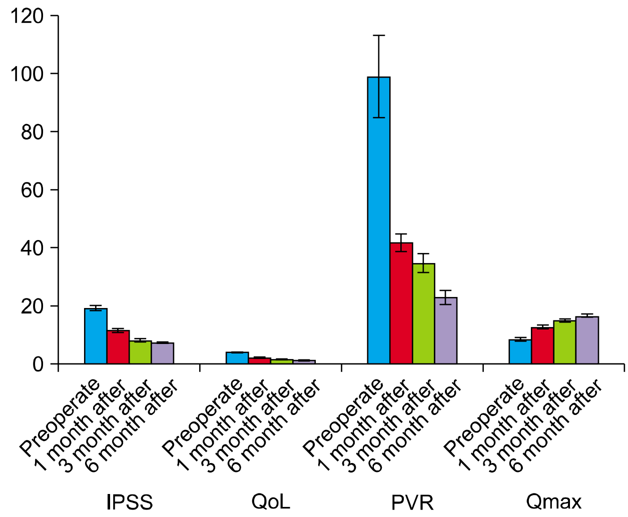

FIG. 1. Changes in preoperative and postoperative International Prostate Symptom Score (IPSS), quality of life (QoL) score, post-void residual volume and score (PVR), maximum urinary flow rate (Qmax).

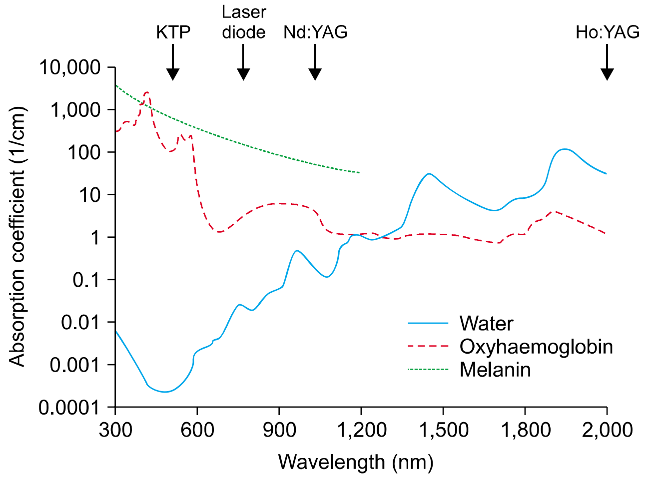

FIG. 2. Absorption characteristics of various wavelengths in two absorption media for potassium-titanyl-phosphate (KTP), holmium:yttrium-aluminium-garnet (Ho:YAG), neodymium:YAG (Nd:YAG), and diode lasers.

Holmium laser enucleation of the prostate provides functional outcomes comparable to those of TURP and open prostatectomy [5,6]. However, a steep learning curve requiring 30 to 50 procedures and a longer operation time has limited widespread use of the procedure [6,7]. The application of the KTP laser (532 nm wavelength) allows good hemostasis owing to its high affinity for hemoglobin as well as prostate vaporization. However, the operation time of KTP-laser prostatectomy is rather long because tissue vaporization is time-consuming. Nevertheless, given that the technique has a minor learning curve, its low morbidity and the published good medium-term results have spread its use [7,10-16].

Seitz et al reported preliminary data from a study based on the utilization of a diode laser of 1,470 nm at 50 W of power [17], obtaining some promising results in patients with BPH. However, the combination of good absorption for both water and hemoglobin make the diode laser at 980 nm a more attractive option in the treatment of BPH by means of vaporization of the prostate tissue. A diode laser working on a wavelength of 980 nm was recently introduced to overcome the described problems of the established laser devices. Because this wavelength offers the highest simultaneous absorption in water and hemoglobin, it is postulated to combine high tissue ablation capacity and good hemostasis (Fig. 2). Further advantages of the diode laser over KTP and Ho:YAG laser devices include a significantly lower energy consumption and the absence of a required high-voltage connection, which improves mobility of the laser generator. Unlike other lasers, the speed of vaporization with the diode laser at 980 nm does not seem to depend on whether the tissue is mucosa or fibromuscular stroma. Regarding its hemostatic properties, it is considered to be equivalent to KTP. Using 120 W of output power, the depth of the coagulation was similar to that obtained by monopolar TUR [18].

