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Diode 980 nm Laser Vaporesection of the Prostate: A Comparison of 150 to 250 Watt

Diode 980 nm Lazer ile Prostat Vaporezeksiyonu: 150 ve 250 Watt Karşılaştırılması

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What's known on the subject? and What does the study add?

To the best of our knowledge, there are no large studies showing the efficacy and morbidity for 250 Watt diode laser for endoscopic prostate vaporization or vaporesection. We showed that it is more efficient than 150 Watt and it can be used safely for large prostates.

Abstract

Objective: The aim of this study is to compare the efficacy and morbidity of the diode 980 nm laser at two different power settings for vaporesection of the prostate.

Materials and Methods: A retrospective evaluation of patients who were operated for benign prostatic enlargement by the same surgeon at two different laser power settings. A hundred thirty six patients included in the study were consecutively randomized into 2 groups by certain time periods. The first group consisted of 57 patients with benign prostatic hyperplasia who were treated with 150 Watt and the remaining 79 treated with 250 Watt. International Prostate Symptom Score (IPSS), IPSS-quality of life (QoL), prostate volume, postvoid residual urine, maximum flow rate (Q_{max}) and prostate specific antigen (PSA) levels were recorded preoperatively and at 3 and 12 months postoperatively. Total energy consumption, lasing times and complications were noted.

Results: IPSS, Q_{max} and IPSS-QoL improved significantly in both groups in accordance with the decrease in prostate volume, postvoid residual and PSA levels. IPSS, Q_{max} improvement and prostate volume reduction were greater in the second group at the 12^{th} month. Early postoperative irritative symptoms such as dysuria and urge incontinence were significantly more common in the first group ($p<0.05$). Infravesical obstruction due to necrotic prostate tissue, which required secondary intervention, solely occurred in 5 patients of the second group.

Conclusion: Both power settings provided adequate patient satisfaction and significant improvements in objective outcome parameters in the long term, however, high power settings would be preferred for bigger glands for greater volume reduction.

Keywords: Diode laser, Prostatectomy, Vaporisation, Vaporesection, Prostate, Benign prostate hyperplasia, Infravesical obstruction

Öz

Amaç: Bu çalışmanın amacı, iki farklı güç seçeneği kullanılarak yapılan 980 nm diode lazer ile prostat vaporezeksiyonu operasyonlarını etkinlik ve morbidite açısından kıyaslamaktır.

Gereç ve Yöntem: Benign prostat büyümesi tanısı ile lazer prostatektomi uygulanan 136 hastanın ameliyat sonrası takiplerindeki bulgularının retrospektif olarak incelendiği bir çalışmadır. Hastalar ameliyat oldukları tarih aralıklarına göre gruplara iki farklı lazer güç seçeneği ile opere olmuş ve buna göre iki gruba ayrılmıştır. İlk grup 57 hastadan oluşmaktadır ve bu hastalar 150 Watt güç kullanılarak opere edilmiştir. İkinci grup ise 79 hastadan oluşmaktadır ve 250 Watt ile opere edilmiştir. Tüm hastaların Uluslararası Prostat Semptom Skoru (IPSS) ve IPSS-yaşam kalitesi (QoL) skorları, prostat hacimleri, maksimum akış hızı (Q_{max}) değerleri ve prostat spesifik antijen (PSA) seviyeleri preoperatif ve postoperatif 3. ve 12. ayda kayıt edilmiştir. Toplam harcanan enerji, lazer kullanım süreleri ve komplikasyonlar da kayda alınmıştır.

Bulgular: IPSS, Q_{max} ve IPSS-QoL parametreleri her iki grup için de prostat hacmi, postvoid rezidü ve PSA seviyelerindeki azalmayla uyumlu olarak belirgin olarak düzelmiştir. On ikinci ay kontrolünde IPSS skor artışı, Q_{max} değerlerindeki artış ve prostat hacim küçülmesi 2. grup için daha belirgin olmuştur. Erken postoperatif irritatif semptomlar ise ilk grupta daha yüksek oranda görülmüştür ($p<0,05$). İkincil müdahale gerektiren nekrotik prostat dokusuna bağlı infravezikal obstrüksiyon 5 hastada görülmüştür.

