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Effect of dual-band semiconductor laser transurethral resection of prostate on efficacy, stress response and quality of life in patients with benign prostatic hyperplasia.

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Abstract

Objective: To explore the effect of dual-band semiconductor laser transurethral resection of prostate on efficacy, stress response and quality of life in patients with Benign Prostatic Hyperplasia (BPH).
Methods: 126 cases of patients with benign prostatic hyperplasia treated in our hospital during January 2014 to January 2015 were randomly divided into observation group and control group, with 63 cases in each. Patients in control group were treated with Transurethral Resection of Prostate (TURP). Patients in observation group were treated with Dual-Band Semiconductor Laser Transurethral Resection of Prostate (DBSCLTURP). The surgical indications, change of maximum urinary flow rate, post-voiding residual urine volume, IPSS score, BI index scores, quality of life before surgery and 3 months after surgery, as well as serum Cor and E levels before and 7 days after surgery were compared.
Results: Blood loss, postoperative indwelling catheter time, postoperative bladder irrigation time, postoperative hospital stay and postoperative complications in observation group were better than that in control group ($p<0.05$). In both groups maximum urinary flow rate significantly increased after 3 months, and post-voiding residual urine volume decreased significantly ($P<0.05$). Maximum urinary flow rate in observation group was higher than the control group 3 months after surgery, and post-voiding residual urine volume lower than the control group ($P<0.05$). Levels of serum Cor and E increased significantly 7 days after surgery in both groups, but with smaller extent of increase in observation group ($P<0.05$). In observation group serum Cor, E level was lower than the control group 7 days after surgery ($P<0.05$). In both groups, IPSS score decreased significantly after 3 months, while the BI index score increased significantly after 3 months ($P<0.05$). In observation group, IPSS score after 3 months was significantly lower than the control group, and the BI index scores after 3 months was higher ($P<0.05$). In observation group, bodily pain, mental health, physical function, physical occupation, emotional function, social function, vitality, general health after 3 months were better than the control group ($P<0.05$).
Conclusion: The effect of dual-band semiconductor laser transurethral resection of prostate in patients with benign prostatic hyperplasia was significant, with little effect on the stress response. It can significantly improve the quality of life of patients, with important research value.

Keywords: Prostatic hyperplasia, Transurethral resection of prostate, Semiconductor laser.

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Introduction

Benign prostatic hyperplasia is a common clinical disease; epidemiological investigation found that the incidence rate showed a rising trend, seriously affecting the health and quality of life of patients. Therefore, taking timely and effective treatment is particularly important. Semiconductor laser, also known as diode laser, is new laser developing in recent years internationally, has been used in several medical centers at home and abroad, preliminary studies have shown that having advantages including good cutting haemostatic effect, few complication etc. [1-3]. Using the optimized new dual-wavelength, dual - band semiconductor laser couples the wavelength of 1470 nm and 980 nm wavelengths into one way, the energy can either be absorbed by the water and by haemoglobin, the power of which can reach 150 w, and therefore has a faster cutting speed and better haemostatic effect. Therefore, the author of the present study was to investigate effect of dual-band semiconductor laser transurethral resection of prostate on efficacy, stress response and quality of life in patients with benign prostatic hyperplasia, thus to provide a reliable clinical reference value.

Objects and Methods

Object of study

126 cases of patients with benign prostatic hyperplasia treated in our hospital during January 2014 to January 2015 were selected. All the patients were diagnosed with BPH by Prostate-Specific Antigen (PSA), Digital Rectal Examination (DRE), Transrectal Ultrasonography (TRUS), Post-Voiding Residual Urine Volume (PVR), International Prostate Symptom Score (IPSS) and urodynamic. The 126 patients in the group aged 45 to 80 years, with mean age (63.29 ± 7.54) years. Disease course was 1 to 2 years, with mean disease course (5.87 ± 1.34) years. Prostate average volume was (58.62 ± 13.29) ml examined by B-ultrasound. Post-voiding residual urine volume was (125.91 ± 28.39) ml. Based on random number table, the patients were randomly divided into two groups, with 63 cases in the control group and 63 cases in observation group. There was no significant difference of general information between the two groups (P>0.05, Table 1).

