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Research Article

Comparison of Therapeutic Outcomes Between Thulium Laser and Cold-knife Optical Internal Urethrotomy for Short Segment Urethral Stricture

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Abstract

Objective: In this retrospective study, we aimed to assess the safety and efficacy of thulium laser in the treatment of urethral strictures and compare the outcomes with cold-knife urethrotomy.

Methods: Sixty-six male patients with primary urethral strictures were treated with thulium laser ablation or cold-knife urethrotomy. The obtained surgical treatment outcomes were analyzed and compared.

Results: The results demonstrated that no significant difference was observed between two groups in terms of patient age, preoperative Qmax, stricture location and length. Operative time was shorter in laser group (20.51±5.64 minutes) when compared with cold-knife group (28.17±7.9 minutes). At 3-month follow-up, recurrence-free rates in the laser group and cold-knife group were 89.19% and 68.97%, respectively. However, the recurrence-free rates at 6 months (72.97% vs 65.52%) and 12 months (70.27% vs 65.52%) were similar between two groups. Compared with cold-knife group, Qmax at the catheter removal, 3 months, 6 months and 12 months were appreciably higher in thulium laser group. No intra- or postoperative complications were encountered.

Conclusion: Collectively, neither complication rate nor recurrence-free rate between laser and cold knife revealed a significant difference. However, thulium laser ablation provided higher Qmax compared with cold knife whereas more sustained response was attained in those undergoing procedure with the cold knife.

Keywords: Cold Knife; Optical Internal Urethrotomy; Thulium Laser; Urethral Stricture

Introduction

Urethral stricture is a common disease in male urology and severely affects patients' quality of life. Optical internal urethrotomy has been accepted as the prior option for urethral stricture and several techniques, including cold-knife, electric resection and different types of laser are used to remove the scar tissue [1,2]. Each method has its own advantages and disadvantages. The cold-knife does not have any extra thermal effect, but it can cause mechanical injury that results in recurrence in long term. Electrical resection can completely eliminate the scarred tissues but also cause fibrovascular proliferation, resulting in the high recurrence rate. The laser shows high capabilities in vaporization and incisions but less thermal effect than cold-knife and electrocautery [3,4]. Up to now, several different types of laser including carbon dioxide, Nd: YAG, the KTP, the Argon, the Ho: YAG and excimer lasers have been used to treat urethral stricture. There was no clear idea as to the primary selection of different operation technology for urethral stricture. Here we aimed to compare the efficacy and outcomes between thulium laser and cold knife urethrotomy for the treatment of urethral strictures.

Materials and Methods

We conducted a retrospective study, analyzing the results obtained from urethral stricture patients who were treated with thulium laser ablation or cold-knife urethrotomy during March

2013 and October 2015 in the Urology Department of the Fourth Affiliated Hospital of China Medical University. The mean age of the patients was 59 years (range 34 ~ 70 years). Among the patients, urinary stricture was caused due to the urologic injury (32/66, 48.5 %), urologic surgery (14/66, 21.2%) and other reasons (20/66, 30.3%), respectively. Of the urethral strictures, 57.4% were located in anterior urethra and 42.6% affected the posterior urethra. The stricture length ranged from 0.5 to 2.0 cm (mean 1.4 cm). The following parameters were evaluated before operation: age, length of stricture segment, the maximum urine flow rate (Qmax), Post-Void Residual urine volume (PVR), the International Prostatic Symptom Score (IPSS), and the Quality of Life (QoL). Inclusion criteria: (1) Short segment strictures (stricture length ≤ 2 cm) as identified by radiological studies; (2) Preoperative Qmax < 15 ml/s.

Exclusion criteria: (1) Strictures length > 2 cm; (2) Multiple strictures; (3) Recurrent strictures; (4) Complete obliteration of lumen of urethra on urethroscopy; (5) Patients lost during follow-up. All patients were evaluated with a full physical examination and complied the surgery indication. The procedure was completed in lithotomy position under epidural anesthesia. Antibiotic was administrated 30 minutes before operation. Physiological saline was used as perfusion solution during surgical procedures.

Surgical Technical

Urethrotomy with Thulium Laser Ablation

The 8/9.8 F urethroscope was retrogradely placed to the distant extremity of the urethral stricture, through which a guiding zebra or ureteral catheter was subsequently pulled into the bladder. The laser fiber was introduced through a side channel. The work power is 15 ~ 40W in both continuous and pulsed wave mode. The stricture segment was retrogradely incised under the guidance of zebra and scar tissue was ablated sufficiently. For posterior urethral stricture, 3 incisions were made at 12-, 11- and 1 o'clock sequentially to release the stricture. On the contrary, the incisions were made at 5-, 6- and 7- o'clock, especially at 6 o'clock position, in the anterior urethral strictures to prevent from incising through corpus cavernosom.

