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OUTCOME OF LASER ABLATION VERSUS COLD KNIFE INCISION OF SHORT URETHRAL STRICTURE

Mohammed A. Hussein[1*], Ghassan Abdulla Raddam[1] and Ahmed Ali Abdul Hussein[1]

[1]Imamein Kadhimein Medical City, Baghdad, Iraq.

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***Corresponding Author**

Mohammed A. Hussein

Imamein Kadhimein Medical City, Baghdad, Iraq.

ABSTRACT

Background: Urethral stricture is a prevalent condition associated with great morbidity which can be severe, jeopardizing the patient's quality of life (QoL). **Aim:** To study the efficacy and outcome of Holmium: YAG laser ablation of short urethral stricture compared to cold knife internal urethrotomy**. Patients and methods:** Thirty three adult male patient presented with urethral stricture less than two cm were randomly allocated into two groups; first group treated with Holmium laser (14 patient), the second group of patient treated with cold knife internal urethrotomy (19 patient). A careful evaluation with retrograde cystourethrogram and uroflowmetry were done on all patients, and they were followed up for one year with urine culture and sensitivity, RUG, and uroflowmetry. **Results:** The most common cause of urethral stricture in both groups was iatrogenic injury. The mean operative time of cold knife urethrotomy procedure was 27.4 minutes compared to 26.78 minutes in the Holmium laser group. Mean VAS of pain was 2 for laser treated patients and 2.15 for cold knife treated patients. Recurrence rate with need for redo surgery was seen in 3 cases in holmium group compared to 9 cases in the cold knife treated patients. **Conclusion:** Both holmium laser and cold knife internal urethrotomy are effective surgical options for the treatment of short urethral stricture less than 2 cm with a promising outcome after 1 year follow up with better success rate using the Holmium laser.

KEYWORDS: Holmium laser, urethral stricture, internal urethrotomy, retrograde urethrogram, uroflowmetry.

BACKGROUND

Urethral stricture is caused by ischemic fibrosis of the corpora spongiosa,[1] resulting in narrowing of the urethral lumen, which in turn leads to difficulty with urination and has a significant adverse impact on the physical and psychological well-being of patients.[2] Common risk factors for urethral stricture in men include urethral infections, a history of trauma, prior endoscopic procedures, urethral catheterization, or mechanical implantation procedures. However, the etiology of urethral stricture in many men is idiopathic.[3,4] An idiopathic urethral stricture occurs in 34% and 63% of cases at the penile and bulbar regions, respectively.[4] Urethral stricture is a condition associated with a high risk of recurrence, with Pansadoro and Emiliozzi reporting a recurrence rate of up to 58% for bulbar urethral strictures after direct vision cold knife urethrotomy.[5] This high recurrence risk is attributed to the inability of urethral dilation, urethral reconstruction, or urethrotomy to completely remove urethral scar tissue and inhibit scar growth.

Direct Visual Internal Urethrotomy (DVIU) was first performed by Ravasini in 1957.[6] He described the use of an electric knife to incise narrow urethral strictures, which inevitably resulted in significant thermal effects on the surrounding healthy tissues. Subsequently, in 1971, Sachse introduced the urethrotome, allowing surgeons to perform urethral incisions using a cold knife, with reported success rates as high as 80%. Compared to the earlier use of the electric knife, cold knife urethrotomy avoided the thermal effects on surrounding healthy tissues.[7] DVIU gained popularity among urologists due to its simplicity, speed, and short recovery period.[6,8,9] Laser urethrotomy offers efficient energy ablation and excellent hemostasis, providing a clear view during the surgical procedure. Additionally, due to the laser shallow penetration depth of only 0.4 cm, it minimizes damage to surrounding normal structures.[5, 10]

Pathophysiology: Injury to the urethral epithelium and/or underlying corpus spongiosum is the basis of anterior urethral stricture development.[13] Urothelium is normally composed of pseudostratified columnar epithelial cells, and injury to the tissue leads to squamous metaplasia.[11,13] The stratified squamous epithelium is more fragile than the pseudo-stratified columnar epithelium and is thus more.

Clinical Presentation: Patients with symptomatic urethral strictures typically present with lower urinary tract symptoms consistent with obstruction, such as slow

stream, dysuria, spraying, straining, terminal or postmicturition dribbling, incomplete emptying with a potential for urinary retention, and hematuria.[13,14] If the stricture has been present for a long duration of time, patients may experience recurring urinary tract infections, prostatitis, or even bladder stones.[15] Strictures may also affect sexual function causing pain with ejaculation with delayed discharge of ejaculate.[13]

Treatment: Endoscopic management of urethral strictures by urethral dilation or direct visual internal urethrotomy (DVIU) is a pertinent option in patients presenting with a first-time, short bulbar urethral stricture (< 2 cm).[11,12]

PATIENTS AND METHODS

Study design and sample size: This prospective study enrolled 33 patients with short urethral stricture, 19 patients underwent cold knife incision and 14 had LASER ablation. The study was carried out in Al-Imamain Al Kadhimeain medical city between 1st October 2022 and 1st September 2024.