Table 1. Comparison of general data between the two groups.

Groups	Number of cases	Mean age (year)	Mean disease course (year)	Prostate average volume (ml)	PVR (ml)
Observation group	63	62.78 ± 7.36	5.69 ± 1.31	58.37 ± 12.89	123.87 ± 28.07
Control group	63	63.79 ± 7.74	5.98 ± 1.38	58.79±13.49	126.89 ± 28.61
t	-	0.7506	1.2097	0.1787	0.5981
P	-	>0.05	>0.05	>0.05	>0.05

Inclusion criteria and exclusion criteria

Inclusion criteria: a) aged 45 to 80 years old; b) approved by the hospital ethics committee; c) signed informed consent.

Exclusion criteria: a) did not meet the above inclusion criteria; b) with severe urinary tract infection, or with bladder stones, bladder cancer etc. that needed surgical treatment; c) with contraindications for surgery in this study; d) cannot take lithotomy position in sequelae of cerebrovascular disease, with elderly cognitive impairment and dementia; e) with severely abnormal lung, kidney, liver and heart function.

Surgical method

Observation group: All the surgeries were completed by the same experienced surgeon. The output power of dual semiconductor laser (CeramOptec GmbH, Germany) was 150 W. The "orange peel" type prostatectomy designed by Xia et al. [4] was applied: Treated with epidural anaesthesia, the patient was in lithotomy position. The resectoscope was put into the bladder, to observe the bladder trigone, and on both sides of the ureteral orifice as well as bladder walls in order. Watch for formation of calculus, tumors, diverticulitis and trabecular. Then retreat to the urethra to observe the situation of prostate. The optical fiber probe was inserted into the prostatic urethra through laser resectoscope working channel. The laser fiber end was adjusted to make contact with the surface of the prostate tissue by the screen. During surgery, the prostate tissue remained at the front end of the laser fiber; the exposed fiber sheath should not exceed 4 mm. Two longitudinal grooves with width of 5 mm at 5 and 7 o'clock were respectively cut between the bladder neck and the verumontanum deep to the surgical capsule. Then the fiber was swung in arc to gradually cut both sides of the lobes in the groove from proximal end of the verumontanum, and cut to 12 o'clock in the opposite direction from both sides. Mid-tissue was resected to the bladder neck. A little chunk of tissue during surgery could be collected for histological examination. When bleeding occurred during the resection process, move the optical fiber to 2-3 mm after bleeding point for haemostasis. Finally vaporized wound dressing along the prostate capsule was preceded. The resected tissue was sent for pathological examination. Fore patients complicated with cystolith, vaporized resection of prostate should be carried out after the stones smashed and suctioned using ballistic pressure or ultrasonic.

Control group: Patients were treated with TURP. Surgical procedures were as follows: Taken lithotomy position, the patients were treated with general anaesthesia or spinal anaesthesia. 26 F resectoscope (produced by the Wolf Company, German) was used for resection using 5% mannitol injection as a medium with power of 180 W, using low-power (40 ~ 70 W) when coagulation. Resectoscope was inserted into the bladder through the urethra, to observe the situation of the bladder. Resectoscope was rolled back to proximal end of verumontanum. The distance between the verumontanum the bladder neck was estimated to determine the range of surgical procedures. A longitudinal groove was cut at 6 o'clock direction between the bladder neck and verumontanum, with the range to surgical capsule, as a standard of which to give resection of part of the middle lobe of prostate in patients. And then the left and right lobes were cut to surgical capsule. Then the prostate apex was treated surgical cutting wound repaired. Resectoscopy was rolled back to see if there was bleeding and prominent prostate tissue. The cut prostate tissue was removed with repeated washing. Triple lumen catheter was used for indwelling after surgery, with traction to stop bleeding. At last the bladder was flushed using continuous saline.