Cold Knife Technique

A 21 Charr optical urethrotome was inserted into the urethra and a guide wire was introduced through the side channel to guide the urethrotome. Stricture section was incised using a cold knife at 12'o clock position till the stricture was incised out adequately to allow the cystoscope or urethrotome to pass through. After the operation, an F18 indwelling drainage catheter was inserted and kept for 1~3 weeks depending on stricture length. All patients received oral ciprofloxacin (1000 mg per day in two divided dose for 10 days). Qmax were measured immediately following the catheter removal after the operation. Patients with spontaneous voiding and Qmax > 15 ml/s were accepted as successful, while those who had a reduction of Qmax (<10 ml/s) and accompanied by obstructive symptoms during follow up were taken as failure of surgery. The operative time was recorded (from insertion of optical urethrotome to removal of urethrotome from external urethral meatus). Follow-up in our study was 6 months. Recurrence rate and Qmax were re-evaluated at 3 and 6 months post-operatively.

Statistical Methods

Statistical analysis was performed using SSPS version 16.0. All the data were presented as mean ± SD. The numerical variables were compared using Mann-Whitney U test. Categorical variables were analyzed by Fisher's exact test. $P < 0.05$ was considered statistically significant.

Results

In this study, we retrospectively analyzed 66 urethral stricture patients who underwent internal urethrotomy with cold-knife or thulium laser. There was no significant difference in etiology of stricture, the number, localization, length, relevant symptoms, the Maximum Urine Flow Rate (Qmax), Post-Void Residual Urine Volume (PVR), the International Prostatic Symptom Score (IPSS) and the Quality of Life (QoL) (Table 1).

Parameters	Laser group	Cold-knife group	P value
Age (y)	59.27±9.61	58.66±9.86	0.598
Length of stricture (mm)	14±3.02	14.45±3.10	0.733
IPSS	26.03±4.17	25.21±4.26	0.996
QoL	4.51±0.99	4.52±0.95	0.732
Qmax (ml/sec)	4.88±2.26	5.33±2.01	0.736
PVR (ml)	57.51±17.26	55.76±15.12	0.432

IPSS: International Prostate Symptom Score; QoL: Quality of Life; Qmax: Maximum Flow Rate Per Second; PVR: Post-Void Residual

Table 1: The clinical characteristics in study groups.

All procedures were achieved successfully with no significant intra- or postoperative bleeding, rectum or corpus cavernosum injury, urine leakage, urethral false passage or perforation. However, 5 patients (13.51%) in laser group and 4 (13.79%) in cold knife group experienced markedly scrotal and penile edema. The mean operative time was shorter in laser group (20.51±5.64 minutes) when compared with cold knife group (28.17±7.9 minutes) ($p < 0.001$) (Table 2).

	Laser group	Cold-knife group	P value
Operate time (min)	20.51±5.64	28.17±7.9	< 0.001
Catheterization time (d)	12.46±4.27	13.62±3.93	0.261
Hospital stay (d)	3.68±0.82	3.77±0.87	0.693

Table 2: Perioperative data.

The patients were hospitalized for 3 ~ 5 day and no significant difference were observed between two groups. The duration of catheter indwelling was 0 or 1 to 3 weeks according to the length of urethral stricture (12.46±4.27 vs 13.62±3.93 for laser group and cold knife group, respectively (p = 0.261). All the patients were able to void spontaneously after the removal of the catheter. The Qmax was assessed after the catheter removal and post-operatively at 3, 6 and 12 months (Figure 1).

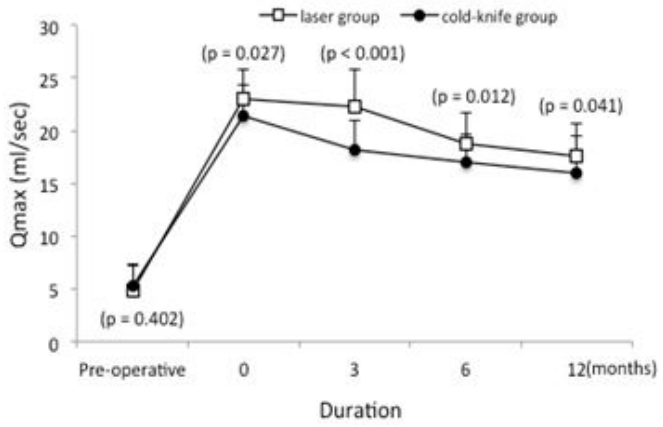

Figure 1: Change of Qmax.

