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Comparison of Using Cold Knife and Holmium Laser in Urethral Stricture: Long-term Outcomes

Fatih Akdemir[1], Emrah Okulu[2], Önder Kayıgil[2]

[1]Samsun Terme State Hospital, Clinic of Urology, Samsun, Turkiye
[2]Ankara Yıldırım Beyazıt University Faculty of Medicine, Department of Urology, Ankara, Turkiye

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

Laser energy can be preferred as an alternative to the traditionally used cold knife for treating urethral stricture. The effectiveness of using different techniques on treatment outcomes is important. It is also important to question the side effects that occur. For this purpose, different types of lasers have been used for treating urethral strictures. The results of studies with holmium laser are positive. Our study compares the efficacy and complications of cold knife and holmium lasers used in urethral stricture. In terms of the number of patients included in the study, it constitutes one of the largest groups in the literature. According to the results of our study, the use of a laser is superior to the cold knife in terms of effectiveness. However, there was no difference between them in terms of side effects.

Abstract

Objective: In this study, the efficacy, complication rates, and treatment results of cold knife and holmium:yttrium aluminum garnet (Ho:YAG) laser for treating urethral stricture was compared.

Materials and Methods: A total of 364 cases were operated with the diagnosis of urethral stricture between 2010 and 2020. Of these patients, 176 were operated using a cold knife and 188 using a Ho:YAG laser. Preoperatively and postoperatively, uroflowmetry, post-voiding residue (PVR), International Prostate Symptom Score (IPSS), and IPSS/quality of life (IPSS/QoL) values were determined in all patients. Additionally, complication rates, operation times, and stricture recurrence rates were determined.

Results: The length of the stricture in all cases was less than 3 cm. The maximum flow rate (Q_{max}), average flow rate (Q_{ave}), PVR, IPSS and IPSS/QoL values of the patients were determined as 8.16/6.45 mL/s, 4.36/4.62 mL/s, 124.50/135.65 mL, 20.33/23.55, 5.25/5.40 in the preoperative period in group 1 and group 2, respectively. In the postoperative 12th months, it was determined as 25.43/27.48 mL/s, 21.32/23.08 mL/s, 25.50/19.04 mL, 7.08/6.06, and 1.36/1.23. Stricture recurrence rates were 29.54% (n=52) and 10.63% (n=20) in groups 1 and 2, respectively.

Conclusion: Long-term recurrence rates are lower with the use of Ho:YAG laser in urethral strictures compared to cold knife.

Keywords: Urethral stricture, Ho:YAG laser, cold knife

Introduction

If not treated urethral strictures that occur due to acquired or congenital causes, they may cause irreversible changes in the urinary system. Different methods such as simple urethral dilatation, visual internal urethrotomy, uroLume stent placement, and urethroplasty can be used in urethral strictures (1). Treated urethral strictures may recur. Sachse's internal urethrotomy applied for this purpose has been accepted since 1974, but high recurrence rates of 35-60% have been reported (2). Excision and primary anastomotic urethroplasty are the gold standard in traumatic urethral strictures; however, bleeding, impotence, infertility, recurrence, and failure rates are high (3).

Correspondence: Fatih Akdemir MD, Samsun Terme State Hospital, Clinic of Urology, Samsun, Turkiye
Phone: +90 538 404 04 94 **E-mail:** nfatihakdemir@hotmail.com **ORCID-ID:** orcid.org/0000-0003-1794-211X
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For this reason, alternative approaches have been evaluated in urethral strictures. The first use of a laser for treating urethral stricture was in 1979 (4). Different laser types such as diode, neodymium yttrium aluminum garnet (Nd:YAG), argon, and holmium: yttrium aluminum garnet (Ho:YAG) laser have been used for treating urethral strictures (5). The Ho:YAG laser cuts the tissue directly while vaporizing it with clearer vision and less bleeding, leaving minimal scarring in the urethra (6). In this study, we compared the treatment results of cold -knife urethrotomy and Ho:YAG laser use in patients with urethral stricture.

