Original Article

Application of two micron laser vaporesection combined with transurethral resection of the prostate in treatment of benign prostatic hyperplasia: analysis of 340 cases

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Abstract: Purpose: To evaluate clinical efficacy and safety of two micron laser vaporesection combined with trans-urethral resection of the prostate (TURP) in treating benign prostatic hyperplasia (BPH). Methods: In total, 340 BPH patients aged 62-86 years, were treated with two micron laser vaporesection plus TURP. Mean prostatic volume was measured as 38-182 ml. Operative time, intraoperative hemorrhage volume, time of postoperative bladder irrigation, time of indwelling urinary catheter and surgical complications were examined. International Prostate Symptom Score (IPSS), quality of life score (QOL), maximal urinary flow rate (Qmax) and post void residual urine volume (PVR) were analyzed. Results: All cases underwent the surgery successfully. No transurethral resection syndrome was noted. Mean operative time was (72±15) min. Mean intra operative hemorrhage volume was (48.4±13.0) ml. Four patients were transfused with 2 U of suspended red blood cells. Time of postoperative bladder irrigation ranged from 0.5-2.5 d. Time of indwelling urinary catheter was 3-6 d. After removing urinary catheter, mild urinary irritation symptoms were noted in 19 cases. Ten patients developing urinary infection were recovered following anti-infection therapy. One with secondary urethral stenosis was healed after urethral dilatation for three times. Postoperative IPSS, QOL, Qmax and PVR were (6.0±2.0), (2.0±0.2), (18.5±1.6) ml/s and (11.0±4.0) ml, significantly improved compared with preoperative levels (all P<0.05). Fifty eight cases with normal sexual function retained sexual function postoperatively and had no retrograde ejaculation. Conclusions: Two micron laser vaporesection plus TURP is efficacious and safe in treating BPH with mild lower urinary tract symptoms and perioperative complications.

Keywords: Benign prostatic hyperplasia, two micron laser vaporesection, transurethral resection of the prostate

Introduction

Benign prostatic hyperplasia (BPH) is one of the most common urinary dysfunction in middle-aged and senior male population [1]. A recent study has demonstrated an overall prevalence of 10.3%, with an overall incidence rate of 15 per 1000 males per year, increasing with age from 3 per 1000 at age 45-49 years to 38 per 1000 at 75-79 years [2]. Transurethral resection of the prostate (TURP) has been regarded as the gold standard of the management if BPH, even though it probably causes intra operative hemorrhage and TUR syndrome [3, 4]. Recently, along with the widespread application of laser technique in urology department, transurethral two micron laser vaporesection of the prostate has been gradually utilized as one of the minimally invasive surgeries in treating BPH. It possesses a variety of advantages, such as precise operation, slight hemorrhage, rapid recovery, mild complications [5]. However, relatively slow cutting speed and significant tissue carbonization, which prevent the substitution of TURP by transurethral two micron laser vaporesection. Between June 2009 and October 2014, two micron laser vaporesection in combination with TURP has been adopted to treat BPH in 340 patients. High clinical efficacy was obtained.

Materials and methods

Clinical data

In total, 340 patients, aged 62-86 years, (71.6 ±4.2) years, diagnosed with BPH in the urology department of Air Force General Hospital of PLA between 2009 and 2014 were recruited in this investigation. Preoperative urodynamic diagnosis detected the signs of bladder outlet

Table 1. Demographic data of all patients

Number of cases (n)	340
Age range (years)	62 to 86
Course of disease	6 months to 15 years
prostate volume (ml)	38 to 182
mean IPSS	26.9±4.6
QOL score	4.9±0.6
Complications (n)	
Urinary retention	21
Vesical calculus	12
Hypertension	62
Diabetes mellitus	26
Renal insufficiency	6

obstruction (BOO). The course of diseases ranged from 6 months to 15 years, 5.5 years on average.