Consent and approval: Verbal consent was obtained from each patient enrolled in the sample after he received full information regarding the aim and nature of the study. The official approval was granted from Urology Council in Arab Board of Health Specializations before conducting the study.

Inclusion and exclusion criteria: Any patient with short anterior (penile and bulbar) urethral stricture < 2 cm was included in the sample.

Exclusion criteria

1. Long strictures (≥ 2 cm)
2. Multiple strictures
3. Recurrent strictures
4. Concomitant urinary tract infections
5. Suspected or approved malignant stricture.
6. Associated bladder or urethral stones.
7. Female patient

Evaluation**:** Initial evaluation of each patient included history and physical examination. Stricture-specific investigations included retrograde urethrogram, antegrade urethrogram, and voiding cystourethrogram. Also, abdominal and pelvic ultrasonography was performed to assess the bladder status in pre and postvoiding and upper tract changes. Uroflowmetry was used to assess maximum flow rate. Routine preoperative testing included urine culture and sensitivity, complete blood count, renal function tests, electrocardiography, and chest X-ray.

Surgical technique**:** All patients were operated on in a lithotomy position under general or spinal anesthesia. A single surgeon performed all cases. Operative time is calculated from induction of anesthesia till end of surgery with foleys catheter insertion.

In cold knife incision group, a 21Fr internal urethrotome was passed through the external urethral meatus under direct vision using 0-degree lens. After identification of the urethral stricture, a guide wire was passed through the stenosis into the bladder. Then, the cold knife was inserted through the stricture with making incisions at the 12 o'clock position and if necessary, at the 5 and/or 7 o'clock positions. Once urethra at stenosed segment allowed the passage of the 21Fr urethrotome, the incisions were stopped. Lastly and after performing the diagnostic cystoscopy, the procedure was terminated with insertion of the 16fr Foley's catheter.

In LASER ablation group, similar as cold knife incision group the 21Fr internal urethrotome was inserted with passing the guide wire through the stricture into the bladder. A 550nm Ho: YAG end firing laser fiber, with setting the energy and frequency at 0.8 Joules and 10 Hz respectively, was passed through urethrotome. The stricture was ablated at the 12 o'clock position by the LASER until the caliber could have accommodated the 21Fr urethrotome. The procedure then was proceeded as described for cold knife incision group.

Postoperatively, the patients were discharged on same day of the operation with Foley's catheter which was removed after 7 days.

Follow-up: Age, stricture site, maximum flow rate, post-void residual, operating time, postoperative complications, postoperative pain (using pain visual analogue scale as illustrated in table 1 and figure 1) and recurrence rate were recorded for each patient. The patients were followed up at 3, 6 and 12 months.

Table 1: Grading pain according to pain visual analogue scale (VAS).

Pain intensity	VAS score
No pain	0
Mild pain	1 to 3
Moderate pain	4 to 6
Severe pain	7 to 10

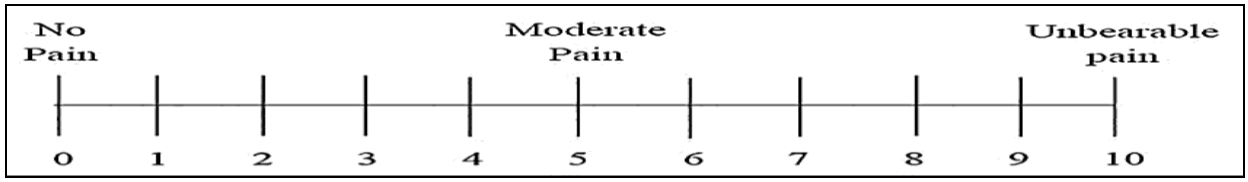

Figure 1: The pain visual analogue scale (VAS).

Statistical analysis: Data management was carried out using Microsoft Excel 2010 and SPSS version 26. Normality of continuous parameters was assessed using Kolmogorov–Smirnov test. Categorical variables were represented as numbers and frequencies while continuous data were expressed in form of means and standard deviations. Qualitative data were compared using chi square or Fisher's exact test while T test was used for comparison of quantitative variables. *P-value* less than 0.05 was regarded as significant.

RESULTS

Thirty-three patients with urethral stricture, of them 19 underwent cold knife incision and 14 patients had LASER ablation, were included in the study. Pre-operative and postoperative parameters were not significantly different between the two groups as illustrated in table 2 and 3 respectively.