Outcome measures

(1) Blood loss, postoperative indwelling catheter time, postoperative bladder irrigation time, postoperative hospital

stay and postoperative complications in both groups were observed and compared. (2) Changes in preoperative and three-month postoperative maximum urinary flow rate and PVR in both groups were observed. (3) Changes in stress response before and 7 days after surgery, serum Cortisol (Cor) and Epinephrine (E) levels were observed. Peripheral blood of 3 ml was collected after surgery and then centrifuged to separate the serum. The resultant liquid was kept in-80°C for further test. Cor, E and NE levels were assayed using radioimmunoprecipitation. (4) Changes in IPSS score and Activities of Daily Living (ADL) score before and 3 months after surgery was analysed. ADL score was evaluating using BI index. (5) Changes in quality of life before and 3 months after surgery were observed. The changes were evaluated by professional doctors of our hospital using SF-36 scale, including 8 dimensions: bodily pain, mental health, physical function, physical occupation, emotional function, social function, vitality and general health, with total score of 100. Quality of life is directly proportional to the score, the higher the score the better the quality of life.

Statistical method

SPSS22.0 was used for statistical processing. $P<0.05$ was regarded as significant difference. Count data was tested using χ^2 test. Independent sample t test was used for measurement data among groups, and paired t-test for the measurement data within group. Measurement data and count data were represented using the percentage and ($\bar{x} \pm s$).

Results

Comparison of blood loss, postoperative indwelling catheter time, postoperative bladder irrigation time, postoperative hospital stay and postoperative complications between the two groups

As illustrated in Table 2, in observation group, blood loss, postoperative indwelling catheter time, postoperative bladder irrigation time, postoperative hospital stay and postoperative complications were better than control group ($p<0.05$).

Table 2. *Comparison of blood loss, postoperative indwelling catheter time, postoperative bladder irrigation time, postoperative hospital stay and postoperative complications between the two groups.*

Groups	Number of cases	Blood loss (ml)	Postoperative indwelling catheter time (d)	Postoperative bladder irrigation time (h)	Postoperative hospital stay (d)	Postoperative complications (%)
Observation group	63	47.14 ± 5.42	1.65 ± 0.42	13.76 ± 3.24	3.29 ± 0.87	6 (9.52)
Control group	63	89.32 ± 8.71	4.87 ± 1.25	51.29 ± 8.91	5.42 ± 1.18	17 (26.98)
t	-	32.6351	19.3816	31.4198	11.5319	6.4356
P	-	<0.05	<0.05	<0.05	<0.05	<0.05

Comparison of maximum urinary flow rate and PVR

As illustrated in Table 3, there was no significant difference of maximum urinary flow rate and PVR between the two groups before surgery ($p>0.05$). In both groups maximum urinary flow rate significantly increased after 3 months, and post-voiding residual urine volume decreased significantly ($P<0.05$). Maximum urinary flow rate in observation group was higher than the control group 3 months after surgery, and PVR lower than the control group ($P<0.05$).

Table 3. *Comparison of maximum urinary flow rate and PVR ($\bar{x} \pm s$).*

Groups	Number of cases	Maximum urinary flow rate (ml/s)		PVR (ml)	
		Before surgery	3 months after surgery	Before surgery	3 months after surgery
Observation group	63	8.29 ± 0.89	24.87 ± 3.42*	123.87 ± 28.07	34.19 ± 5.69*
Control group	63	8.17 ± 0.94	19.82 ± 2.76*	126.89 ± 28.61	59.82 ± 12.36*
t	-	0.7358	9.1206	0.5981	14.9507
P	-	>0.05	<0.05	>0.05	<0.05

Note: Compared with before surgery, *p<0.05.

Changes in Cor and E levels in the two groups

As illustrated in Table 4, levels of serum Cor and E increased significantly 7 d after surgery in both groups, but with smaller extent of increase in observation group ($P<0.05$). In observation group serum Cor, E level was lower than the control group 7 d after surgery ($P<0.05$).

Table 4. *Changes in Cor and E levels in the two groups ($\bar{x} \pm s$).*

Groups	Number of cases	Cor (mmol/L)		E (mmol/L)	
		Before surgery	7 d after surgery	Before surgery	7 d after surgery
Observation group	63	5.78 ± 1.39	15.39 ± 3.24*	58.97 ± 7.83	138.27 ± 19.83*
Control group	63	5.63 ± 1.34	38.71 ± 6.52*	59.46 ± 8.14	221.76 ± 34.29*
t	-	-	-	-	-
P	-	>0.05	<0.05	>0.05	<0.05

Note: Compared with before surgery, * p<0.05.