Twenty one cases were complicated with urinary retention, one of whom undergoing suprapubic cystostomy and 20 receiving indwelling urinary catheter. After TURP, 5 patients recurred, 12 were complicated with vesical calculus, 62 with hypertension, 26 with diabetes mellitus and 6 with renal insufficiency. The prostate volume was measured from 38 to 182 ml, (74±13) ml, by transrectal prostate ultrasound. International Prostate Symptom Score (IPSS) was employed to assess the symptoms of BPH and the mean IPSS was 26.9±4.6 and the quality of life (QOL) score was 4.9±0.6 on average (**Table 1**). Prior to surgery, 319 had no acute urinary retention with maximum flow rate (Qmax) of (5.2±2.0) ml/s on average and mean post void residual urine volume (PVR) of (138.5±60.0) ml. Digital rectal examination (DRE) found prostate nodules in 3 cases and 6 patients with serum level of prostate specific antigen (PSA) >10 ng/ml. All these cases underwent prostate needle biopsy to exclude the possibility of prostate cancer.

Preoperative preparation

Blood pressure-lowering treatment: patients with spontaneous hypertension were administered with blood pressure-lowering medication and the blood pressure was maintained below 140/90 mmHg.

Glycemic control: diabetic patients were injected with insulin or received oral administration of hypoglycemic drugs. The fasting blood glu-

cose level was controlled <8.0 mmol/L and postprandial blood glucose level <11 mmol/L.

Renal function improvement: the catheter was retained for over 2 weeks for patients with renal insufficiency caused by urinary retention, kidney function medication was delivered to protect renal function. The surgery was initiated after the renal function recovered.

Treatment methods

RevoLix 2 μm continuous wave-laser vaporesection was employed to perform laser resection of the prostate at 70 W. Laser energy is emitted at 2.013 μm in continuous-wave mode. The energy was delivered using a 550-μm bare-ended fibre (RevoLixTM, Lisa Laser Products, Katlenburg, Germany). The 26 Fr resectoscope was equipped in the surgery (Storz, Germany). The patients were subjected to continuous epidural or general aneasthesia in lithotomy position, physiological buffer saline (PBS) or mannitol irrigation under a pressure of 80 cm H_2O.

The prostate resectoscope was inserted into the urinary bladder to observe external urethral sphincter, prostatic apex, seminal colliculus, shape of hyperplasic prostate, cervix vesicae and bilateral ureterostoma and the inner structure of urinary bladder to estimate the distance between bladder neck and seminal colliculus. Then, the optical fiber was inserted into the urethra prostate guided by resectoscope. The laser intensity of the red optical fiber was examined to adjust the length of optical fiber end, making the optical fiber approximately 5 mm in front of the sheath under resectoscope. The cover of blue fiber was exposed. The excision mark was labelled at 6- and 12-o'clock positions proximal to seminal colliculus to delineate the boundary of prostate resection.

The prostatic median lobe was vaporesected. A 2-3 mm longitudinal channel was incised at 5- and 7-o'clock positions between cervix vesicae and seminal colliculus, which were gradually deepened and stretched to the prostate capsule and block the blood supply of prostatic median lobe. The resected prostatic median lobe was partitioned and vaporesected by block or layer until the proximal end of proximal end to construct a channel between urinary bladder neck to proximal end of seminal colliculus. If the prostatic median lobe were exces-

sively enlarged, the vaporesection procedures should be suspended after widening the sulcus, and treated along with the TURP.

A deep incision was made at 12-o'clock position vertically between bladder neck and seminal colliculus, stretching to the prostate capsule. The vaporesection was initiated from bladder neck to the proximal end of seminal colliculus. The resectoscope sheath was sway towards 5- and 7-o'clock positions, allowing for circular motion of optical fiber. Bilateral prostatic lateral lobes were resected to 4- and 8-o'clock positions along with the prostate capsule to block the blood supply of lateral lobe of prostate tissue. Normally, no intraoperative hemorrhage was observed. If intraoperative hemorrhage occurred, the optical fiber was placed to approximately 2 mm from the bleeding site for immediate hemostasis.

Subsequently, the mannitol irrigation was delivered. The enlarged prostatic tissues without blood supply were immediately vaporesected. The prostatic apex was repaired and thorough hemostasis was delivered. After complete resection of hyperplasic prostate and thorough hemostasis, the urinary bladder was irrigated repeatedly, the remnant tissues inside the urinary bladder were aspirated, 22 Fr urinary catheter was indwelled. A portion of 30 ml of PBS was administered into the bladder via a ureter sacculus. No traction was delivered. The irrigation speed was adjusted according to the color of irrigation solution.

