The Egyptian Journal of Hospital Medicine (April 2023) Vol. 91, Page 4896-4902

Holmium Laser versus Cold Knife in Visual Internal Urethrotomy for Management of Short Segment Urethral Stricture

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ABSTRACT

Background: Fibrosis in the urethral mucosa and surrounding tissues causes the urethral lumen to narrow, which is known as urethral stricture disease. Congenital or idiopathic conditions may be the cause.

Objective: This study aimed to evaluate the safety and efficacy of holmium laser versus cold knife in management of short segment urethral stricture.

Patients and Methods: A prospective study was conducted in the Department of Urology, Outpatient Clinic, Zagazig University Hospital through the period from October 2019 to June 2020. 34 male patients with short segment anterior bulbar urethral strictures were included. Patients were randomly allocated into two groups: Group A, (cold–knife group) Sachse cold knife was used for internal urethrotomy and group B, (holmium laser group), internal urethrotomy was done with holmium laser. Patients were followed up after the operation at 1, 3 and 6 months respectively.

Results: In our study there was recurrence at 6 months in both groups and we found that laser group had lower recurrence rate 2 patients (11.8%) than cold-knife group 3 patients (17.6%) with no significant difference between the two groups (P =0.25). Folly catheter (18 f) was inserted per urethra for approximate 5 to7 days for both groups without significant difference between them.

Conclusions: This study showed that holmium laser is a good alternative option for visual internal urethrotomy (VIU) rather than cold-knife urethrotomy as Laser urethrotomy is effective, easy, has minimal invasive procedure and has advantage for shorter operative time and less occurrence perioperative complications.

Keywords: Cold knife urethrotomy, Holmium laser urethrotomy, Urethral stricture.

INTRODUCTION

About 300 males per 100,000 are affected by the prevalent disorder urethral stricture disease [(1)]. Fibrosis in the urethral mucosa and surrounding tissues causes the urethral lumen to narrow, which is known as urethral stricture disease. Congenital or idiopathic conditions may be the cause [(2)]. Depending on the length, position, and depth of the scar, many procedures have been used to treat urethral strictures, including simple dilatation, urethrotomy, uroLume stent implantation, urethroplasty, and perineal urethrostomy [(3)]. For the same patient, endoscopic procedures like urethrotomy and dilatation are simple, convenient, and repeatable; but, over the long run, up to 40% of these procedures will fail and strictures will return [(4)].

One of the most often practised techniques for urethral stricture is visual internal urethrotomy (VIU) [(5)]. Although Sachse first presented the sharp-bladed cold knife urethrotome under direct vision in 1971 and reported an 80% success rate with this operation in 1974 [(6)], Ravasini first described internal urethrotomy under direct vision in 1957 and employed electrocautery to incise the stricture. Since 1977, lasers have been utilised to treat urethral strictures [(7)]. Various lasers, including carbon dioxide, Nd: YAG, KTP, Argon, Ho: YAG, and excimer lasers, have been utilised for urethrotomies. There hasn't been any proof that one kind of laser is better than another [(8)].

A recent addition to the variety of accessible laser modalities is holmium: YAG, which offers both direct contact cutting and vaporisation with little forward scattering [(9)]. This study aimed to evaluate the safety and efficacy of holmium laser versus cold knife in management of short segment urethral stricture.

PATIENTS AND METHODS

This is a prospective, randomized comparative study that has been held at Urology Outpatient Clinic, Faculty of medicine, Zagazig University between October 2019 and June 2020. 34 male patients with short segment anterior bulbar urethral strictures were randomly allocated into two groups, Group A, (cold–knife group) where Sachse cold knife was used for internal urethrotomy and group B, (holmium laser group), internal urethrotomy was done by holmium laser.

Inclusion criteria:

Short segment anterior bulbar urethral strictures ($\leq$ 1 cm in length). Q max less than 15 ml/sec.

Exclusion criteria were:

Patients with skeletal abnormality that can affect the lithotomy position. Patient who were unfit for surgery and/or anesthesia. Bleeding tendency and/or coagulopathy. Pediatric age group. Multiple strictures and other causes of infra-vesical obstruction.

