New Technology/Lasers in Urology

Twelve-Month Follow-up Results of Photoselective Vaporization of the Prostate With a 980-nm Diode Laser for Treatment of Benign Hyperplasia

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Purpose: This study was conducted with the use of 12 months of follow-up data to evaluate the efficacy of photoselective vaporization of the prostate (PVP) with the 980-nm diode laser for the treatment of symptomatic benign prostatic hyperplasia (BPH).

Materials and Methods: The clinical data of 84 men with symptomatic BPH who underwent PVP with the 980-nm K2 diode laser between March 2010 and October 2011 were retrospectively analyzed. Postoperative parameters, including International Prostate Symptom Score (IPSS), quality of life (QoL) score, maximum urinary flow rate (Qmax), and postvoid residual volume (PVR), were assessed and compared with preoperative baseline values.

Results: Mean patient age was 72.4±6.5 years, and mean preoperative prostate volume was 47.2±16.3 g. Mean operative time was 23.3±19.1 minutes, and total amount of energy was 128±85 kJ. Mean catheterization time was 23.7±5.9 hours. At 1 month, significant improvements were noted in IPSS (11.5±6.8), QoL score (2.2±1.3), Qmax (12.9±6.5 mL/s), and PVR (41.2±31.3 mL). Three months after surgery, all postoperative follow-up parameters showed significant improvements, and the 6- and 12-month data showed sustained improvement of postoperative follow-up parameters. Bladder neck strictures were observed in 10.7% of the patients and urge incontinence in 16.6%.

Conclusions: PVP using a K2 diode laser is an effective procedure for the treatment of lower urinary tract symptoms secondary to BPH. PVP leads to an immediate and sustained improvement of subjective and objective voiding parameters. Surgeons should be vigilant for postoperative bladder neck stricture and urge incontinence.

Keywords: Benign prostatic hyperplasia; Complications; K2 diode; Laser

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INTRODUCTION

With the aging of society, the absolute number of patients undergoing surgery after a diagnosis of benign prostatic hyperplasia (BPH) is on the rise, which may be associated with the increase in the absolute number of BPH patients [1]. Transurethral resection of the prostate (TURP) is still considered the reference standard in the surgical therapy of lower urinary tract symptoms related to BPH even though the procedure may be associated with noticeable morbidity [2,3]. The introduction of different laser devices in the past two decades has offered new options for the transurethral management of BPH with the aim of reducing major perioperative complications such as TUR syndrome and hemorrhage [4]. Seitz et al. [5] reported preliminary data of a study based on the utilization of a diode laser of 1,470 nm at 50 W of power and obtained promising results in patients with BPH.

Numerous studies have shown that photoselective vaporization of the prostate (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 [6-8]. 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.

Here, we present our experience with 980-nm diode laser PVP after 84 cases and 12 months of follow-up.

MATERIALS AND METHODS

A retrospective study was performed from March 2010 to October 2011. The study was conducted on 84 patients who visited the department of urology for lower urinary tract symptoms and in whom BPH was diagnosed. In all cases, pharmacological treatment had been tried, with a minimal or null response. Patients were evaluated by means of anamnesis (the symptoms being evaluated through the International Prostate Symptom Score [IPSS] and quality of life [QoL] score), physical examination including digital rectal examination (DRE), prostate-specific antigen (PSA), transrectal ultrasonography, and uroflowmetry (peak maximum flow [Qmax]). Inclusion criteria were moderate to severe urinary symptoms, as determined by IPSS score ≥8 and Qmax of less than 15 mL/s with or without postvoid residual volume (PVR). Exclusion criteria were urethral stricture, previous prostatic surgery, prostate cancer, and obvious manifested neurogenic bladder dysfunction (PVR>400 mL). Spinal anesthesia was used in all cases, and surgery was performed by a single surgeon. The prophylactic antibiotics consisted of only one dose of 250 mg levofloxacin IV. Prostate vaporization was carried out by a diode laser at 980 nm (K2 diode laser system, Huentek Co., Gwangju, Korea) delivering 120 W of maximum output power with a 600-nm side-firing fiber within a spot 1 mm in diameter. In all cases, saline solution was used as the irrigant through a 23-Fr cystoscope.