Materials and Methods

The Patient Evaluation

In this prospective randomized controlled study, the results of a total of 364 patients who underwent internal urethrotomy with cold knife or Ho:YAG laser for primary urethral stricture between September 2010 and April 2020 were evaluated. In the preoperative evaluation, the patients presented with complaints such as decreased urine flow rate, difficulty in urination, residual urine sensation, pollakiuria, dysuria, and nocturia. In the preoperative period, etiological factors that may cause urethral stricture such as trauma, urine infection, iatrogenic injury (instrumental or surgical), previous transurethral catheter placement history, and previous coroner angiography or bypass surgery history were determined. Genital examinations of all cases were performed, and conditions such as meatal stenosis and hypospadias that made urinary flow difficult were excluded. Uroflowmetry and post-voiding residue (PVR) measurements were performed in all cases. Additionally, the severity of the patient's symptoms was evaluated by applying the International Prostate Symptom Score (IPSS), and IPSS/quality of life (QoL) questionnaires. All cases were evaluated with complete urinalysis and urine culture, complete blood count, and kidney function tests. Patients with active urinary tract infections have been treated with antibiotics preoperatively. Cases that were multiple sites (>1), completely obliterated, or had stenosis longer than 3 cm were excluded from the study. Patients who underwent urological intervention due to urethral stricture and another concomitant cause (such as prostate cancer, benign prostatic hyperplasia, bladder tumor or stone, ureteral stone) were excluded from this study. Additionally, patients who had undergone previous endoscopic or open surgery due to urethral stricture were excluded from this study. Also, patients neurological diseases have been excluded from this study. The patients were divided into two as the cold knife group (group 1, n=176) and the Ho:YAG laser group (group 2, n=188). After the patients were informed about the laser and cold knife, the technique to be used was explained and their informed consent was obtained. Ciprofloxacin was administered to the patients 2 h before the operation and continued for 5 days postoperatively. The patients were discharged on the postoperative first day. The transurethral catheter was removed after an average of 5 (range 3 to 10 days) days. Perioperative and postoperative complications were noted. All patients were evaluated regularly at the 1st, 6th, and 12th months postoperatively. Patients who had no symptoms during their follow-up, who urinated at least 150 mL in uroflowmetry, had a maximum flow rate of more than 15 mL/s, had residual urine of less than 50 mL and an IPSS score between 0-7 were considered successful. In the presence of symptoms such as decreased urine flow, dysuria, difficulty urinating and urinary retention, patients were evaluated with uroflowmetry, PVR, IPSS, IPSS/QoL tests and cystoscopy was performed. A definitive diagnosis of recurrence for urethral stricture was made by performing cystoscopy. The study protocol was approved by the Ankara Atatürk Training and Research Hospital Ethics Committee, and all patients signed an informed consent agreement.

Surgical Technique

All cases were operated by a sinle surgeon experienced with endourethrotomy. The surgical procedure was performed under general or spinal anesthesia and in the lithotomy position. A 21-F rigid internal urethrotome and 0-degree optic (Karl STORZ® medical, Germany) were used in the operation. At the beginning of the operation, after entering the external urethral meatus, urethral stenosis was observed, and the guide wire (0.035 inch) was inserted and advanced beyond the stricture. Then, the cold knife was advanced through the stenosis segment and incisions were made at the 12 o'clock position. If necessary, another incisions were made into the scar tissue at the 5 and/or 7 o'clock position. This procedure was repeated until the 21-F internal urethrotome passes comfortably through the urethra, and a sufficient caliber opening was obtained in the urethra. Then, diagnostic cystoscopy was performed and the procedure was terminated by placing a 18-F silicone catheter transurethrally. Patients in group 2 were being seen urethral stricture using 21-F internal urethrotome and 0-degree optics (Karl STORZ® medical, Germany), and the guide wire (0.035 inch) was inserted and advanced beyond the stricture. Then, using Ho:YAG laser (SPHINX®, Germany) energy, the stricture segment was enlarged until an opening was obtained for the internal urethrotome to pass easily. All the scarred tissues in the stricture area were coagulated and preserved the healthy mucosa. A 550-nm Ho:YAG end firing laser fiber was used and the energy of the Ho:YAG laser was set to 2 Joules and its frequency to 30 Hz. This energy and frequency setting was chosen because it results in a satisfactory compromise of low tissue penetration