Patients were randomized using a computer-generated randomization list and sequentially numbered opaque sealed envelopes, each containing the allocation information written on a card. Envelopes were opened sequentially by a study nurse to allocate patients to the

Received: 08/12/2022
Accepted: 10/02/2023

assigned group. These patients were divided into 2 groups:

Group A: 17 patients for holmium laser technique
Group B: 17 patients for cold- knife technique.

Operative technique:

Pre-operative assessment

All patients were assessed by history taking and full physical examination. Complete blood picture, coagulation profile, renal function tests, liver function tests and midstream urine analysis with culture and sensitivity to ensure that the patients had sterile urine before the procedure were done. Retrograde Urethrography (RGU) with voiding film, pelvic-abdominal US with estimation of post voiding residual urine, uroflowmetry (Q max) and International Prostate Symptom Score (IPSS) pre and post-operative were performed.

Operative technique:

Under spinal anaesthesia, the surgery was carried out in the lithotomy position with pressure points padded. 500 mg of the antibiotic cefoperazone was administered 12 hours before and after the surgery. Under video surveillance, a 16-feet-long diagnostic cystoscope (Karl Storz, Germany) was used for the first urethrocystoscope, and a guide wire (0.035 mm) was placed into the bladder.

The cold knife technique:

Through the cystoscope sheath, the Sachse urethrotome was inserted into the urethra. The knife was kept pulled in as it was pushed into the urethra up to the stricture location. The cold knife was used to make the incision at the hour of twelve. Until the stricture was sufficiently opened up, the operation was repeated. The diagnostic cystoscope was inserted into the urinary bladder once the stricture was abated. Safety wire could be removed when bladder was drained. For around 5 to 7 days, a folly catheter (16f) was put per urethra.

The Holmium laser technique:

Through the (16 fr) laser diagnostic cystoscope, the holmium laser fiber 550 m was introduced. At twelve o'clock, a laser fiber was used to make an incision that was only sliced to the mucosa's pinkish colours. The diagnostic cystoscope was inserted into the urinary bladder once the stricture was abated. Safety wire could be removed when bladder was drained. For around 5 to 7 days, a folly catheter (16 f) was put per urethra. The machine used was Holmium: YAG laser device (Sphinx 100 Watt, holmium-YAG laser, LISA Laser Products–OHG, Germany) with setting of 2J and 15Hz.

Postoperative Assessment:

All patients were discharged at the same or second day. Spontaneous voiding with peak flow rate more than 15 ml/seconds without any requirement of post-operative urethral dilatation was taken as a successful procedure. Patients were followed up after the operation at 1, 3 and 6 months respectively. At each follow up visit they were subjected to IPSS, uroflowmetry with Q max if < 10 ml/sec we prepare the patient for retrograde urethrography (RGU), post volume residual (PVR) by pelvic-abdominal U/S and urine analysis and culture.

Ethical approval:

For the patient to take part in the trial, written informed consent was required. Following Institutional Review Board (IRB) clearance, the Urology Departments at Zagazig University Hospitals granted their consent for the study. The work was done in conformity with the World Medical Association's Code of Ethics (Declaration of Helsinki) for human subjects research.

Statistical analysis

SPSS version 24.0 programme was then used to import the data and perform analysis. The following tests were performed to determine if differences in the qualitative variable's relationship and the quantitative variable were significant. According to the type of data, qualitative were represented as number and percentage, and quantitative continues were represented by mean ± SD. The qualitative variable's association with the quantitative variable was determined by the Chi-square test (X^2). Comparisons between quantitatively independent groups by using a paired t-test. The p-value was set at ≤ 0.05 for outcomes that were significant and 0.001 for those that were very significant.

RESULTS

This study included 34 males patients with short segment urethral stricture. Patients were randomly allocated in two groups, group A (holmium laser group) included 17 patients with mean age of 42.58 ± 9.32 years. Internal urethrotomy was done with holmium laser. group B (Cold knife group) included 17 patients with mean age of 44.23 ± 12.04 years. Sachse cold knife was used for internal urethrotomy. The age of patients ranged from 18 to 60 years old.

4 patients were exclused not meeting inclusion criteria and two patients were missed from the 1st follow up of the study so only 34 patients were randomly allocated into two groups.