Sonuç: Uzun vadede her iki güç seviyesinde de hasta memnuniyeti ve objektif parametrelerde belirgin gelişmeler elde edilmekteyse de, yüksek güç seviyesi özellikle daha büyük prostat hacimlerinde daha etkili olmuştur.

Anahtar Kelimeler: Diode lazer, Prostatektomi, Vaporizasyon, Vaporezeksiyon, Prostat, Benign prostat hiperplazisi, İnfravezikal obstrüksiyon

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Introduction

Various lasers at different wavelengths and power settings have been used for benign prostatic hyperplasia (BPH) as proven alternatives to the gold standard transurethral resection of the prostate (TURP) (1). Laser vaporization and vaporesection are more widely used due to a relatively short learning curve compared to enucleation. TURP has its own drawbacks despite still being considered as the gold standard for the surgical treatment of BPH. Size of the gland (i.e., greater than 80 g) and high risk in patients with bleeding tendency in whom anticoagulant use is a must, are among the primary limitations (2,3,4). Since the introduction of 80 Watt potassium-titanyl-phosphate (KTP) 532 laser, both the fiber durability and the laser power have been among the major concerns despite successful initial short term results (5). Therefore, the power of KTP 532 has been increased from 80 to 180 Watt, and more durable fiber was concomitantly developed (6,7,8). Similar attempts have also been made for 980 nm wavelength diode lasers. While the power has been increased from 100 Watt to 300 Watt, side firing fiber was completely replaced by the Twister™ fiber, which allows working in the contact mode as the easiest way of resection or vaporization (9). According to our earlier experience obtained from KTP 532 and 980 diode lasers, higher power increases the speed of vaporization as well as possibility of higher complication rates particularly in the hands of an inexperienced surgeon (10). Considering the fact that men use more anticoagulants as they get older as most of BPH patients who need surgical intervention in an increasing manner, lasers, with no distinction among them, constitute better alternatives for such patients (11,12). The size is not a contraindication for laser enucleation, however, vaporization or vaporesection works as a function of time depending upon the fiber durability (13). Long and steep learning curve of enucleation prevents its worldwide use contrary to the easier vaporization or vaporesection techniques (14). Although successful reports appeared in the literature, even with the powers as low as 80 Watt, higher reoperation rates in the long term have led to the new developments both in power as well as fiber technology. KTP 532 reached up to 180 Watt power, with self-cooling fiber, on the other hand, 300 Watt 980 nm diode lasers are now in use with uniquely designed fiber. Twister™ fiber allows working in the contact mode, being capable of both resection and vaporization, not requiring special expertise as long as the surgeon is familiar with TURP. We have been able to speed up the vaporization parallel to the increasing power, however, it is not known what should be the uppermost energy level, which is adequately effective while keeping the patients out of the harm's way. Enucleation using holmium laser at the power as low as 50 Watt has been successful (15). Therefore, high powers may only be necessary when vaporization or vaporesection is attempted. Hence, we compared the two different power settings at the same wavelength to seek an answer to this question. In this study, we compared the data obtained from a 3-year period of laser vaporization with 980 nm diode using Twister™ fibers at two different powers, 150 and 250 Watt, regarding their efficacy as well as complication rates.

Materials and Methods

Patients who were operated for benign prostatic enlargement at two different laser power settings were retrospectively evaluated. The patients were selected consecutively by a certain time period which they were operated. The first treatment arm (180 Watt) consisted of patients who were operated between January 2014 and December 2015. The second treatment arm (250 Watt) consisted of patients who were operated between January 2015 and December 2016. All the operations were made by the same surgeon.

A total of 136 patients, who underwent laser prostate vaporesection, were included in the study. Digital rectal examination (DRE), urinalysis, International Prostate Symptom Score (IPSS), quality of life (QoL) assessment, uroflowmetry, prostate volume and postvoid residual (PVR) urine volume measurement via transabdominal ultrasound were performed, and serum prostate specific antigen (PSA) levels were evaluated prior to the operation. The possibility of prostate cancer was excluded in patients with suspicious DRE findings and/or a high PSA level by prostate biopsies. The patients on warfarin were switched to a low molecular heparin when possible, whereas aspirin use was not a contraindication. An informed consent was obtained from each patient prior to the operation. Data were analyzed after approval of the İstanbul Bahçeşehir University Ethics Committee (number: BAU- 2013/U1).