Comparison of IPSS score and BI index in the two groups

As illustrated in Table 5, in both groups, IPSS score decreased significantly after 3 months, while the BI index score increased significantly after 3 months (P<0.05). In observation group, IPSS score after 3 months was significantly lower than the control group, and the BI index scores after 3 months was higher (P<0.05).

Table 5. Comparison of IPSS score and BI index in the two groups ($\bar{x}$ ± s).

Groups	Number of cases	IPSS score (points)		BI index score (points)	
		Before surgery	3 months after surgery	Before surgery	3 months after surgery
Observation group	63	19.78 ± 4.35	7.49 ± 0.68*	34.81 ± 5.42	57.32 ± 7.32*
Control group	63	20.29 ± 4.59	8.62 ± 0.79*	33.97 ± 5.91	45.87 ± 6.58*
t	-	-	-	-	-
P	-	>0.05	<0.05	>0.05	<0.05

Note: Compared with before surgery, *p<0.05.

Improvements of quality of life

As illustrated in Table 6, there was no significant difference of bodily pain, mental health, physical function, physical occupation, emotional function, social function, vitality and general health between the two groups before surgery (p>0.05). 3 months after surgery, bodily pain, mental health, physical function, physical occupation, emotional function, social function, vitality and general health significantly improved in both groups (p<0.05). In observation group, bodily pain, mental health, physical function, physical occupation, emotional function, social function, vitality, general health after 3 months were better than the control group (P<0.05).

Table 6. Comparison of quality of life improvements ($\bar{x}$ ± s).

Groups	Observation group (n=63)		Control group (n=63)	
	Before surgery	3 months after surgery	Before surgery	3 months after surgery
bodily pain	45.42 ± 4.31	73.21 ± 8.93*#	44.98 ± 4.50	64.28 ± 8.13*
mental health	47.89 ± 4.17	67.82 ± 8.13*#	48.31 ± 4.38	60.18 ± 6.57*
physical function	45.52 ± 4.39	69.37 ± 8.43*#	46.08 ± 4.59	62.11 ± 6.30*
physical occupation	46.92 ± 4.78	65.13 ± 7.98*#	47.43 ± 4.53	58.93 ± 7.03*
emotional function	47.19 ± 4.28	70.91 ± 8.43*#	46.82 ± 4.39	63.18 ± 5.87*
social function	46.98 ± 4.61	71.87 ± 8.19*#	47.61 ± 4.78	63.26 ± 7.63*
vitality	48.98 ± 5.41	75.20 ± 9.76*#	48.31 ± 4.97	68.92 ± 6.42**
general health	47.29 ± 3.91	69.83 ± 7.42*#	46.87 ± 4.13	62.19 ± 6.51*

Note: Compared with before surgery, *p<0.05. Compared with control group, #p<0.05.

Discussion

Benign prostatic hyperplasia is a major cause of lower urinary tract symptoms in elderly men. For those patients with benign prostatic hyperplasia symptoms without efficacy of drug therapy, the surgery is still the most effective treatment. There are several surgical treatments of benign prostatic hyperplasia; transurethral resection has been considered the gold standard in treatment of benign prostatic hyperplasia [5,6]. But there are many surgical complications of transurethral resection, such as requiring transfusion therapy when surgical bleeding (25%), TUR syndrome (2%), bladder neck contracture (4%), retrograde ejaculation (65-70%) and long-time of indwelling catheter etc. [7-9], therefore a new surgical method needs to be found.

Laser treatment of benign prostatic hyperplasia is more and more favoured by urologists thanks to its less bleeding, shorter operative time, high safety, fewer complications, and many other advantages. Its rapid development over the past decade shows a strong prospect of clinical application. Among them, the selective green laser vaporization, thulium laser and holmium laser enucleation of the prostate are most widely used [10-13]. Semiconductor laser is a new type of laser, also known as red laser or diode laser. Its use in benign prostatic hyperplasia surgery is still in its infancy. There are a variety of different wavelengths of semiconductor lasers used clinically, such as 940 nm, 980 nm and 1470 nm. The dual-band semiconductor laser is coupling two different wavelengths to obtain the efficient tissue cutting performance and good haemostatic effect. Preliminary domestic and foreign researches show that the semiconductor laser transurethral resection of the prostate has advantages including definite haemostasis, shorter operative time, less surgical complications, significant improvements of postoperative urodynamic indices and IPSS scores [14,15]. Same as other laser surgeries, the biggest drawback of the semiconductor prostatectomy is lack of sufficient prostate tissue for pathological examination, which requires the clinicians to conduct a comprehensive assessment to patients before surgery