Patients complicated with vesical calculus underwent pneumatic nephrolithotripsy or holmium laser lithotripsy. After removal of urinary calculi, they were treated with the vaporesection combined with TURP.

Observation index

Before and after surgery, blood samples were collected and prepared for detection of Na+, K+ and Cl- concentration and blood routine examination. Operative time and intraoperative hemorrhage were recorded. Intraoperative hemorrhage volume=amount of irrigation solution × postoperative hemoglobin concentration of the irrigation solution/preoperative blood hemoglobin concentration. Cyanmethemoglobin colorimetry was employed [6] by 721 spectrophotometer (Shanghai Shenhua Co., Ltd). Posto-

peratively, the patients were examined for the incidence of TURS, time of postoperative bladder irrigation, time of indwelling urinary catheter, urination after catheter extraction and urinary tract stimulation symptoms. Pathological examination was performed to exclude the risk of prostate cancer. During 3-month follow-up, IPSS, QOL, Qmax, PVR, postoperative complications, sexual dysfunction and retrograde ejaculation were observed.

Statistical analysis

SPSS 17.0 statistical software was utilized for statistical analysis (SPSS, Chicago, IL, USA). Measurement data were expressed as means ± standard deviation. The mean values of observation indexes before and after surgery were statistically compared using paired t-test. $P<0.05$ was considered as a statistical significance.

Results

All 340 patients were surgically treated successfully with explicit visual field. No apparent hemorrhage was noted. No TURS was observed during perioperative period. BPH was confirmed by pathological examination. Mean operative time was (72±15) min. Preoperative blood levels of Na^+, K^+, Cl^- and hematocrit (HCT) were (140.5±3.2), (4.3±0.6), (105.1±4.3) mmol/L and 0.39±0.20, respectively. After the surgery, the values were (139.2±2.5), (4.1±0.5), (104.7±3.9) mmol/L and (0.37±0.51), respectively. No statistical significance was noted before and after operation in terms of all parameters (all $P>0.05$). Intraoperative hemorrhage volume was (48.4±13.0) ml on average. Two cases were transfused with 2 U of suspended red blood cells due to preoperative anaemia and relatively large prostate. Another two patients were immediately transfused with 2 U of suspended red blood cells postoperatively because of large quantity of intraoperative hemorrhage. The time of postoperative bladder irrigation ranged from 0.5 to 2.5 d, 1.5 d on average. The time of indwelling urinary catheter ranged from 3-6 d with a mean of (4.5±1.0) d. Nineteen patients presented with mild urinary tract stimulation symptoms after removal of urinary catheter. Ten cases developed dysuria and real urinary incontinence. Ten had urinary infection postoperatively and recovered by anti-infection therapy. One case had

secondary urethral stenosis at 1 month after surgery and fully healed after three times of urethral dilatation. During postoperative follow-up, IPSS, QOL, Qmax and PVR were (6.0±2.0), (2.0±0.2), (18.5±1.6) ml/s and (11.0±4.0) ml, which were significantly improved compared with those before surgery (all P<0.05). Fifty eight cases with normal sexual function retained the sexual function after surgery. No incidence of retrograde ejaculation was noted.

Discussion

TURP has been regarded as the gold standard surgical treatment of BPH considering less surgical injury and intraoperative hemorrhage and faster recovery compared with conventional surgery. However, it mainly applies to resection of middle- or small-sized BPH with a surgical complication rate of 15-20% and a blood transfusion rate of 5-11%. Moreover, the hemorrhage volume and TURS are elevated along with the increasing size of gland [7].

As a novel generation of laser system, RevoLix two micron laser vaporesection integrates multiple advantages of vaporization and holmium laser resection and utilizes semiconductor laser pumping and continuous wave mode [8, 9]. Meanwhile, 2 micron laser is of high safety. In water environment, the resection area of two micron laser vaporesection is limited to 2 mm in front of the optical fiber and causes no additional damage to the tissues 2 mm outside the optical fiber. RevoLix two micron laser vaporesection is able to penetrate the tissue with a depth of 0.3 mm. The coagulation layer is 1 mm in thickness after tissue removal. It is unlikely to lead to severe tissue edema, necrosis, secondary sloughing or alternative adverse reaction [10]. Compared with TURP, 2 μm laser vaporesection possess alternative advantages. First, it can achieve effective hemostasis, yield less hemorrhage, more explicit visual field, shorter time of indwelling urinary catheter and more rapid recovery [11]. Second, PBS is used for intraoperative irrigation, which averts the incidence of TURS [12] and guarantees surgical safety. In addition, the operative time is not limited. Third, it is convenient to operate with a short learning cycle [13]. Fourth, it can complete the resection without intraoperative bleeding without electric current. It is suitable for patients with coagulation disorders, receiving anticoagulation therapy or with cardiac pace-