Erol et al reported that in a trial of diode laser PVP with 47 patients, the IPSS decreased from a preoperative value of 21.9 to 4.9 after 6 months and Qmax increased from 8.9 ml/s to 18.3 ml/s [19]. In the present study with diode laser PVP, the IPSS changed from a preoperative value of 19.3 to 11.7, 8.2, and 7.4 at 1, 3, and 6 months after surgery, respectively, and Qmax changed from 8.5 ml/s preoperatively to 12.8, 15.1, and 16.7 ml/s after 1, 3, and 6 months, respectively. Compared with the reported results for the use of a diode laser by Erol et al, the decrease in IPSS and increase in Qmax were similar in this study [19].

In a single nonrandomized clinical series comparing the diode laser treatment at 980 nm with other lasers, complication rates were low and the authors reported low or no perioperative bleeding [20]. However, as a result of the increased tissue necrosis induced by the diode laser compared with the other laser, irritative symptoms as short-term complications such as prolonged dysuria or transient urge incontinence occurred more often in the diode laser group. In a human cadaver model, Seitz et al demonstrated that the coagulation depth could reach beyond 7 mm in the diode laser at 980 nm. Although diode laser prostatectomy could ablate the prostatic tissues immediately, the deeper coagulated tissues could escape vaporization, which led to remaining necrotic tissues [21]. This result explains the higher irritative events after diode laser prostatectomy. In our study, immediately after the procedure, 16 patients (16%) experienced mild dysuria, which resolved within 2 weeks without any specific treatment.

According to Seitz et al, there was no report of impotence in the 1 year follow-up observation of the group subjected to diode laser PVP [17]. Although completion of the International Index of Erectile Function (IIEF) was enticed in the present study, there were difficulties in evaluation because most of the patients failed to fill in the questionnaires. Although no patients voluntarily complained of impotency, it is difficult to objectively compare these results with the results of other existing research because accurate assessment of the extent of erectile function before the surgery could not be made. Assertive and specific investigation is deemed to be necessary in future follow-up examinations.

Although Te et al reported that PVP displays a lower extent of retrograde ejaculation in comparison to TURP [7], Erol et al reported the frequency as 31.7% in their study on diode laser PVP [19]. In the present study, none of the outpatients voluntarily complained of retrograde ejaculation. However, this result was based only on the complaints of the patients. We suspect that the number of patients experiencing retrograde ejaculation would be substantially higher, and more assertive and specific investigation of this will be considered in the future. Accordingly, it is difficult to objectively compare the retrograde ejaculation data obtained in the present study with those of other studies, and continuous outpatient observation is deemed to be necessary in the future.

This research has a weakness in that, as an early stage of research, the period of outpatient follow-up was short. In addition, consideration of the interpretation of the results is necessary for patients with risk factors (old age, high blood pressure, diabetes, and stroke). Although the presence of long-term complications such as urethral stricture and bladder neck contracture were not reported in this research, we suggest that continuous, long-term observation is needed in the future.

This study is significant as the first report in Korea to analyze the initial results of high-output 980 nm diode laser vaporization of the prostate, which did not differ significantly from the results of studies of high-output diode laser vaporization published overseas to date. Long-term follow-up observation of a larger number of patients should be carried out to confirm the favorable short-term results reported in this study.

CONCLUSIONS

In our current study, high-power diode laser vaporization of the prostate provided significant improvements in IPSS, Qmax, QoL, and PVR. Moreover, the complication rate was relatively minimal. According to our experience, it is a safe procedure that is easy to learn. Therefore, the outcome of the current study is encouraging. A longer period of data observation of a larger population and of postoperative complications should be evaluated next.

Conflicts of Interest

The authors have nothing to disclose.

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