Vaporization was started at the bladder neck and proceeded 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-Fr three-way catheter was placed despite obtaining clear urine or minimal hematuria. The urethral catheter was placed after the operation and was removed the next day, taking into consideration the degree of hematuria.

1. Statistical analysis

Postoperative Qmax, PVR, and IPSS with QoL score were obtained at 1, 3, 6, and 12 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 use of the Student t-test (paired); p-values of less than 0.05 were defined as statistically significant.

RESULTS

A total of 84 patients met the inclusion criteria. The patients' mean age was 72.4±6.5 years (range, 51 to 81 years), and the mean follow-up period was 16.6 months (range, 12 to 22 months). Preoperative parameters were as follows: IPSS, 19.8±8.6; QoL, 4.1±1.3; Qmax, 8.8±5.9 mL/s; PVR, 96.2±140.1 mL; PSA, 3.3±2.1 ng/mL; and prostate volume, 47.2±16.3 g (Table 1). Mean operation time (lasing time) was 23.3±19.1 minutes, and mean applied energy was 128±85 kJ.

Mean catheterization duration was 23.7±5.9 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 (11.5±6.8, $p < 0.05$), QoL score (2.2±1.3, $p < 0.05$), Qmax (12.9±6.5 mL/s, $p < 0.05$), and PVR (41.2± 31.3 mL, $p < 0.05$). 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 (8.0±5.7, $p < 0.05$), the QoL score (1.7±0.9, $p < 0.05$), Qmax (15.6±5.5 mL/s, $p < 0.05$), and PVR (33.6±31.5 mL, $p < 0.05$). All postoperative follow-up parameters were assessed again at 6 months after surgery. The 6-month total IPSS was 7.2±2.4 ($p < 0.05$), the QoL score was 1.3±0.8 ($p < 0.05$), Qmax was 16.4±5.01 mL/s ($p < 0.05$), and PVR was 22.6±23.8 mL ($p < 0.05$). The 12-month total IPSS was 5.8±3.4 ($p < 0.05$), the QoL score was 1.2±1.1 ($p < 0.05$),

TABLE 1. Characteristics of the patients

Variable	Mean±SD (range)
Age (y)	72.4±6.5 (54–81)
IPSS	19.8±8.6 (0–35)
QoL score	4.1±1.3 (1–6)
Qmax (mL/s)	8.8±5.9 (1.5–25.0)
PVR (mL)	96.2±140.1 (0–400)
PSA (ng/mL)	3.3±2.1 (1–5)
Prostate volume (g)	47.2±16.3 (21–90)

SD, standard deviation; IPSS, International Prostate Symptom Score; QoL, quality of life; Qmax, maximum urinary flow rate; PVR, postvoid residual volume; PSA, prostate-specific antigen.

TABLE 2. Perioperative outcomes

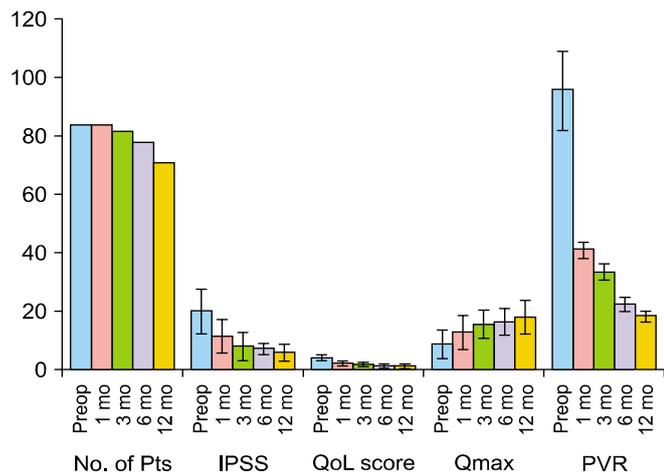|	Mean±SD (range)
Operation time (lasing time) (min)	23.3±19.1 (10–60)
Applied energy (kJ)	128±85 (5–250)
Catheterization time (hr)	23.7±5.9 (20–48)

SD, standard deviation.

