

Original Research Article

A STUDY OF THE MANAGEMENT OF UPPER URETERIC CALCULI IN A RURAL TERTIARY CARE CENTRE

Yanala Vinay Kumar Reddy¹, Narendar Tiramdas², A Srinivas³, Raghava Tiramdas⁴

¹Assistant Professor, Department of Urology, Kamineni Institute of Medical Sciences Narketpally, Nalgonda, Telangana, India.

²Associate Professor, Department of Urology, Kamineni Institute of Medical Sciences Narketpally, Nalgonda, Telangana, India.

³Resident, Department of Urology, Kamineni Institute of Medical Sciences Narketpally, Nalgonda, Telangana, India.

⁴MBBS Student, GMC, Secunderabad, Hyderabad, Telangana, India.

Received : 25/07/2025
Received in revised form : 08/09/2025
Accepted : 29/09/2025

Corresponding Author:

Dr. Narendar Tiramdas,
Associate Professor, Department of
Urology, Kamineni Institute of Medical
Sciences Narketpally, Nalgonda,
Telangana, India.
Email: narendaruro@gmail.com

DOI: 10.70034/ijmedph.2026.2.332

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 1987-1993

ABSTRACT

Background: The aim is to evaluate the efficacy of pneumatic lithotripsy with thulium laser lithotripsy in treating upper ureteric calculi.

Materials and Methods: It was prospective observational study. The present study was conducted at Kamineni Institute of Medical Sciences, after taking written informed consent from all the patients. Ethical committee approval was obtained prior to start study. 50 patients admitted in urology department who were cases of upper ureteric calculi. The study was conducted during from July 2024 to June 2025, patients were divided into 2 groups PL group and LL group.

Results: In present study both group patients were comparable in view of mean age, gender, laterality, co-morbidities and stone threshold. Mean age of LL group patients was 40.56 ± 13.6 years and PL group was 49.80 ± 13.3 years. Mean HU of the ureteric stones of LL group patients was 1080.84 ± 332.7 and PL group was 979.04 ± 345.9 . In present study chances of retropulsion is more with PL group and post operative period pyrexia is more with LL group. But this association was statistically not significant ($P > 0.05$) 5 patients in PL group patients were required for RIRS and 3 patients from LL group. But this association was not significant ($P > 0.05$). In present study, almost all retropulsion cases were found within 6cm of PUJ distance. The nearer to the PUJ more chance of retropulsion of the stone in to pelvis. In present study, as HU increases chances of post operative fever also increases. But this association was statistically not significant. ($P > 0.05$) Retropulsion rate in LL group was 12.0% and in PL group was 20.0%. In present study we observed 9 out of 50 patients were having tight ureteric orifices so that we couldn't pass rigid ureteroscope in the first attempt.

Conclusion: In conclusion, we found that both the PL and LL approaches were effective and safe for upper ureteric calculi, but the LL method had advantages, especially in stone free rate, over the PL treatment. Stone free rate was high in LL procedure. Procedure duration was more LL group. Mean threshold of stone was more in LL group patients compare to PL group. But these associations were statistically not significant ($P > 0.05$).

Keywords: Upper ureteric calculi, pneumatic lithotripsy, laser lithotripsy, retropulsion, pyrexia.

INTRODUCTION

Stone incidence depends on geographical, climatic, ethnic, dietary, and genetic factors. The recurrence risk is basically determined by the disease or disorder causing the stone formation. Accordingly, the prevalence rates for urinary stones vary from 1% to 20%.^[1] The spontaneous passage of stone is 68% in

patients with stone size less than 5mm, and spontaneous passage is very low, 5% when the stone size is more than 6mm. According to the site, size and other factors, there are many treatment options for the removal of stone from the ureter like conservative medical expulsion therapy, extracorporeal shock wave therapy (ESWL), stone fragmentation through antegrade and retrograde ureteroscopy (URS), laparoscopy and open ureterolithotomy.^[2,3]

Ureteroscopy plays a pivotal role in the management of ureteric calculi, facilitated by advancements in technology that enhance access to stones throughout the kidney and ureter. Specifically, the evolution of ureteroscopic instrumentation underscores the importance of employing effective, miniaturized intracorporeal lithotripsy devices. Consequently, the incidence of complications, particularly ureteral perforation, has decreased to below 5%, while the frequency of long-term complications such as stricture formation is now less than 2%. The overall stone-free rate is notably high, ranging from 81% to 94%, contingent upon the stone's location and size, with most patients achieving stone-free status after a single procedure.^[4]

Technology has allowed important advances in stone treatment since the development of lithotripsy. Several modalities for intracorporeal lithotripsy have been described historically such as electrohydraulic or pneumatic fragmentation, with laser lithotripsy being the gold standard for fiber flexibility and the ability to treat stones in any location of the urinary tract.

