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ORIGINAL ARTICLE

Preliminary results on selective light vaporization with the side-firing 980 nm diode laser in benign prostatic hyperplasia: an ejaculation sparing technique

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This study examined efficacy and safety of the 980 nm side-firing diode laser operating at a power of 100 W in patients with lower urinary tract symptoms associated with benign prostatic hyperplasia (BPH). Patients were selected for surgery on the basis of maximum urinary flow rate (Qmax) $\leqslant$15 ml/s or transvesically measured post-voiding residual volume (PVR) $>$100 ml in conjunction with an International Prostate Symptom Score (IPSS) $>$7. Laser therapy was conducted under spinal anaesthesia. Qmax, IPSS, prostate volume, PVR, IPSS-Quality of Life (QoL) questionnaire and ejaculatory function were measured at baseline and at 1, 3, 6 and 12 months post-laser therapy. A total of 52 consecutive patients aged 52–65 years with mean (s.d.) prostate volume of 45.14 (9.15) g were treated. All patients were able to leave the hospital at a mean (s.d.) of 5 (2) h after the procedure. Mean (s.d.) follow-up was 100 (75.49) days. A significant reduction in IPPS was reported at 1 month ($P<0.0001$) and this was maintained through to 6 months. Significant durable improvements in Qmax, PVR and IPSS-QoL score were also reported for all patients ($P<0.0001$). No severe complications were reported, including any cases of urinary incontinence or significant irritative symptoms. None of the patients complained of a worsening of erectile function. This early experience in a pilot study with the 980 nm diode laser seems promising in the short-term and long-term outcome is being monitored.
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Keywords: benign prostatic hyperplasia; laser therapy; lower urinary tract symptoms; antegrade ejaculation preservation

Introduction

The gold standard treatment of benign prostatic hyperplasia (BPH) has been transurethral reaction of the prostate (TURP), but in recent years, alternative methods of removing prostate tissue have been developed. These techniques have aimed to overcome the not inconsiderable complications associated with TURP, including bleeding, retrograde ejaculation and incontinence.[1,2] One such procedure is laser prostatectomy involving tissue vaporization, which results in an instantaneous debulking of the tissue. According to the wavelength, the power and the mode of action (continuous or pulsed mode) there is the possibility of avoiding coagulative effects within the prostate tissue. These effects are considered to be responsible for irritative symptoms experienced after the laser procedure. The neodymium: Yttrium aluminum garnet (YAG) laser emits a beam at 1064 nm and can penetrate to a depth of 10 mm.[3] More recently, the potassium-titanyl phosphate (KTP) crystal laser that operates at a wavelength of 532 nm, which has been developed to vaporize the tissue,[4] is absorbed by haemoglobin but not by water and penetrates to a depth of 0.8 mm. The diode operating laser system, operating at a wavelength of 980 nm penetrates to a depth of 0.5 mm, has a high absorption in both water and haemoglobin and is proposed to offer high tissue ablation with good haemostasis.[5] These characteristics also afforded the possibility of working in a pulsed mode, which allowed the development of the 'Lifting and Rolling' technique described in this report. The laser has been studied at operational power levels of 30–120 W in *ex-vivo* studies.[5] A small-scale study involving 10 patients has been reported using the side-firing diode laser operating in a continuous mode a wavelength of 1470 nm and a 50 W power in a contact/non-contact mode.[6] At 12-month follow-up, significant improvements in maximum flow rate (Qmax) and post-voiding residual (PVR) volume were shown. No intraoperative bleeding was reported and the overall morbidity was low. None of the patients had transient haematuria or urgency. This report is the first study on the use of the 980 nm diode laser operating at a power of 100 W

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in a contact pulsed mode in patients with BPH. In terms of outcome, this pilot study focused not only on the functional outcome but also on the associated morbidity of the technique.