FIG. 1. Changes in preoperative (preop) and postoperative values. No. of patients (Pts), IPSS, QoL score, PVR, and Qmax. IPSS, International Prostate Symptom Score; QoL, quality of life; PVR, postvoid residual volume; Qmax, maximum urinary flow rate.

Qmax was 18.1±6.4 mL/s (p<0.05), and PVR was 18.5±18.1 mL (p<0.05). All of the above 1-, 3-, 6-, and 12-month postoperative values were statistically significant when compared with baseline values and these significant differences were sustained throughout the follow-up period (Fig. 1).

There were no perioperative deaths or cases with systemic complications. Urethrotomy for postoperative urethral stricture was required in 1.2% (n=1) of patients. Dysuria occurred in 17.8% of patients (n=15). The complaints of these patients resolved spontaneously within 4 weeks.

Urge incontinence developed in 16.6% of patients (n=14), and some symptoms lasted until 6 months after surgery (n=1). But, after 12 months, that symptom had subsided. No patients had incontinence at the end of the follow-up period. The rate of bladder neck stricture was 10.7% (n=9) in our patients, with a significantly higher rate in patients with a small prostate (p<0.05). The mean prostate size for patients who developed bladder neck stricture after PVP was significantly smaller (36 mL vs. 49 mL, p<0.05) than that in patients without bladder neck stricture, whereas the mean energy delivered per mL of prostate tissue was comparable (3.0 kJ vs. 3.0 kJ).

DISCUSSION

The prevalence of BPH has shown a progressive increase, owing much to an increase in the elderly population, advancements in diagnostic methods, economic growth, and desire for a better QoL. Ninety percent of men aged 85 or older are believed to have BPH [9], of whom 25% to 30% need therapy [10]. Despite the large number of alternative procedures available, TURP remains the gold standard surgical technique for experienced surgeons.

However, with the recent increase in interest in non-surgical methods and minimally invasive therapy, many laser-using techniques for the treatment of BPH have been developed. Among these, promising surgical techniques are any kind of visual laser ablation procedures, such as potassium-titanyl-phosphate (KTP) vaporization, holmium:yttrium-aluminium-garnet (Ho:YAG) laser enucleation of the prostate, and diode lasers. The KTP laser allows good hemostasis owing to high affinity for hemoglobin as well as prostate vaporization. Given that the technique has a relatively easy learning curve, low morbidity, and published good medium-term results, its use has spread [6,11-18]. However, the operation time of KTP-laser prostatectomy is rather long because tissue vaporization is time-consuming. The Ho:YAG laser has high absorption in prostatic tissue and a minimal depth of penetration, allowing vaporization of the tissue. It has been used in the treatment of BPH either by vaporizing the tissue or by performing a split of the adenoma and carrying out enucleation of the gland [19,20]. But, the relatively longer learning curve of this procedure has been an obstacle, which has limited the widespread use of both techniques. Seitz et al. [5] reported the preliminary data of a study based on the utilization of a diode laser of 1,470 nm at 50 W of power and obtained some promising results in patients with BPH. 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. Seitz et al. [21] published in 1996 the use of the diode laser at 980 nm in the treatment of BPH (VLAP modality), although only a decade later new contributions with this energy source have been collected. In an *ex vivo* study, a 980-nm diode laser used at 120 W of power showed a capacity of ablation clearly superior (almost double) to the one obtained with laser KTP of 80 W [22].The main drawback of the diode laser is the lack of tissue retrieval, as with the Ho:YAG and KTP lasers. Therefore, patient evaluation regarding prostate cancer is very important. Although lower tissue ablation capacity compared to TURP may be considered another shortcoming of the technique, it is still superior to KTP, as shown in *ex vivo* studies, compared with other laser ablation techniques [23].