Preoperative Qmax in laser group and cold knife group were 4.88±2.26 and 5.33±2.01 respectively, which increased to 23.01±2.83 and 21.4±2.95 after removal of the urethral catheter. The Qmax remains at a high level after 3 months (22.24±3.63) in laser group, while 6 months later an apparently decrease was observed (18.84±2.83) when compared with 3 months. However, a rapid decrease of Qmax was found from 3 months (18.24±2.79) in the cold-knife group. All in all, Qmax at the catheter removal, 3 months, 6 months and 12 months were markedly higher in thulium laser group when compared with cold-knife group (p values were 0.027, < 0.001, 0.012 and 0.041, respectively) (Table 3).

Duation	Laser group	Cold-knife group	P value
Preoperative	4.88±2.26	5.33±2.01	0.402
Catheter removal	23.01±2.83	21.4±2.95	0.027
3 months	22.24±3.63	18.24±2.79	< 0.001
6 months	18.84±2.83	17.07±2.62	0.012
12 months	17.66±3.06	15.97±3.53	0.041

Table 3: Changes in maximum flow rate (ml/sec).

In this study, recurrence free rate at 3 months was higher in laser group (89.19%) than that in the cold knife group (68.97%, p=0.04). However, no significant difference was observed in recurrence free rates between two groups after 6-month (72.97% vs 65.52%, p = 0.513) and 12 months (70.27% vs 65.52%, p = 0.486) of follow-up (Figure 2).

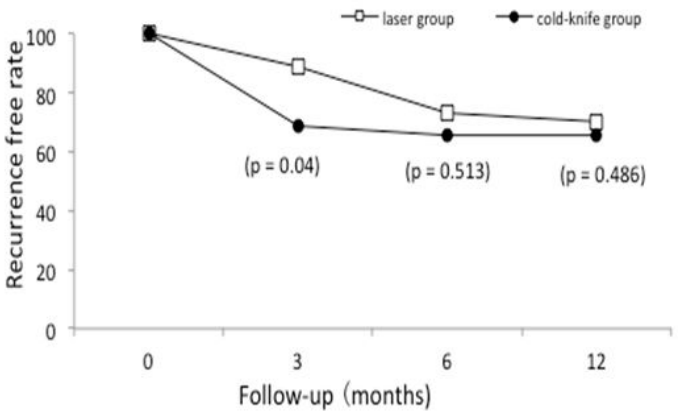

Figure 2: Recurrence free rate for 12 months.

Discussion

Urethral stricture refers to a scar formation in or around the urethra that narrows or blocks the flow of urine from bladder. It occurs in many situations, including injury, instrumentation, infection and certain non-infectious forms of urethritis. Traditionally, excision and end-to-end anastomosis were used to extenuate the symptoms of urethral stricture when the strictures were short, while a buccal mucosal graft urethroplasty was selected for long segment stricture cases [5]. Compared with conventional urethroplasty, Optical Internal Urethrotomy (OIU) becomes a prior option for urethral stricture. Urethrotomy such as cold knife incision, electric urethrotomy, especially laser urethrotomy, has shown therapeutic benefits, including good technical reproducibility, minimal intraoperative bleeding, accelerated postoperative recovery, etc [6]. Cold knife is safe and repeatable, but has severe blood loss and high recurrence rate. Currently, lasers have been widely used in endoscopic urologic surgery as one of the most preferred technological modalities for its much more clear vision and precise incision of the scarred tissue than cold knife [7]. Endoscopic lasers can be divided into many subtypes according to the wavelength such as Neodymium: YAG laser, Holmium: YAG laser and Thulium: YAG laser. The restenosis after laser

application is closely related to the wavelength, tissue absorption and thermal effects of the laser energy. Theoretically, laser with wavelength near an absorption peak of water (1940 nm) has better water absorption and slighter thermo-injury. Neodymium: YAG (wavelength = 1064 nm) has the deepest tissue penetration but poor water absorption and unendurable thermo-injury. The Holmium: YAG laser is a new surgical laser with the wavelength of 2140 nm, which has excellent hemostatic effect and the thermo-injury depth was reduced to 0.4 mm [8]. However, the thermo-injury was reduced to 0.18 mm in Revolix™ Thulium laser (wavelength = 2013 nm) and even to 0.1 mm in some newer type Thulium: YAG laser [9]. Besides, thulium: YAG laser works in a continuous mode， which provides an advantage against cutting surface and beneficial to the postoperative epithelial reconstruction [10]. So far, studies published have not demonstrated an apparently better outcome with thulium laser over other types of lasers or cold-knife urethrotomy.