Materials and methods

From May 2007 to May 2008 patients with lower urinary tract symptoms associated with BPH were selected for laser surgery. Patients who did not respond to medical therapy were selected for the treatment (α_1-blocker/5α-reductase inhibitor therapy for >1 year) or declined to use medical therapy. Inclusion criteria were Qmax $\leqslant 15$ ml/s, transvesically measured PVR volume >100 ml and an International Prostate Symptom Score (IPSS) >7. All patients were required to have a normal ejaculatory function before the procedure. Patients were not required to discontinue anticoagulant therapy before the procedure. In this single-centre pilot study, patients were treated by a single surgeon with the 980 nm diode laser (Evolve, Biolitec, Germany). The procedure was conducted under epidural anaesthesia using a diode side-firing laser with a 70°-emitting beam. The fibre had an orange marker on one side and a black marker on the opposite side corresponding to the direction of firing of the beam. A 100 W pulsed power (0.1 s pulse length; 0.01 s pulse interval) was used in contact mode for vaporesection. Occasionally, the procedure was finalized using a 70 W power in a continuous, non-contact mode to remove any residual tissue. To obtain a sliding movement, a 26-Ch continuous flow laser cystoscope was used with a special working element for a laser side fibre of 600 micron, a 30° optical view and a video column. Normal saline solution was used for irrigation throughout the procedure.

The technique adopted paid special attention to preserving ejaculatory function and involved sparing a triangle of urethral mucosa, which was defined as the ejaculatory triangle, and that had the bladder neck at its base and ended in a flat apex with the seminal colliculus. The actual technique began by engraving the ejaculatory triangle to be saved, starting from the bladder neck at 5 and at 7 o'clock, progressing downwards and keeping a distance of approximately 0.5 cm from the median urethral crest, bilaterally up to approximately 2 mm from the seminal colliculus. Several furrows were created by lifting prostate tissue in a contact mode from the bladder neck to the apex. The crests of the furrows were then ablated using a rolling movement of the fibre also in a contact mode. The term 'Lifting and Rolling' was used to describe this novel technique. In addition, to preserve ejaculatory function, the muscle fibres at the bladder neck were preserved. Two options were used to remove the median lobe. The first involved vaporization with a non-contact technique at a lower power of 70 W, smoothing progressively the surface from the tip to the base. The other method involved using the laser fibre, such as a Collin's knife, proceeding from the 5 to 7 o'clock positions in a transverse direction to obtain a decapitation of the median lobe. Before decapitation, the lobe was divided into two parts and after decapitation, it was extracted from the bladder. The procedure was stopped when the surgical capsule had been reached

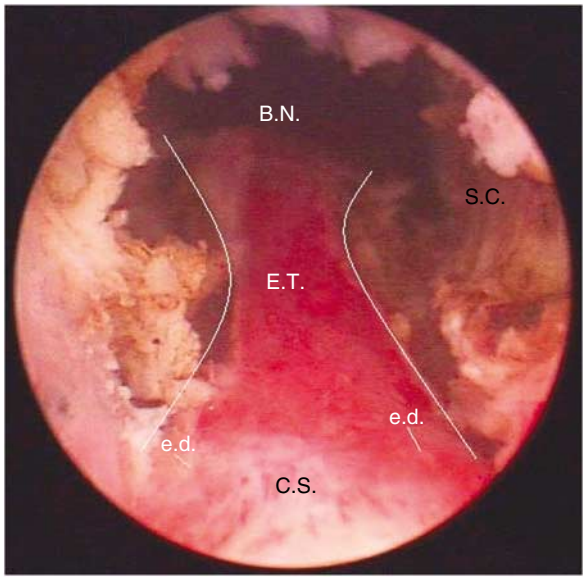

Figure 1 The final endoscope vision after treatment with the diode laser with preservation of the ejaculatory triangle (ET); BN, bladder neck; ed, ejaculatory duct; CS, colliculus seminalis; SC, surgical capsule.