Table (1) showed that mean age in **Laser group** was 42.58 ± 9.32 and in **Cold knife group** was 44.23 ± 12.04 with no significant difference between both groups. BMI was distributed as 29.17 ± 3.72 and 29.94 ± 3.83 respectively with no significant difference between both groups. Also, there was no significant difference between both groups regarding possible causes, previous surgical history and stricture length RGU.

Table (1): Demographic and clinical data distribution between studied groups

			Laser group (n=17)	Cold knife group (n=17)	t/X2	P
Age (years)			**42.58±9.32**	**44.23±12.04**	**-0.446**	**0.659**
BMI (kg\m^2)			**29.17±3.72**	**29.94±3.83**	**-0.590**	**0.560**
Stricture Length(cm) RGU			**0.85±0.23**	**0.88±0.21**	**-0.378**	**0.708**
Possible causes	**Trauma**	**N**	**11**	**12**		
		%	**64.7%**	**70.6%**		
	Inflammatory	**N**	**2**	**2**	**0.18**	**0.91**
		%	**11.8%**	**11.8%**		
	Post Catheterization	**N**	**4**	**3**		
		%	**23.5%**	**17.6%**		
Previous surgery	**No**	**N**	**11**	**12**		
		%	**64.7%**	**70.6%**		
	Urethroplasty	**N**	**2**	**2**	**0.18**	**0.91**
		%	**11.8%**	**11.8%**		
	VIU	**N**	**4**	**3**		
		%	**23.5%**	**17.6%**		
Total		**N**	**17**	**17**		
		%	**100.0%**	**100.0%**		

Laser group was significantly shorter regard operation time than cold-knife group as they were distributed as 20.11 ± 4.32 and 27.29 ± 4.34 respectively (Table 2).

Table (2): Operation time distribution between studied groups

	Laser group (n=17)	Cold knife group (n=17)	T	P
Operative Time*(min)	**20.11±4.32**	**27.29±4.34**	**-4.827**	**0.001****

* Operative time was measured from the introduction of diagnostic cystoscope in the urethral meatus till catheter fixation.

There was no significant difference between both groups as regards PVR with gradual decrease significantly in each group during the follow up period with no significant difference between both groups, but increased in 6 month (Table 3).

Table (3): PVR distribution between studied groups at pre and post- operative

	Laser group (n=17)	Cold knife group (n=17)	t	P
PVR pre	**260.0±57.11**	**257.94±58.17**	**0.104**	**0.918**
PVR 1M	**39.35±12.6**	**41.85±13.87**	**0.413**	**0.682**
PVR 3M	**38.87±11.58**	**41.72±13.22**	**1.425**	**0.099**
PVR 6M	**47.88±15.25**	**53.28±17.58**	**1.214**	**0.211**
P1	**0.00****	**0.00****		
P2	**0.00****	**0.00****		
P3	**0.00****	**0.00****		
P4	**0.614**	**0.214**		
P5	**0.021***	**0.012***		
P6	**0.018***	**0.041***		

P1 pre & 1M, P2 pre & 3M, P3 pre & 6M, P4 1M & 3M, P5 1M & 6M , P6 3M & 6M

There was no significant difference between both groups as regards Q max with gradual increase significantly in both groups during the follow up period with no significant difference between both groups, but decreased in 6 month (Table 4).

Table (4): Q max distribution between studied groups at pre and post- operative

	Laser group (n=17)	Cold knife group (n=17)	T	P
Q max pre	**6.88±1.76**	**6.58±1.69**	**0.495**	**0.624**
Q max 1m	**18.88±2.2**	**18.71±2.17**	**0.235**	**0.816**
Q max 3m	**18.91±3.06**	**18.88±2.84**	**-0.295**	**0.811**
Q max 6m	**15.12±3.11**	**15.37±3.08**	**-0.417**	**0.687**
P1	**0.00****	**0.00****		
P2	**0.00****	**0.00****		
P3	**0.00****	**0.00****		
P4	**0.745**	**0.765**		
P5	**0.025***	**0.027***		
P6	**0.458**	**0.464**		

P1 pre& 1M, P2 pre&3M, P3 pre & 6M, P4 1M&3M, P5 1M & 6M , P6 3M & 6M

There was no significant difference between both groups as regards IPSS with gradual decrease significant in both groups during follow up period with no significant difference between both groups (Table 5).