For the treatment of urethral stricture, ureteroscopy is much easier to enter the narrow distal than the cystourethroscope or electricity resectoscope, which makes ureteroscopy has more advantages in endoscopic laser treating of urethral strictures, especially for some refractory cases. The incisions varied according to the stricture location. For the posterior urethral strictures, incision at 11, 12 and 1 o'clock was made to avoid the rectum injury. For anterior urethral strictures, incision at 5, 6 and 7 o'clock have been recommended in order to avoid an incision through corpus cavernosum and cause severe hemorrhage. Special attention should be paid to those who have had prostate surgery, or the stricture location is near to membranous urethra. It is critical to protect urethral sphincter from injury, which lead to postoperative incontinence. The duration of urethral catheterization after internal urethrotomy remains a highly contentious issue. The drainage period should be evaluated individually according to multiple parameters: stricture length, stricture degree, infection risk level and so on. It has been reported that postoperatively prolonged urethral catheterization was one of the most important risk factors for urinary tract infection [11]. In order to reduce the related complications, we didn't left indwelling in patients with stricture length < 0.5 cm in our study. For patients with stricture > 1 cm, the catheter was placed for 1 week or even 2 to 3 weeks. Overall, there is no conclusion about the timing of catheter removal.

Qmax is an important parameter for assessing the treatment effectiveness of urethral strictures because it was a reliable reflection of the urethra reconstruction. Besides, other parameters, like IPSS, QoL or PVR were easily affected by bladder function or other factors. Figure 1 and 2 showed the treatment effectiveness in the laser group was apparently higher when compared with cold knife group. This is because the Thulium laser can both incise the stricture and ablate scarred tissue through vaporization. This elimination of scarred tissue and rapid urethral re-epithelialization is superior to that achieved with the cold-knife or electric resection. The fall in Qmax apparently appeared within the first 3 months in the cold-knife group, whereas the rapidly fall in Qmax were observed at the end of sixth month in the Thulium laser group. Urethral stricture is a common, but frustrating urologic disease for its high-postoperative recurrence rate. The overall reported stricture recurrence rate was 15.6% (range from 8.3% ~ 18.7%) [12]. In our study, relatively lower recurrence rate was noticed in laser group when compared with cold-knife group at 3 months postoperatively. However, a rapidly increasing recurrence rate was observed in the 6 months after surgery. Finally, recurrence-free rates at 6 and 12 months were similar between two groups. Collectively, Thulium laser vaporizes scar tissue adequately, which lead to higher Qmax than cold-knife group and late recurrence. On the contrary, cold-knife couldn't remove the scar tissue well, and this resulted in a smaller Qmax with earlier recurrence but more sustained response. Sudhir Kumar Jain, et al. and Slawomir A. Dutkiewiecz, et al. revealed both laser and cold-knife are safe and effective treatment on urethral stricture with similar recurrence rates to our study [13,14]. Previous study also reported that there was no significant correlation between stricture recurrence and the stricture site, operative time, or the duration of catheterization [15]. It reasoned that the postoperative development of restructure not only depend on laser type, but also on many other factors, such as length of urethral stricture, prior urethroplasty, failed endoscopic therapy, smoking and diabetes mellitus [16].

In our study, no serious complications occurred. 13 patients suffered scrotal and penile edema due to the irrigating fluid extravasation, which was induced by the deep vaporization and the high infusion pump pressure intraoperative. However, internal urethrotomy is not an ideal strategy for the patients with stricture length ≥ 1.5 cm. It has been reported that the stricture length has a positive correlation with the recurrence rate [17,18]. Therefore, urethroplasty are still recommended as the first-line treatment option of choice in patients with long-segment urethral strictures [19]. To determine the optimal choice for treating urethral stricture is depend on not only clinical indicators, but also economic and geographical factors. Urethrotomy was recommended as an alternative temporizing measure for poor surgical candidates or until further reconstruction in surgery planning and executing. The limitations of our work include the small sample of patients with short follow-up and the retrospective nature of the study. A prospective study should be performed with similar patient characteristics and sufficient follow-up.

Conclusion

We demonstrated that both thulium laser ablation and cold knife urethrotomy were effective and safe therapy for patients

with single and short segment (≤ 2 cm) urethral strictures. Neither complication rate nor recurrence-free rates between laser and cold knife revealed an apparently difference. However, thulium laser ablation provides higher Qmax compared with cold knife whereas more sustained response was attained in those undergoing procedure with the cold knife. Further comparative studies with longer follow-up are required to compare the two modalities.

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