(Figure 1). For patients with a prostate volume of 30–40 ml, no post-laser catheterization was used. In cases, in which the prostate was 40–60 ml, a 20-Ch three-way catheter was inserted without irrigation post-procedure and left *in situ* for no more than 36 h. In normal circumstances, the patients were able to leave the hospital at a mean of 5 h after the procedure.

Assessment

The following parameters were measured at baseline and at 1, 3, 6 and 12 months post-laser therapy: Qmax, IPSS, PVR and IPSS-QoL (Quality of Life questionnaire). Prostate volume (transrectal ultrasonographic measurement) was measured at baseline. International Index of Erectile Function-5 score was measured at baseline and 1 month.

Statistics

The change from baseline was analysed for each variable using a Wilcoxon signed-rank test. This tests whether the change is significantly different from zero, and makes no assumptions as to the underlying distribution of the data. A two-sided P-value of <0.05 was considered to be statistically significant.

Results

A total of 52 consecutive patients aged 52–65 years were treated with the diode laser. Prostate volumes ranged from 30 to 60 ml; mean (s.d.) 45.14 (9.15) ml; eight patients had prostates with a median lobe. Operating times ranged from 30 to 60 min, with a mean (s.d.) of 40.75 (8.8) min. Blood loss during the procedure was minimal. There was no significant change in haemocrit

Table 1 Outcome in patients treated with the side-firing 980 nm diode laser

Parameter	*Baseline* (n = *52*)	*1 month* (n = *52*)	*3 months* (n = *52*)	*6 months* (n = *52*)	*12 months* (n = *22*)
Mean (s.d.) IPSS	18.4 (5.8)	9.5 (6.8)	7.5 (5.9)	6.2 (3.5)	6 (0.6)
% improvement		48%	59%	66%	67%
Mean (s.d.) Qmax (ml sec^{-1})	7.5 (4.1)	18.5 (9.4)	20.9 (8.4)	21.0 (7.2)	19.7 (1.4)
% improvement		147%	179%	180%	163%
Mean (s.d.) PVR (ml)	160 (140)	32 (14)	24 (22)	23 (20)	20.3 (4.4)
% improvement		80%	85%	86%	87%
Mean (s.d.) IPSS–QoL	3.5 (1.2)	1.6 (1.8)	1.3 (1.2)	1.2 (1.1)	1.2 (0.4)
% improvement		54%	63%	66%	66%

Abbreviations: IPSS, International Prostate Symptom Score; PVR, postvoid residual urine; Qmax, maximum flow rate; QoL, quality of life.
The change from baseline for all parameters at all timepoints was significant ($P < 0.0001$).

after the procedure, with mean reduction of <0.5% recorded. All patients were able to leave the hospital at a mean (s.d.) of 5 (2) h after the procedure. The transurethral catheter was removed after 12–36 h; mean (s.d.) was 24 (16.96) h. Follow-up on all patients at 6 months and on 22 patients at 12 months is shown in Table 1. A significant reduction in IPPS ($P < 0.0001$) and IPSS-QoL ($P < 0.001$) was reported at 1 month and this was maintained through to 6 months (−66% reduction). Durable improvements in Qmax (+180% at 6 months; $P < 0.0001$) and PVR (−86% at 6 months; $P < 0.0001$) were reported for all patients. No severe complications were reported, including any cases of urinary incontinence. In three patients, the catheter had to be reintroduced after 48 h for a further 24-h period because of temporary urine retention. Only one case of mild haematuria was recorded at the fourteenth postoperative day, which required catheterization with a continuous irrigation for 2 days as a precaution. None of the patients complained of significant irritative symptoms post-treatment that were significant on the basis of the lack of requirement for treatment or their severity. Before surgery, all patients had functional antegrade ejaculation and this was maintained in 50 patients; two patients reported retrograde ejaculation (no emission of seminal fluid) and two patients reported a reduced volume of ejaculate. No patient complained of a worsening of erectile function. International Index of Erectile Function-5 score was 22–25 at baseline and no reduction in score was reported at 1-month post-procedure.