to rule out prostate cancer. In this study, we used the "orange peel" type laser resection of the prostate designed by Professor Xia. Two longitudinal grooves at 5 and 7 o'clock were respectively cut between the bladder neck and the verumontanum deep to the surgical capsule. Then the fiber was swung in arc to gradually cut both sides of the lobes in the groove from proximal end of the verumontanum. Mid-tissue was resected to the bladder neck. The experience of us during the surgery was as follows: a) when the depth of marking grooves at 5 and 7 o'clock reached surgical capsule, depth mark can be provided for two sides of lobes. b) When resecting the two sides of lobes, laser sheath should swing in an arcuate path to avoid capsular perforation. c) The distance of fiber over the front resectoscope sheath should be appropriate. If the distance is too long, the fiber is easy to break, and if it is too short, the lens is easy to damage. The appropriate distance will be 3-4 mm. Same as KTP laser, the energy of dual-band semiconductor laser can be absorbed by the haemoglobin in the tissue, and can also be absorbed by water in tissue, therefore, it has a faster vaporization cutting speed and better haemostatic effect [16].

Because the haemostatic effect of dual-frequency semiconductor laser is exact, this group of patients did not receive routinely bladder irrigation after surgery, and were encouraged to get out of bed as soon as possible, which can reduce the incidence of postoperative cardiopulmonary complications, so that the surgical risk of high-risk patients with benign prostatic hyperplasia can be significantly reduced. Literature reported that the most common complication after semiconductor laser prostatectomy is short-term frequency micturition, urinary urgency and other symptoms of urinary storage up to 36% [17]. Discovered by Seitz et al. in the body model, the coagulation depth 980 nm semiconductor lasers can be more than 7 mm [18]. Therefore, although the semiconductor laser can quickly vaporize and resect prostate tissue, deep solidification tissue can escape vaporization, resulting in necrotic tissue residues, which explain the cause of postoperative frequent urination. For the above reasons, some foreign scholars used cold saline at 4°C in place of perfusion fluid with room temperature, effectively reduced postoperative pain, dysuria and urinary storage symptoms and other complications without affecting the patient's temperature [19,20]. This study demonstrated that in observation group, blood loss, postoperative indwelling catheter time, postoperative bladder irrigation time, postoperative hospital stay and postoperative complications in observation group were better than that in control group. Maximum urinary flow rate in observation group was higher than the control group 3 months after surgery and post-voiding residual urine volume lower than the control group. Levels of serum Cor and E 7 d after surgery in observation group was significantly lower than that in control group. And IPSS score after 3 months was significantly lower than the control group, and the BI index scores after 3 months were higher. Bodily pain, mental health, physical function, physical occupation, emotional function, social function, vitality, general health after 3 months were better than the control group. The above results demonstrated that DBSCLTURP could significantly shorten hospital stay, reduce postoperative complications, reduce blood loss, speed up the maximum flow rate, decrease PVR, and with small impact on stress response. So it could significantly improve activities of daily living and the quality of life of patients.

In addition, the application of surgery causes the body to produce stress response, which is closely related to the degree of surgical trauma size. The more severe the trauma, the more severe the stress response. This study demonstrated that levels of serum Cor and E increased significantly 7 d after surgery in both groups, but with smaller extent of increase in observation group. In observation group serum Cor, E level was lower than the control group 7 d after surgery. This indicated that DBSCLTURP had small impact on stress response. In summary, the effect of DBSCLTURP on patients with BPH is significant, with high security and few postoperative complications. It can also improve the quality of life of patients, which is a safe and effective surgical approach, with extensive potential of clinical application. But it still needs to be confirmed by increasing the sample size, extending follow-up period and randomized controlled studies.

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