depth and low coagulation effect. It was observed that the 21-F internal urethrotome passed easily through the opening and procedure was terminated by inserting a 18-F silicone catheter transurethrally after diagnostic cystoscopy.

Statistical Analysis

All data were expressed as mean ± standard deviation. Statistical analysis was performed using SPSS version 22.0 (SPSS, Chicago, IL, USA). Parametric variables were assessed using a One-Sample t-test. Numerical variables, such as demographic data, and peroperative and postoperative complications were assessed using the Mann-Whitney U test. A p-value less than 0.05 was considered as statistically significant.

Results

The mean age was determined as 59.5 (20-79) years in group 1 and 61.3 (18-82) years in group 2. No significant difference was observed between the two groups in terms of etiological factors (Table 1). Iatrogenic factors were the most common etiologic factors in both groups. The length of the stricture in all cases included in the study was determined to be less than 3 cm. When the operation times were compared, it was found that it was significantly shorter in the cold -knife group compared with the Ho-Laser group. The mean operation time (time between entry and exit of the urethrotome into the urethra) was 11.50±5.42 minutes in group 1 and 23.40±13.24 minutes in group 2. Mean Q_{max}, Q_{ave}, PVR, IPSS, and IPSS/QoL values were preoperatively 8.16±1.12 mL/s, 4.36±1.06 mL/s, 124.50±45.30 mL, 20.33±4.16, and 5.25±0.94 in group 1 and 6.45±1.19 mL/s, 4.62±1.03 mL/s, 135.65±54.35 mL, 23.55±5.18, and 5.40±0.88 in group 2, respectively. The same values were 25.43±4.38 mL/s, 21.32±3.18 mL/s, 25.50±5.75 mL, 7.08±2.08, and 1.36±0.16 in group 1 and 27.48±5.81 mL/s, 23.08±2.36 mL/s, 19.04±8.45 mL, 6.06±2.04 and 1.23±0.21 in group 2, respectively, in the last postoperative control (Tablo 2). Recurrence rates were determined as 29.54% (n=52) and 10.63% (n=20) in groups 1 and 2, respectively ($p<0.05$ for all comparisons). The mean stricture development time was found to be 6.4 months in groups 1 and 9.3 months in group 2. The most common postoperative complications were urinary tract infection and dysuria. However, there was no statistically significant difference between the two groups in terms of intraoperative and postoperative complications (Table 3).

Discussion

Ho-YAG Laser can be used for treating urological diseases such as urolithiasis (7), benign prostatic hyperplasia (8), urethral strictures (9), bladder tumors (10), and external genital lesions

Table 1. Etiologic factors of the patients with urethral stricture

	Group 1 (n=176)	Group 2 (n=188)	p
Idiopatic	55 (31.25%)	63 (33.51%)	0.765
Transurethral catheterisation	13 (7.38%)	11 (5.85%)	0.801
Coronary heart disease	23 (13.06%)	18 (9.57%)	0.697
Urethritis/recurrent UTI	10 (5.68%)	17 (9.04%)	0.635
Perineal trauma	2 (1.13%)	1 (0.53%)	0.631
Iatrogenic factors	73 (41.47%)	78 (41.48%)	0.843

UTI: Uriner tract infection. Etiological factors were assessed by using Mann-Whitney U test ($p<0.05$: Statistically significant)

Table 2. Preoperative and postoperative uroflowmetry, ultrasonography and IPSS values