Table 2: Comparison of preoperative parameters between cold knife incision and LASER ablation groups.

Parameters	Cold knife incision group (n=19)	LASER ablation group (n=14)	*P-value*
Age(years) Mean (SD)	43.21(11.80)	39(12.02)	0.32
Stricture site; n (%) Penile Bulbar	11(57.89%) 8 (42.11%)	9(64.2%) 5(35.8%)	
Qmax(mL/s) Mean (SD)	8.63(1.17)	8.4(1.22)	0.58
PVR (mL) Mean (SD)	57.94(8.54)	57.57(9.54)	0.90

*Qmax; maximum flow rate, PVR; post-void residual, *P-value* less than 0.05 was regarded as significant.

Table 3: Comparison of intraoperative and postoperative parameters between cold knife incision and LASER ablation groups.

Parameters	Cold knife incision group (n=19)	LASER ablation group (n=14)	*P-value*
OT (minutes) Mean (SD)	27(3.60)	26.78(2.83)	0.85
Pain VAS score Mean (SD)	2.15(0.95)	2(0.87)	0.63
Fever; n (%) Yes No	5(26%) 14(74%)	4(29%) 10(71%)	0.88
Hematuria; n (%) Yes No	7(37%) 12(63%)	4(29%) 10(71%)	0.61

*OT; operating time, VAS; visual analogue scale, *P-value* less than 0.05 was regarded as significant.

During follow-up period, postoperative variables were not significantly different between patients who had cold knife incision and those who underwent LASER ablation and as shown table 4.

Table 4: Comparison of follow-up parameters between cold knife incision and LASER ablation groups.

Follow-up	Parameters	Cold knife incision group	LASER ablation group	*P-value*
At 3 months	Qmax(mL/s) Mean (SD)	23.28(4.60)	24.64(4.47)	0.40
	PVR (mL) Mean (SD)	16.15(17.81)	14.71(15.92)	0.81
	UTIs; n (%) Yes	6(32%)	4(29%)	1.00

	No	13(68%)	10(71%)	
	Recurrence; n (%) Yes No	 2(11%) 17(89%)	 1(7%) 13(93%)	1.00
At 6 months	Qmax(mL/s) Mean (SD)	 21.75(5.34)	 24.66(3.34)	0.09
	PVR (mL) Mean (SD)	 21.29(19.19)	 15.76(13.39)	0.38
	UTIs; n (%) Yes No	 2(11%) 15(79%)	 4(29%) 9(64%)	0.35
	Recurrence; n (%) Yes No	 2(11%) 15(79%)	 1(7%) 12(86%)	1.00
At 12 months	Qmax(mL/s) Mean (SD)	 22.85(4.36)	 23.89(4.44)	0.54
	PVR (mL) Mean (SD)	 18.64(22.22)	 16.81(18.51)	0.82
	UTIs; n (%) Yes No	 4(21%) 11(58%)	 3(21%) 9(64%)	1.00
	Recurrence; n (%) Yes No	 5(26%) 10(53%)	 1(7%) 11(79%)	0.18

*Qmax; maximum flow rate, PVR; post-void residual, UTIs; urinary tract infections, *P-value* less than 0.05 was regarded as significant.

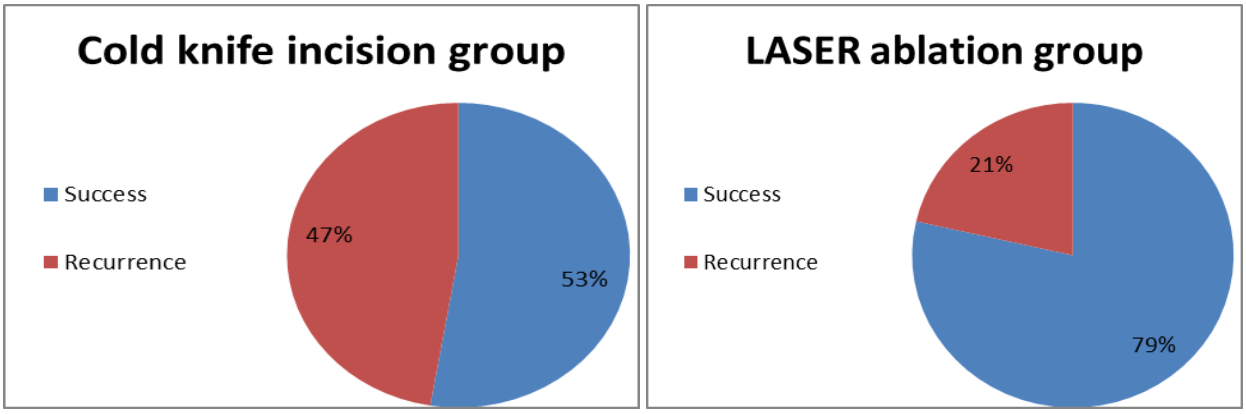

Figure 2: Overall recurrence rate at 12 months of follow-up in cold knife incision and LASER ablation groups.