Table (5): IPSS score distribution between studied groups at pre and post- operative

	Laser group (n=17)	Cold knife group (n=17)	T	P
IPSS score pre	**25.05±2.48**	**24.88±2.54**	**0.204**	**0.839**
IPSS score 1 m	**4.47±1.17**	**4.17±1.39**	**0.613**	**0.544**
IPSS score 3 m	**4.24±2.21**	**4.15 ±1.95**	**0.135**	**0.874**
IPSS score 6 m	**5.81±1.74**	**6.12±1.57**	**0.689**	**0.518**
P1	**0.00****	**0.00****		
P2	**0.00****	**0.00****		
P3	**0.00****	**0.00****		
P4	**0.658**	**0.553**		
P5	**0.061**	**0.051**		
P6	**0.072**	**0.075**		

P1 pre& 1M, P2 pre & 3M, P3 pre & 6M, P4 1M & 3M, P5 1M & 6M , P6 3M & 6M

Laser group was less than cold knife group significantly regarding complications rate especially bleeding per urethra and UTI. With no significant difference between both groups regarding re- stricture (Table 6).

Table (6): Complications distribution between studied groups

			Group		Total	X2	P
			Laser group (n=17)	Cold knife group (n=17)			
Complications	**No**	**N**	**13**	**7**	**20**	**13.6**	**0.0002****
		%	**76.4%**	**41.2%**	**58.8%**		
	Re stricture	**N**	**2**	**3**	**5**	**1.28**	**0.25**
		%	**11.8%**	**17.6%**	**14.7%**		
	Bleeding per urethra	**N**	**1**	**3**	**4**	**5.26**	**0.02***
		%	**5.9%**	**17.6%**	**11.8%**		
	UTI	**N**	**1**	**4**	**5**	**10.38**	**0.001****
		%	**5.9%**	**23.6%**	**14.7%**		

DISCUSSION

In our study we found that no significant difference between studied groups regarding stricture length (P =0.708) that for cold-knife was 0.88 ± 0.21 and for holmium laser was 0.85±0.23, which is in agreement with the study of **Atak *et al.*** [10] who reported that there was no significant difference between both groups (P = 0.159, for cold-knife was 12.3±2.98 and for holmium laser was 11.09±3.28). Also, **Solakhan and Bayrak** [11] found that there was no significant difference between the two groups (p=0.321, for cold-knife was 10.39 ± 3.12 and for holmium laser group was 10.8±3.06). Similar to our results, **Jhanwar *et al.*** [12] reported that there was no significant difference between the two groups (P = 0.53, for Cold- knife group was 1.31 ± 0.252 and for holmium laser was 1.34 ± 0.251). But, in the studies of **Solakhan and Bayrak** [11], **Jhanwar *et al.*** [12] and **Atak *et al.*** [10] the stricture length are more than we selected ≤ 1cm.

In our study we found that laser group had shorter operative time than cold knife group with significant difference between both groups (20.11 ± 4.32 min and 27.29 ± 4.34 min respectively), which is in agreement with the study of **Atak *et al.*** [10] who reported that the operative time was significantly shorter in laser group (16.4 ±8.04 min) compared to cold knife group (23.8 ±5.47 min) and is in disagreement with study of **Jain *et al.*** [13] who reported that the operative time was significantly longer in laser group (range 15-30 min) than in cold knife group (range 5-10 min) and study of **Yenice *et al.*** [14] who found that the operative time for laser group was 21.9 ± 3.8 min, which is longer than cold-knife group where it was 18.4 ± 2.3 min. The difference between these results may be related to technical difficulty and lack of experience for laser treatment or stricture length more than we selected in our study.