maker, inducing no surgical contraindications. Fifth, it is safe and yields mild surgical complications, especially for senior patients or those with high risk factors [11]. Besides, 2 μm laser vaporesection also has the following limitations. First, it requires longer operative time compared with TURP [14]. Second, tissue carbonization is probably induced during the vaporization procedures. Third, a slight amount of pathological sample can be obtained when treating small-sized prostate, which affects postoperative histodiagnosis. Fourth, compared with semi-ring-like electrode, it is more difficult to utilize optical fiber to repair prostatic apex and control the hemorrhage of the great arteries.

Therefore, 2 μm laser vaporesection in combination with TURP was adopted to surgically resect the enlarged prostate in our hospital. We first applied 2 μm laser vaporesection to vaporize the gland at 5-, 7- and 12-o'clock positions, which mainly functioned to block the blood supply of hyperplasic prostate. It also formed 1 mm coagulation layer, induced vascular occlusion, decreased the absorption of irrigation solution, maintained body homeostasis and averted the risk of cardiopulmonary function damage and hyponatremia. Consequently, intraoperative hemorrhage volume was significantly reduced and no urinary bladder fistula was required intraoperatively. Meantime, 2 μm laser vaporesection was changed to TURP during the later phase of surgery, which contributed to prostatic apex repairing and hemostasis of blood vessels proximal to prostate capsule. The combined therapy of 2 μm laser vaporesection and TURP achieved satisfactory effect in terms of operative time, hemorrhage volume, surgical complications, postoperative recovery and urination, etc.

In previous studies, 2 μm laser vaporesection has been applied to treat large prostate with a size >120 ml. However, the resection speed of 2 μm laser vaporesection was significantly slower compared with TURP. Combination of 2 μm laser vaporesection and TURP properly shortens operative time and achieves full hemostasis [15]. In this study, the combined techniques were adopted to resect different sizes of the prostate, ranging from 38 to 182 ml. For the prostate <50 ml, 2 μm laser vaporesection should be mainly utilized. The induced energy is dominantly located in topical tissues and is

unlikely to injure the prostate capsule. In addition, it can precisely excise the bladder neck and decreases the risk of mucosal nerve plexus of bladder neck and urethral sphincteric injury. Moreover, it is able to retain normal sexual function, averts the incidence of retrograde ejaculation and enhances patients' QOL. For the enrolled patients with normal sexual function preoperatively, no erectile dysfunction or retrograde ejaculation was noted, suggesting the superiority of 2 μm laser vaporesection. In addition, the operative time was not significantly prolonged compared with TURP. In the later stage of surgery, TURP was utilized to repair the prostatic apex and obtain more pathological specimen. For patients with prostate >100 ml, we recommended to create three channels at 5-, 7- and 12-o'clock positions using 2-μm optical fiber first. After the blood supply of gland was blocked, TURP was utilized as soon as possible, which enhanced the resection efficiency and shortened operative time. Urinary bladder fistula could be conducted during the surgery as necessary to guarantee clear visual field and prevent the incidence of TURS. For those with 50-100 ml prostate, 2 μm laser vaporesection in combination with TURP required shorter operative time compared with two micron laser vaporesection alone. However, the risk of intra-operative hemorrhage volume and TURS was considerably reduced compared with TURP alone. High clinical efficacy was equally obtained.

Taken together, 2 μm laser vaporesection in combination with TURP is efficacious and safe in treating BPH in terms of operative time, hemorrhage volume, postoperative recovery and perioperative complications. During 3-month follow-up, IPSS, QOL, Qmax and PVR are significantly enhanced after surgery. However, this clinical trial is a single-center investigation. In addition, merely short-term clinical efficacy has been evaluated. Hence, long-term, multi-center investigation remains to be conducted.

Disclosure of conflict of interest

None.

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