DISCUSSION

The current study enrolled 33 patients with urethral stricture, of whom 19 patients underwent cold knife and the rest had LASER ablation of short urethral stricture. In agreement with the current study, Kegham et al[16] and his co-authors a prospective study on 31 patients with urethral stricture, in whom cold knife incision and LASER ablation were performed in 16 and 14 patients respectively. On the contrary, 176 patients underwent cold knife incision, and 188 patients had LASER ablation in a study by Akdemir et al.[17] On other hand, Ali et al[18] enrolled a total of 20 patients with urethral stricture, 10 of them underwent cold knife incision and 10 patients had Ho: YAG laser ablation.[18]

According to a recent study, the average age in patients who underwent cold knife incision and LASER ablation was 43.21 years and 39 years respectively. In line with our findings, Jhanwar et al[19] found that average age was 39.38 years in cold knife incision group and 38.13 years in LASER ablation group. Also, another study demonstrated that the mean age in patients who had cold knife incision 54.93 years and in LASER ablation group was 42.06 years. In contrast, Jhanwar et al reported that the mean age was 59.5 years and 61.3 years in cold knife incision and LASER ablation groups respectively.[16,19]

In the current research, operating time was comparable between patients who had a cold knife incision and those who had LASER ablation group (27 minutes vs 26.78 minutes, P-value 0.85). In line with our results, recently[7] conducted systematic meta-analysis that included 8 studies. After analysis of data regarding operative time from these studies,[7] concluded that operative time was not significantly different between patients who had cold knife incision and those who

underwent LASER ablation. In contradiction with our results, other series showed that operative time was significantly longer for cold knife incision in comparison with LASER ablation.[6,9] Whilst other series reported that operating time for cold knife incision was significantly shorter than LASER ablation.[16,19] Longer time needed for urethral stricture ablation using LASER may stem from higher technique difficulty and limited surgical experience.[8] However, wider adoption of LASER ablation with accumulated experience among surgeons may resolve these obstacles and shorten operating time for LASER technique.[7] Generally speaking, variability in operative time between cold knife incision and LASER ablation techniques may reflect differences in the surgical proficiencies in the surgical technique and the diversities among the surgeons themselves.[7]

In the current study, postoperative complications were not significantly different between patients who underwent cold knife incision and those who underwent LASER ablation. The overall complication rate was comparable between cold knife incision and LASER ablation techniques as reported by previous literature.[7,20] However, complications related to bleeding were found to significantly lower in patients who underwent LASER ablation technique.[7,20] LASER ablation is associated with lesser damaging effects with higher hemostatic characteristics.[7] In the recent study, the frequency of hematuria was lower in patients who underwent LASER ablation compared to those who had cold knife incision, but the difference was not statistically significant (29% vs 37%, P-value 0.61). Small sample size in our study may limit statistical power of the analysis thus obscuring discovery of events under investigation.

A recent study demonstrated that the maximum flow rate was comparable between cold knife incision and LASER ablation groups at 3 months, 6 months and 12 months of follow-up. In accordance with our findings,[21] reported comparable results. Also, postoperative pain intensity was not significantly different between patients who had cold knife incision and those who underwent LASER ablation. This finding is in line with previous literature.[7]

The recent research showed, after 12 months of follow-up, that the recurrence rate was higher in patients who had cold knife incision in contrast with those who underwent LASER ablation but without statistical significance (47% vs 21%, P-value 0.16). The recurrence was variable for cold knife incision and LASER ablation techniques among series.[22] During 12 months of follow-up, the recurrence rate was ranged from as low as 21% to as high as 65% for cold knife incision technique while for LASER ablation it was between 19% and 30%.[20] This increased recurrence rate may be related to incomplete removal of scar tissue post urethrotomy.[7]

However, LASER can vaporize a significant portion of scar tissues with less damaging effects to healthy tissues owing to its superficial penetration depth (only 0.4 mm). This attribute of LASER may act on reducing the 12 months-recurrence risk compared to cold knife stricture incision technique.[7]

Limitations

1. Small sample size
2. Short follow-up
3. Loss to follow up.

CONCLUSION

LASER ablation and cold knife incision of short urethral stricture are equally safe and effective. However, LASER ablation may be associated with lower risk with respect to bleeding-related complications and stricture recurrence.

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