In our study we found no significant difference between studied groups regarding PVR at pre-operative (P=0.918, it was 260.0 ± 57.11 for laser group and 257.94 ± 58.17 for cold-knife group). But, each group decreased significantly from pre-operative to 1 month post-operative (39.35 ± 12.6 for laser group and 41.85±13.87 for cold-knife group), 3 months post-operative (38.87±11.58 for laser group and 41.72±13.22 for cold-knife group) and then increased significantly at 6 months post-operative (47.88±15.25 for laser group and 53.28±17.58 for cold-knife group). But, there was no significant difference between both groups at 1 month, 3 months and 6 months post-operative (P=0.682, P=0.099, P=0.211 respectively), which is in agreement with study of **Zhang *et al.*** [15] who found that there was no significant difference between the two groups (P= 0.432). While, **Dutkiewicz and Wroblewski** [16] reported that values of PVR preoperative were significantly different between both groups (p<0.05) with no significant difference between both groups during the follow up period (p>0.05).

The current study showed that there was no significant difference between both groups regarding Q max pre-operative (P=0.624) where it was 6.88 ± 1.76 for laser group and 6.58 ± 1.69 for cold-knife group. But, each group increased significantly from pre-operative to 1 month post-operative, it was 18.88 ± 2.2 for laser group and 18.71 ± 2.17 for cold-knife group, 3 months post-operative, it was 18.91 ± 3.06 for laser group and 18.88 ± 2.84 for cold-knife group, and then decreased slightly significant at 6 months post-operative where it was 15.12 ± 3.11 for laser group and 15.37 ± 3.08 for cold-knife group. There was no significant difference between both groups at 1 month, 3 months and 6 months post-operative (p=0.816, p=0.811, p=0.687 respectively), which is in agreement with the study of **Yenice *et al.*** [14] who found that there was no significant difference between both groups in terms of Q max preoperative (6.5 ± 0.7 for laser group and 6.5 ± 0.7 for cold-knife group, P = 0.874), 1 month post-operative (14.85 ± 1.80 for laser group and 15.75.0 ± 1.95 for cold-knife group, P = 0.314), 3 months post-operative (16.9 ± 1.4 for laser group and 17.0 ± 1.4 for cold-knife group, P= 0.719) and 6 months post-operative (14.7 ± 2.0 for laser group and 15.3 ± 1.7 for cold-knife group, P = 0.232). **Atak *et al.*** [10], also reported that there were no statistically significant differences between both groups in terms of Q max pre-operative (P=0.44) and with no significant difference during follow up period. Also, **Solakhan and Bayrak** [11] reported that there were no statistically significant differences between both groups in terms of Q max pre-operative (p=0.921), but in contrast with our follow up results the Q max values in the 3rd and 6th months post-operative showed significant difference toward the laser group (p=0.03), (p=0.001) respectively. This may be because they selected large number of patients in laser group.

The current study showed that there was no significant difference between both groups regarding IPSS score at pre-operative (P=0.839) where it was 25.05 ± 2.48 for laser group and 24.88 ± 2.54 for cold-knife group, but each group decreased significantly from pre-operative to 1 month post-operative where it was 4.47 ± 1.17 for laser group and 4.17±1.39 for cold-knife group, and 3 months post-operative were it was 4.24 ± 2.21 for laser group and 4.15 ± 1.95 for cold- knife group, and 6 months post-operative was 5.81 ± 1.74 for laser group and 6.12 ± 1.57 for cold-knife group. But, there was no significant difference between both groups at 1 month, 3 months and 6 months post-operative (P=0.544, P=0.874, P=0.518 respectively), which is in agreement with the study of **Dutkiewicz and Wroblewski** [16] who concluded that there was no significant difference between both groups as regards IPSS score pre-operatively (P>0.05) and 1 month, 3 months and 6 months post-operatively (P>0.05).

Chen *et al.* [17] agrees with our preoperative results who concluded that there was no significant difference between both groups as regards IPSS score (P=0.795) where it was 23.5 ± 2.6 for laser group and 24.0±2.8 for cold- knife group, but in contrast with our study for post-operative results, where at 1 month post-operative was 7.6 ± 2.1 for laser group and 9.2 ± 2.9 for cold- knife group (P < 0.05), 3 months post-operative was 5.9 ± 1.8 for laser group and 7.0 ± 2.0 for cold- knife group (P < 0.05), and 6 months post-operative was 4.8 ± 1.3 for laser group and 6.1 ± 1.7 for cold knife group (P < 0.05).