Patients were elected for surgery if they had urinary retention or a maximum flow rate (Q_{max}) <12 mL/sec, PVR >150 mL, IPSS >8 and IPSS-QoL score >3 despite medical therapy. IPSS was considered 35 if the patient had a chronic indwelling catheter. Exclusion criteria were previous lower urinary tract surgery (i.e., urethral stricture, TURP for BPH or bladder tumor), prostate cancer, bladder overactivity, urinary tract infection, and bladder stone.

The first 57 patients (group 1) underwent prostate vaporesection using an older version of 980 nm diode laser (Evolve® laser, Biolitec AG, Germany) with a maximum power of 180 Watt. Since it was replaced by the current version with 300 Watt maximum power, prostate vaporesection was performed at 250 Watt continuous power using the same Twister™ large fiber (Twister™ SF, Biolitec AG, Germany) in the second group of 79 patients (group 2). Twister™ is a recently developed laser fiber with its own angle at the tip, but devoid of internal reflective

mechanisms, which makes it possible to work in the contact mode due to less vulnerability to the reflected beams. There is no energy limit up to a 3.5 hours lifespan.

Urethral catheters were removed on the next day. Prostate volumes, IPSS, Q_{max}, IPSS-QoL score, PVR and serum PSA levels were recorded at 3 and 12 months postoperatively. Total energy consumption and lasing times were noted. Complications were also recorded.

Statistical Analysis

The distribution of variables was tested with the Kolmogorov-Smirnov test. The independent samples t-test and Mann-Whitney U test were used for the comparison of quantitative data. The Wilcoxon test was used for the repeated measurement analysis. Chi-square test was used for the comparison of the qualitative data. SPSS 22.0 was used for statistical analysis. A p value of less than 0.05 was considered statistically significant.

Results

The groups were found to be similar in terms of age (group 1: 72.4±8.2, group 2: 73.8±1, p=0.444) and the number of patients with an indwelling catheter (group 1: 38.2%, group 2: 39.2%, p=0.902) and the American Society of Anesthesiologists physical status (group 1: 2.04±0.90, group 2: 2.47±1.02, p=0.028), however, the number of patients on anticoagulant medications was significantly higher in group 2 than in group 1 (49.1% vs 77.2%, p<0.001).

Preoperative IPSS, Q_{max}, the mean prostatic volume, PVR and PSA levels were similar in both groups as the mean IPSS-QoL score (group 1: 4.6±0.9, group 2: 4.7±0.1, p=0.892). Objective outcome parameters were significantly improved in both groups throughout the follow-up. IPSS improvement was significantly greater in group 2 at 3rd and 12th month. However, Q_{max} value was significantly higher in the second group only at 12 months after surgery (Table 1). Prostate volume reduction was greater in the second group at 3rd and 12th month (p=0.002 and p=0.004).

The mean energy consumption in the first group was 32% lower than the second group (p=0.003), also indicating 17.4% less energy usage per gram of prostatic tissue (p=0.004). Nevertheless, higher power was faster than lower power when the lasing time required per gram of tissue was taken into account (p=0.055) (Table 2). The overall lasing time did not differ significantly (p=0.159).

Of the 79 patients in the group 2, one was unable to void at the first attempt and needed recatheterization and one necessitated a longer catheterization due to hematuria. No transfusion was required. Urinary tract infection and stress urinary incontinence rates were similar. One patient from each group required urethral dilatation due to urethral or bladder neck stricture. Early dysuria and urge incontinence were seen more frequently in group 1 than in group 2 (p=0.016 and p=0.044, respectively) (Table 3). An unexpected complication of high power laser was obstructive necrotic tissue remnants which required re-operation and removal of necrotic tissues in 5 patients of the group 2 who had midsized prostates (<60 g) (Figure 1).