	Preoperative Group 1/2	Postoperative 1st month Group 1/2	Postoperative 6th month Group 1/2	Postoperative 12th month Group 1/2	p
*Q_{max} (mL/s)	8.16±1.12 6.45±1.19	27.17±4.85 31.11±5.35	25.98±3.85 28.45±4.96	25.43±4.38 27.48±5.81	0.794
*Q_{ave} (mL/s)	4.36±1.06 4.62±1.03	23.16±2.14 25.32±3.56	21.50±3.05 24.36±2.65	21.32±3.18 23.08±2.36	0.826
*PVR (mL)	124.50±45.30 135.65±54.35	23.35±5.43 26.05±5.28	25.45±6.21 23.50±6.65	25.50±5.75 19.04±8.45	0.693
*IPSS	20.33±4.16 23.55±5.18	4.36±1.65 4.09±1.35	6.80±1.56 4.92±1.34	7.08±2.08 6.06±2.04	0.687
*IPSS/QoL	5.25±0.94 5.40±0.88	1.16±0.18 1.05±0.14	1.12±0.21 1.02±0.11	1.36±0.16 1.23±0.21	0.774

Q_{max}: Maximum flow rate, Q_{ave}: Average flow rate, PVR: Post voiding residue, IPSS/QoL: International Index of Prostate Symptom Score/quality of life. *Parametric variables were assessed by using One-Sample t-test ($p<0.05$: Statistically significant)

Table 3. Peroperative and postoperative complications			
	Group 1, n=176	Group 2, n=188	p
Hematuria	3 (1.70%)	-	0.865
Urinary extravasation	4 (2.27%)	1 (0.53%)	0.722
UTI	16 (9.09%)	13 (6.91%)	0.757
Dysuria	12 (6.81%)	7 (3.72%)	0.828
Urinary incontinence	4 (2.27%)	1 (0.53%)	0.653
Urinary retantion	-	-	-
Urinary fistula	-	-	-
Epididymoorchitis	9 (5.11%)	7 (3.72%)	0.846
Erectile dysfunction	-	-	-
Penile or scrotal edema	4 (2.27%)	1 (0.53%)	0.663
UTI: Uriner tract infection. Peroperative and postoperative complications were assessed by using Mann-Whitney U test (p<0.05: Statistically significant)			

(11). The management of urethral strictures has often been a challenge for urologists. Its incidence in men was approximately 0.6% (12). Although the symptoms are different, dysuria, urinary retention, urinary incontinence, and urinary obstruction can be observed (13). Although it is generally associated with trauma, transurethral interventions, and infections, it can also be seen idiopathically. Stricture occurs because of mucosal laceration, infection, and scar tissue formation (14). Important risk factors that play a role in recurrence are the length of the stricture, the depth of the scar tissue, the etiology, the location of the stricture, and the severity, which is characterized by spongiofibrosis (14,15). The treatment method to be chosen can be determined depending on the location of the stricture, its length, and the experience of the surgeon (13).

A laser was first used in 1979 for treating urethral strictures (4). The Ho:YAG is a solid laser at a wavelength of 2.140 nm and emits pulse-like energy. Tissue absorption is non-selective but uniform, with a penetration depth of only 0.4 mm. The emission time is as short as 0.25 millisecond, and it applies a transient power of no more than 10 kilowatt. Laser energy acts by vaporizing its target with minimal thermal effect in tissues such as stones and scars (16). Endouretrotomy with Ho:YAG laser is a minimally invasive, effective, and reliable method and compared to other methods such as electrical resection and laser incision, it removes scar tissue through evaporation and thermal damage to neighboring urogenital tissues is minimal. Additionally, the scar formed after urethrotomy is insignificant (17). Ho:YAG laser has advantages such as less bleeding, a clear vision, more precise incision, and ablation in the scar tissue.