In our study, there was recurrence in 6 month in both groups and we found that laser group had lower recurrence rate [2 patients (11.8%)] than cold-knife group [3 patients (17.6%)] with no significant difference between the two groups (P =0.25), and we made urethroplasty for these patients. This is in agreement with the study of **Castellanos *et al.* [18]** who found that laser urethrotomy had a lower recurrence rate compared to cold-knife urethrotomy with no significant difference between two groups. Also **Solakhan and Bayrak [11]** reported that recurrence rates were determined to be lower in the laser group (18.4%) than in cold-knife group (52.8%) with significant difference founded between two groups (p = 0,001). In contrary, **Yenice *et al.* [14]** reported that recurrence rates were determined to be lower in the cold knife group (20.7%) than in laser group (32.4%) with no significant difference between studied groups (P = 0.299). Our low recurrence rates may be due to short- term follow up and strict inclusion criteria.

Regarding complications, our study showed that there was a statistical significant deference between the studied groups regarding bleeding per urethra (P=0.02), where it was recorded in 1 patient (5.9%) in laser group, but in cold knife group it was recorded in 3 patients (17.7%) and these patients were managed conservatively. Similar result was found with **Chen *et al.* [17]** who reported that bleeding per urethra was significantly lower in the laser group compared to the cold knife group (P<0.05), indicating less harm of holmium laser method. And also **Kegham *et al.* [19]** reported that cold-knife group had 1 patient (6.6%) who developed bleeding per urethra, but no post-operative complications in laser group such as bleeding per urethra and UTI. While, **Solakhan and Bayrak [11]** reported that the bleeding per urethra was found in 3 patients (4.61%) of laser group and in 10 patients (18.8%) of cold-knife group, with no significant difference between the two groups (p =0.209).

our study showed that there was a highly significant difference as regards urinary tract infection UTI (P = 0.001), where it was recorded in 1 patient (5.9%) in laser group and in 4 patients (23.6%) in cold-knife group. These patients were given antibiotic and kept under follow-up in out- patient clinic. Also **Kegham *et al.* [19]** reported that 2 of 19 patients (13.3%) developed urinary tract infection in cold-knife group, but no post-operative complications in laser group. While, **Solakhan and Bayrak [11],** reported that 2 of 53 patients (3.7%) developed UTI in cold-knife group, and 7 of 65 patients (10.7%) in laser group with no significant difference between the two groups (p=0.209). This may be due to large number of patients and comorbidity with laser group. And the study of **Zhang *et al.* [15]** reported that neither complication rate nor recurrence-free rates between laser and cold- knife revealed an apparent difference.

In the current study, Folly catheter (18 f) was inserted per urethra for approximate 5 to7 days for both groups without significant difference between them, which is in agreement with the study of **Kegham *et al.* [19]** who reported that a 16-Fr silicone Foley catheter was inserted per urethra at the end of the procedure which was removed after 5-7 days for both groups with no significance difference between both groups. In contrary, **Zhang *et al.* [15]** found that duration for catheter removal in laser group was 23.01 ± 2.83, while it was 21.4 ± 2.95 in cold-knife group with a statistical significant difference between both groups (P = 0.027). The duration time was long, may due to they select patients with long urethral stricture.

Duration of urethral catheterization after internal urethrotomy is still a controversial issue. In the literature, this duration ranged from 24 h up to 3 months [20]. Postoperative prolonged urethral catheterization is accepted as the most important risk factor for urinary tract infections [13]. While **Jain *et al.* [13]** reported that a 16-18 F silicone Foley catheter was inserted per urethra at the end of the procedure, which was removed after 24 h to avoid related complications.

CONCLUSION

This study showed that holmium laser is a good alternative option for VIU rather than cold-knife urethrotomy as laser urethrotomy is effective, easy, with minimal invasive procedure, had advantage for shorter operative time and less occurrence of perioperative complications. Further comparative studies with longer follow ups are required to compare the two modalities.

Sponsoring financially: Nil.
Competing interests: Nil.

REFERENCES

1. **Santucci R, Joyce G, Wise M (2007):** Male urethral stricture disease. J Urol., 177: 1667–1674.
2. **Jordan G, Devine P (1988):** Management of urethral stricture disease. Urol Clin North Am., 15*:* 277–289.
3. **Singh O, Gupta S, Arvind N (2011):** Anterior urethral strictures: A brief review of the current surgical treatment. Urol Int., 86: 1-10.
4. **van Leeuwen M, Brandenburg J, Kok E *et al.* (2011):** Management of adult anterior urethral stricture disease: Nationwide survey among urologists in the Netherlands. Eur Urol., 60: 159–166.