Discussion

In our study, we were able to show that both lasers have equally been effective in terms of objective outcome parameters throughout the follow-up. However, the low power caused

Table 1. Preoperative and follow-up comparative data in each group

Parameter	Follow-up	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p value
IPSS	Preoperative	27.7±6.7	27.4±7.4	0.742
	3 months	4.6±2.2*	3.7±1.4*	0.011
	12 months	2.9±1.3*	2.3±1.1*	0.003
Q_{max} (mL/sec)	Preoperative	8.0±2.5	7.7±3.5	0.380
	3 months	20.5±5.9*	18.8±3.6*	0.114
	12 months	21.6±5.9*	18.7±3.4*	0.006
Prostate volume (cc)	Preoperative	67.8±32.4	75.3±34.5	0.162
	3 months	32.4±14.6*	32.2±18.3*	0.499
	12 months	29.3±12.9*	28.6±16.3*	0.390
PVR (mL)	Preoperative	127.6±45.1	154.1±67.9	0.747
	3 months	16.7±12.2*	20.8±34.1*	0.394
	12 months	12.5±14.3*	12.8±10.0*	0.876
PSA (ng/mL)	Preoperative	3.5±1.9	5.0±6.9	0.789
	3 months	2.0±1.9*	1.5±0.9*	0.155
	12 months	1.7±1.3*	1.5±0.9*	0.887
IPSS-QoL score	Preoperative	4.6±0.9	4.7±0.1	0.892
	3 months	1.1±0.6*	1.0±0.6*	0.445
	12 months	1.1±0.6*	1.0±0.7*	0.406

IPSS: International Prostate Symptom Score, Q_{max}: Maximum flow rate, PVR: Postvoid residual, PSA: Prostate specific antigen, QoL: Quality of life, SD: Standard deviation
*Highly significant to baseline (p<0.001)

Table 2. Comparison of laser data

Variables	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p value
Lasing time (min)	45.6±23.5	38.7±19.2	0.159
Energy consumption (kJ)	333±166	440±214	0.003
Lasing time per tissue weight (min/g)	0.45±0.23	0.38±0.19	0.055
Energy consumption per tissue weight (J/g)	4969±1405	6015±2339	0.004

more irritative symptoms in the short term, probably due to shallower coagulation depth at the surface rendering the nerves more susceptible to stimuli in the early postoperative period.

Using side firing fibers for vaporization is somewhat challenging, because the distance between the fiber tip and the tissue should be kept stable during vaporization, working either too close or far from the tissue, may result in fiber damage or coagulation. Contrary, Twister™ fiber obviates the reflected or scattered beams and creates a smaller spot size due to working in the contact mode regardless of the surgical technique. The 980 nm wave length tends to penetrate deeply, however, the power setting and lasing time are the other important determinants with regards to vaporization efficacy and the depth of coagulation as reported by Takada et al. (9) recently. They used bovine prostate as an experimental model to investigate the effects of diode (980 nm) laser at various power settings up to 300 Watt and irradiation times. They concluded that the speed of vaporization and depth of coagulation were correlated with the power and irradiation times up to 250 Watt. Conversely, increasing the power from 250 Watt to 300 Watt did not increase vaporization efficiency but the depth of coagulation. Therefore, limiting the uppermost energy level at 250 Watt seems reasonable, considering the fact that the animal model was devoid of blood circulation.

Table 3. Comparison of postoperative complications

Complications	Group 1	Group 2	p value
Significant hematuria	0	1 (1.3%)	0.418
Retention during hospital stay	0	1 (1.3%)	0.418
Dysuria	11 (20.0%)	5 (6.3%)	0.016
Urge incontinence	6 (10.9%)	2 (2.5%)	0.044
Stress incontinence	0	3 (3.8%)	0.269
Urinary tract infection	0	2 (2.5%)	0,512
Bladder neck contracture	1 (1.8%)	1 (1.3%)	0.788
Obstructive necrotic tissue	0	5 (6.3%)	0.059