There is no consensus on the long-term results of the use of cold knives and lasers in urethral strictures. In addition to the publications reporting that laser use is superior (18,19), studies (20-22) showing that laser is not superior to a cold knife have been published. Because of the 12-month follow-up of 138 patients who were operated using Ho-YAG laser, the recurrence of stricture was reported in 26.8% cases. Recurrens have been reported to be at the site of the old stricture and milder than previous strictures. Additionally, the authors have been stated that these recurrences were mostly seen in the bulbar region, occurring in patients with strictures longer than 2 cm and with a history of trauma (23). In a study comparing Ho-YAG laser and cold knife, it has been reported that the recurrence rate was 20.7% in the cold knife group and 32.4% in the Ho-YAG group because of a 12-month follow-up. Although there was no difference between the two groups in terms of Q_{max} and postoperative complications, it was stated that the operation time was longer in the laser arm (24). In another study comparing Ho-YAG laser and cold knife, including 80 patients, recurrence of urethral stricture was reported at a rate of 20% in the cold knife group and 10% in the laser group after a 1-year follow-up. In this study, which included cases with strictures shorter than 1.5 cm, it was stated that there was no difference between the groups in terms of postoperative complications, but the operation time was significantly longer in the laser group (9). Additionally, it has been reported that holmium laser can be used effectively and safely for treating urethral strictures in children, and the success rate is higher (76.2% vs. 47.61%) compared with the use of cold knife (25). In a study of 78 patients who underwent Ho:YAG laser, in 31 patients (40%) who were completely obliterated and had a stricture longer than 1.5 cm reported recurrence of the stricture. It was also stated that these patients had undergone an intervention before. It has been emphasized that they get better results in short bulbar strictures (6). Choi et al. (17) used Ho:YAG laser in 14 patients with stenosis less than 2 cm and developed secondary to trauma or inflammation and reported that this method is minimally invasive, safe and effective. In a prospective randomized clinical study involving 51 patients in which the use of Ho:YAG laser and cold knife was compared, it was reported that the Ho:YAG laser provided a lower recurrence rate and shorter operative time without a significant difference in Q_{max} (26). In a study of 190 patients, it was reported that the use of Ho:YAG laser in long urethral strictures was a safe and minimally invasive technique providing high success rates (27). Success rates of 60-85% have also been reported in other studies using Ho:YAG laser (28).

Using the Ho:YAG laser is a process that requires experience. In cases where the stricture is close to the external urethral sphincter, pubis, rectum, pelvic vessels, and nerves, complications such as urinary incontinence and rectal fistula may occur because of incidental damage (29). Apart from these, internal urethrotomy has complications such as bleeding, urinary tract infection, urosepsis, extravasation, impotence, and recurrence of stricture (6). Using the necessary antibiotherapy for patients with uriner tract infection in the preoperative period and paying

attention not to damage the sphincter during the operation can reduce complications. In our study, Ho:YAG laser was used in 188 patients and a cold knife was used in 176 patients, whereas the success rate (no recurrence) was 70.46% in cases treated with cold knife, whereas the success rate was 89.37% in cases treated with Ho:YAG laser. The fact that the patient follow-up period is 12 months, similar to the literature, can be considered a factor limiting the study. However, it can be considered the advantage of this study that it is prospective, comparative, and includes a large number of patients. We believe that conducting other studies with longer follow-up periods will guide the determination of the importance of the use of Ho-YAG laser in urethral strictures.

Conclusion

According to the results of our study, in Ho:YAG laser urethrotomy, the stricture is less likely to recur compared with cold knife urethrotomy, and holmium laser urethrotomy can be considered a minimally invasive and effective method that can be used safely for treating urethral strictures.

Ethics

Ethics Committee Approval: The study protocol was approved by the Ankara Atatürk Training and Research Ethics Committee.

Informed Consent: All patients signed an informed consent agreement.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.A., E.O., Ö.K., Concept: F.A., E.O., Ö.K., Design: F.A., E.O., Ö.K., Data Collection or Processing: F.A., E.O., Ö.K., Analysis or Interpretation: F.A., E.O., Ö.K., Literature Search: F.A., E.O., Ö.K., Writing: F.A., E.O., Ö.K.

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