5. **Ghosh B, Dorairajan L, Kumar S *et al.* (2013):** Randomized clinical trial comparing effectiveness of intracorpus spongiosum block versus topical anesthesia for performing Visual internal urethrotomy for urethral stricture disease. Urology, 81: 204-207.
6. **Saavedra-Briones D, Merayo-Chalico C, Sanchez-Turati G *et al.* (2009):** Urethral stricture recurrence following internal urethrotomy. Rev Mex Urol., 69: 153-158.
7. **Jabłonowski Z, Kedzierski R, Miekoś E *et al.* (2010):** Comparison of neodymium-doped yttrium aluminum garnet laser treatment with cold knife endoscopic incision of urethral strictures in male patients. Photomed Laser Surg., 28: 239-244.
8. **Herrmann T, Liatsikos E, Nagele U *et al.* (2012):** EAUGuidelines Panel on Lasers, Technologies. EAU Guidelines on Laser Technologies. Eur Urol., 61: 783-795.
9. **Wein A, Kavoussi L, Novick A *et al.* (2012):** Campbell-walshurology. 10th ed. Surgery of the penis and urethra, Philadelphia: Elsevier Saunders, Pp: 967-973. https://www.elsevier.com/books/campbell-walsh-urology/partin/978-0-323-54642-3
10. **Atak M, Tokgöz H, Akduman B *et al.* (2011):** Low-power holmium: YAG laser urethrotomy for urethral stricture disease: comparison of outcomes with the cold-knife technique. Kaohsiung J Med Sci., 27 (11): 503-507.
11. **Solakhan M, Bayrak Ö (2020):** Endoscopic Surgery of Urethral Strictures: Laser Versus Knife. Yeni Üroloji Dergisi., 15 (1): 39-44.
12. **Jhanwar A, Kumar M, Sankhwar S *et al.* (2016):** Holmium laser vs. conventional (cold knife) direct visual internal urethrotomy for short-segment bulbar urethral stricture: Outcome analysis. Can Urol Assoc J., 10 (5-6): 161-66.
13. **Jain S, Kaza R, Singh B (2014):** Evaluation of holmium laser versus cold knife in optical internal urethrotomy for the management of short segment urethral stricture. Uro Annals, 6 (4): 328-336.
14. **Yenice M, Seker K, Sam E *et al.* (2018):** Comparison of cold-knife optical internal urethrotomy and holmium: YAG laser internal urethrotomy in bulbar urethral strictures. Cent European J Urol., 71 (1): 114-120.
15. **Zhang Y, Zhang X, Liu Y *et al.* (2018):** Comparison of Therapeutic Outcomes Between Thulium Laser and Cold-knife Optical Internal Urethrotomy for Short Segment Urethral Stricture. J Urol Ren Dis., 112 (10): 2575-7903.
16. **Dutkiewicz S, Wroblewski M (2012):** Comparison of treatment results between holmium laser endourethrotomy and optical internal urethrotomy for urethral stricture. Inter Urol Nephrol., 44 (3): 717-724.
17. **Chen J, Qian L, Zheng B *et al.* (2018):** Comparison of holmium laser combined ureteroscopy and cold knife urethrotomy in treatment of simple urethral stricture: a 5 year follow-up study. Int J Clin Exp Med., 11 (12): 13792-13796.
18. **Castellanos L, Bencardino M, Bravo-Balado A *et al.* (2017):** Evaluation of the efficacy and safety of laser versus cold knife urethrotomy in the management of patients with urethral strictures: a systematic review and meta-analysis of randomized clinical trials. Urolo Inter., 99 (4): 453-459.
19. **Kegham H, Khudhur A, Ameen A (2017):** Comparison between holmium laser and cold knife direct vision internal urethrotomy for treatment of urethral stricture. Inter Surg J., 4 (8): 2424-2428.
20. **Dubey D (2011):** The current role of direct vision internal urethrotomy and self-catheterization for anterior urethral strictures. Indian J Urol., 27 (3): 392-396.