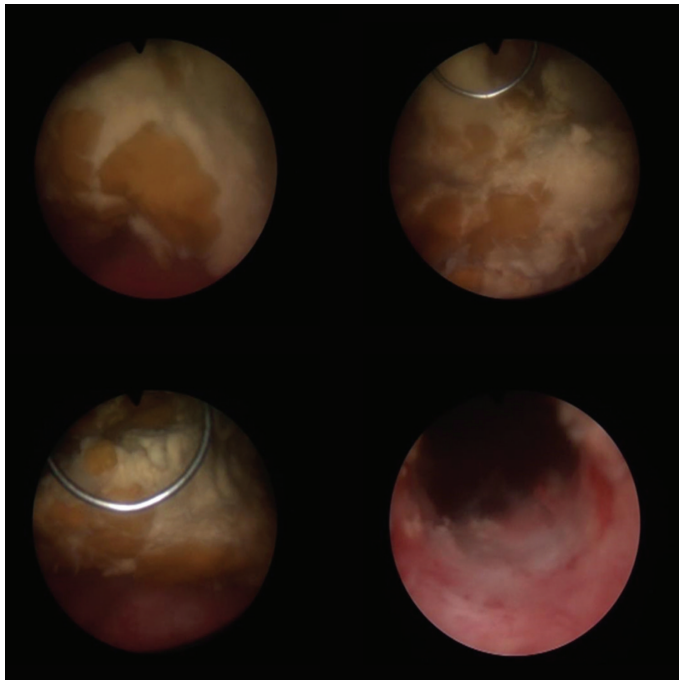

Figure 1. Removal of obstructive necrotic tissue remnants

A more recent study from Turkey by Cetinkaya et al. (16) showed that vaporization of the prostate with a diode laser was as safe and effective as TURP, and both had similar complication rates and functional results. Diode laser has the advantage of shorter hospitalization and catheter indwelling times and there is no need for discontinuation of anticoagulant therapy (16). Bipolar endoscopic enucleation of the prostate was recommended by the 2016 European Association of Urology guidelines as the first choice of surgical treatment in men with a substantially enlarged prostate and moderate-to-severe lower urinary tract symptoms and it is getting more popular in the last few years. In their randomized controlled study, Zou et al. (17) from China demonstrated that diode laser prostate enucleation was non-inferior to bipolar enucleation regarding Q_{max} and IPSS at 12 months postoperatively.

Our data revealed 17.4% faster speed with 250 Watt at a cost of 32% more energy consumption. This suggests that a substantial amount of energy may go deeper leading to a larger coagulation zone, which may be followed by a larger tissue sloughing or even a total transitional zone necrosis, albeit rare. A deep vascular compromise may also be responsible for this phenomenon apart from homogenous deep coagulation. Patients usually describe the evacuation of necrotic pieces during micturition, which may not be possible in case of poor bladder contractility or in the presence of big pieces of necrotic tissue. Timing of obstruction due to necrotic tissues is variable. It may develop a couple of months after the operation. Urinary difficulties or complete urinary retention may suggest obstructive necrotic tissue, which requires re-intervention. Fortunately, the necrotic tissues were well demarcated facilitating removal without using energy in most cases. Simply pushing the necrotic tissues towards the bladder followed by irrigation is enough, however, forceful maneuvers should be avoided if a resistance is encountered. Suprapubic methylene blue injection into the bladder may be useful as a guide in cases with severe obstruction. Patients may require cystostomy due to complete obstruction prior to the surgical intervention. We prefer 5 and 7 o'clock bladder neck incision in case of bladder neck stenosis after removal of the necrotic tissues. No recurrent obstruction has occurred in these patients. Fortunately, the external sphincter has always remained intact even in cases with total necrosis and obstruction. Necrotic tissue remnants tended to occur in the older and diabetic patients with relatively small prostates (<60 mL), who supposedly had

poorer bladder contractility not enough to completely wash out the large necrotic tissues. These tissues attracted calcium salts thereby frequently calcified in case of long lasting.

Study Limitations

The main limitation of this study was the retrospective and non-randomised design. We did not focus on the complications including retrograde ejaculation and erectile dysfunction and we encourage further studies concerning about these.

Conclusion

Both power settings at 250 or 150 Watt using Twister™ fiber are capable of relieving the symptoms of BPH in a safe manner. High-power 250 Watt 980 nm diode laser is faster and it may be preferred for big sized glands. It also cause less irritative symptoms during the early postoperative period, however, necrosis of the remaining tissue may lead to secondary intervention as far as smaller prostates are concerned (i.e.,<60 mL). Therefore, the power may be adjusted to a lower level accordingly as the prostate gets smaller.

Ethics

Ethics Committee Approval: The approval was taken from the İstanbul Bahçeşehir University Ethics Committee (number: BAU-2013/U1).

Informed Consent: All patients included signed an informed consent form.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.E., S.D., Concept: A.E., S.K.K., Design: A.E., S.K.K., Data Collection or Processing: E.K.B., Analysis or Interpretation: E.K.B., Literature Search: A.E., S.D., Writing: A.E., S.K.K.

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