Discussion

The technique used to ablate tissue with the 980 nm diode laser has been shown to be safe and effective in this pilot series of patients with short-term follow-up. The use of the laser in a contact mode with the prostate tissue is considered to be an advantage and is similar to urologists' experience with the TURP procedure. This form of vaporization is considered to be more controllable than other procedures, in which the laser has to be fired from a certain distance to the tissue, such as with the KTP laser.[7] In this study, improvements in all three key parameters associated with BPH were reported; the percentage change in mean IPSS, Qmax and PVR at 6 months was −66, +180 and −86%, respectively. These results are comparable to 6-month outcome data published on other lasers. Bachmann *et al*.[8] reported changes in the mean IPSS, Qmax and PVR at 6 months of −71.3, +162.3 and −91.2%, respectively, after photoselective vaporization with the 80 W KTP laser. Malek[4] also reported good outcome with this laser, but at the lower power of 60 W; changes in mean American Urological Association Symptom Index (AUA-SI), Qmax and PVR at 6 months were −79.1, +238, −81%, respectively. One of the more established lasering techniques involves the holmium (Ho):YAG laser in two procedures termed Ho laser ablation and Ho laser enucleation of the prostate (HoLEP). 6-month outcome data using HoLEP for IPSS, Qmax and PVR are typically −70, +184 and −74%, respectively.[9] Both the KTP and Ho:YAG lasers are associated with durable long-term results.[4,9] Significant improvement in the patients' QoL was reported postoperatively. Similar results have been reported with other lasers.[10,11]

The 980 nm diode laser has good coagulative properties and the incidence of bleeding during the procedure was minimal. The patient, in whom haematuria occurred, had bleeding from large vessels at the bladder neck. These vessels were coagulated by firing the laser at a greater tissue distance, which reduced the power, but the haematuria may have been because of the falling-off of the coagulated tissue. It was also unnecessary to discontinue anticoagulant therapy before the procedure. Targeted vaporization was achieved in this study even in sensitive areas, such as the prostatic apexes and the region of the ejaculatory ducts, thus reducing the incidence of incontinence and ejaculatory dysfunction. No cases of incontinence were reported. Incontinence rates reported with the HoLEP range from 0.5[10] to 3%,[12] whereas incontinence rates reported with the PVP using the 80 W KTP laser range from 0 to 1.4%.[13] In terms of retrograde ejaculation, the two cases reported in this study occurred in patients with a median lobe, which was lasered in a non-contact mode. This potentially could have caused the damage to the circular muscle fibres at bladder neck. The incidence of ejaculatory dysfunction is far lower than with other lasers. A retrograde ejaculation rate of 70% at 6 months after the HoLEP procedure has recently been reported,[14] whereas electrovaporization of the prostate using the Nd:YAG laser has resulted in retrograde ejaculation rate of 63%.[15]

The low rate of post-treatment irritative symptoms reported in this study is thought to be because of a low thermal diffusion in the tissues that are not vaporized according to the characteristics of the wavelength used, the possibility of working in a contact (Lifting and Rolling) pulsed mode and very low depth coagulative necrosis. The pulsed mode also allows the heat to

disperse more easily in the tissue's haematic flow.[16] Dysuria rates reported with other laser therapies vary from 6[17] to 9.4%[13] with the 80 W KTP laser. In this study, temporary urinary retention reported in three patients (5.8%) was resolved by 24-h catheterization. Recatheterization with the HoLEP procedure varies from 0 to 7.7%[18,19] and with the 80 W KTP laser from 1[4] to 15.4%.[20]

Conclusion

This early experience in a pilot study with the 980 nm diode laser seems promising in the short-term with good outcome and a low rate of complications. There is also good possibility of preservation of anterograde ejaculation with the technique described. Long-term outcome is being monitored.

Conflicts of interest

None.

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