The relatively low number of patients who underwent postoperative TRUS imaging may be because the patients were unwilling to be in such an uncomfortable procedure after an operation. Despite these limitations, our present data revealed that significant tissue ablation can be attained. There are a few preliminary clinical studies on the efficacy of diode laser technology in the treatment of BPH [5,24,25]. All of these studies reported good results with this method compared with TURP. The energy of the novel diode laser is absorbed by hemoglobin in the tissue as well as is the energy of the KTP laser, and also by water in the tissue, thus making rapid vaporization and hemoglobin stasis possible [23,26,27]. Its application is as easy as KTP, and the energy generation device is more compact

and cheaper compared with Ho:YAG. Thus, it is more mobile and affordable [23]. Moreover, an *ex vivo* study showed that the diode laser has a higher tissue ablation capacity than does the KTP laser, which means a shorter operative time for the same amount of tissue [26]. Complication rates were low and the authors reported low or no perioperative bleeding. A single nonrandomized clinical series compared diode laser treatment at 980 nm with treatment with another laser [25]. However, as a result of the increased tissue necrosis induced by the diode laser compared with the other laser, irritative symptoms such as the short-term complications of prolonged dysuria or urge incontinence occurred more often in the diode laser group. In a human cadaver model, Seitz et al. [28] demonstrated that the coagulation depth could reach beyond 7 mm in the diode laser at 980 nm. Although diode laser prostatectomy could immediately ablate the prostatic tissues, the deeper coagulated tissues could escape vaporization, which led to remaining necrotic tissues. This result explains the higher irritative events after diode laser prostatectomy. In our study, immediately after the procedure, 15 patients (17.8%) experienced mild dysuria, which resolved within 4 weeks without any specific treatment. A possible explanation behind the absence of clinically problematic dysuria might be the experience associated with carrying out diode vaporization.

As a diode vaporization surgeon becomes more experienced, inadvertent coagulation caused by inefficient fiber sweep and tissue contact occurs less often. It is postulated that this coagulation instead of vaporization might be responsible for the increased dysuria experienced subsequently.

Urge incontinence developed in 14 of our patients (16.6%), and some symptoms lasted until 6 months after surgery (n=1). However, after 12 months, that symptom had subsided. These patients were usually treated successfully with anticholinergics and oral anti-inflammatory drugs and analgesics. No patients had incontinence at the end of the follow-up period. In our series, no clinically relevant urge incontinence was observed.

According to Ruszat et al. [29], there was no report of impotence in the 1-year follow-up observation of the group subjected to diode laser PVP. Although completion of the International Index of Erectile Function was attempted in this 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 deemed to be difficult to make objective comparisons with the results of other 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 during follow-up examination in the future. Although Te et al. [6] reported that PVP displayed a lower extent of retrograde ejaculation compared with TURP, Erol et al. [24] reported the frequency as 31.7% in their study on diode laser PVP. In the present study, none of the outpatients voluntarily complained of retrograde ejaculation. However, this was on the basis only of the complaints of the patients and it is likely that there would be a substantially larger number of patients with retrograde ejaculation. More assertive and specific investigation of this should be considered in the future. Accordingly, it would be difficult to objectively compare the retrograde ejaculation data obtained in the present study with data from other studies, and continuous outpatient observation in the future is needed. The rate of bladder neck stricture was significantly associated with small prostates in our study ($p < 0.05$). This complication is more likely to occur by excessively widening a small sized prostate, which damages normal tissue. The complications after diode laser surgery have considerably decreased over the past decades because of advances in surgical techniques and more widespread expertise. However, the use of lasers remains investigational. We solved this risk with bladder neck incision and recatheterization for several days, but a prophylactic bladder neck incision procedure may be a good option to lower risks. There are some complications associated with diode PVP, but the results of our study showed that improvements in functional outcomes begin in the postoperative third month and are sustained through 12 months postoperatively.

CONCLUSIONS

The search for the best and least invasive endoscopic treatment for BPH continues. Although patients may need a repeat operation owing to bladder neck stricture or urethral stricture, or may briefly experience discomfort due to urge incontinence, the diode laser is a promising treatment method. The preliminary results of our series suggest that the 980-nm diode laser is effective for the treatment of BPH with few side effects. The improvements in functional outcome began in the third month and were sustained for 12 months of follow-up. However, to make a stronger recommendation, studies with long-term results that are conducted in a larger patient population and that include comparison with other treatment methods, such as KTP or TURP, are needed.

CONFLICTS OF INTEREST
The authors have nothing to disclose.

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