In 1986, Watson and Wickham,^[5] described the use of a pulse dye laser to treat urolithiasis and since then, laser lithotripsy technology has evolved significantly. The holmium:yttrium-aluminum-garnet (Ho:YAG) laser has become the gold standard for lithotripsy of urinary calculi in the last two decades with excellent success rates and low complication rates as demonstrated in the initial series.^[6,7] These characteristics have been confirmed throughout the subsequent years of use. Despite the consistently good results achieved with the Ho:YAG laser, it does present some relative shortcomings such as the large size of the device. In the search for improvement in laser technology,^[8-10] the thulium fiber laser (TFL) has demonstrated good in vitro lithotripsy efficacy,^[11,12] encouraging early clinical results for all stone types.^[13] The initial clinical experience was published in 2018,^[14] and since then there has been an increasing number of basic and clinical reports analysing TFL characteristics and comparing its outcomes to the gold standard Ho:YAG laser.

Pneumatic (Ballistic) lithotripsy relies on energy generated by the movement of a projectile. Once the projectile is in contact with another object, the ballistic energy is transferred to the object. The Swiss Litho Clast, introduced in the early 1990s, was the first ballistic lithotrite. The metal projectile in the hand piece of the Litho- Clast is propelled by measured bursts of compressed air against the head of a metal probe at a frequency of 12 cycles per second. The probe tip is placed against the stone, and the Litho Clast is activated by a foot pedal when it is in contact with inflexible objects, such as stone, fragments on impact (jackhammer effect). The advantages of ballistic lithotrites are their relatively low cost and low maintenance. Disadvantages of ballistic devices include the rigid nature of the technology, which requires ureteroscopes or nephroscopes with straight working channels. In

addition, ballistic lithotripsy is associated with a relatively high rate of stone retropulsion.^[15]

The present study aims to assess the efficacy of thulium fiber laser and pneumatic (ballistic) lithotripsy in the management of upper ureteric calculi by evaluating various parameters including stone-free rate (SFR), safety, morbidity, feasibility, and complications, as well as the necessity for additional procedures to achieve complete stone clearance. Specifically, this investigation is designed to compare the effectiveness of pneumatic lithotripsy (PL) and laser lithotripsy (LL) in treating upper ureteric stones. The objectives include comparing the outcomes of PL and LL, identifying factors that predict stone-free rates, evaluating the complications associated with each technique, and determining the need for a secondary procedure in cases where stone retropulsion occurs.

Management of upper ureteric calculi is a challenge. First, it is not easy to access the stone in all the cases especially in young and muscular individuals in whom the ureters are narrow and UV-junctions are tight. Secondly migration (retropulsion) of the calculi in to the PCS of the kidney resulting in failure of the procedure. This results in secondary procedures like PCNL or ESWL. The advent of FURS with laser energy enable to complete stone disintegration in the same sitting when there is a migration of stone to the kidney.

Aim & objectives

Aim

To evaluate the efficacy of pneumatic lithotripsy with thulium laser lithotripsy in treating upper ureteric calculi

Objectives Primary Objectives

- To assess the Stone Free Rate (SFR)
- To analyse the factors predicting the SFR

Secondary Objectives

- To assess the need for another/second procedure if retropulsion occurs.

MATERIALS AND METHODS

The present study was conducted at Kamineni Institute of Medical Sciences, after taking written informed consent from all the patients. Ethical committee approval was obtained prior to start study.

Study Site: Department of Urology, Kamineni Institute of Medical Sciences, Narketpally.

Study Population: 50 patients admitted in urology department who were cases of upper ureteric calculi.

Study Design: Prospective observational study.

Sampling Technique: Random sampling method

Study Duration: 12 months

Time Frame: July 2024 to June 2025 Patients were divided into 2 groups

PL group LL group

Inclusion criteria:

- ALL cases of upper ureteric calculi admitted in the urology department.

Exclusion criteria:

- Presence of urosepsis
- Bleeding disorders
- Pregnancy

Methodology

Lab Investigations

- USG KUB,
- X-ray KUB
- IVU/NCCT-KUB
- Urine culture and sensitivity

Routine investigations for assessing fitness for Surgery and Anaesthesia

- Complete blood count
- Blood sugar, lipid profile
- Liver function tests and serum electrolytes
- Renal function tests assessed by S. urea, S. creatinine and S uric acid.
- Blood grouping and Rh compatibility
- Bleeding and clotting time
- HIV and HBsAg

Allocation of Groups: Patients will be divided randomly in to two groups of 25 each namely LL group

PL group

Procedure: All the patients were to undergo preoperative routine blood investigations, urine analysis and radiological evaluation using USG KUB, X-Ray KUB, IVU, or NCCT KUB. Informed and written consent was obtained from all the patients.

In the laser lithotripsy group TFL frequency was usually set between 5 and 10 Hz at a power setting of 0.5to 1.4 J. Using 200-micron fibre and 6/7.5Fr semi-rigid ureteroscope (Richard Wolf, Germany).

In the pneumatic lithotripsy group, the Swiss lithoclast with 3 fr size lithoclast probe used, which works by propelling measured bursts of compressed air against the head of metal probe at 3 atm pressure and 12HZ frequency (12 cycles per second). All the procedures are done with a 6/7.5Fr semi-rigid ureteroscope.

In all the procedures, a double J stent (5Fr) was placed after the procedure in every case, followed by

catheterization. Check ultrasonography and plain X-ray KUB was done in all the patients on the second postoperative day to look for anyresidual stone. Foleys catheter was removed the following day. Double J stent was removed after 15 days. Patients were discharged on the third postoperative day, given uneventful recovery. To check for the complications during the hospital stay, patients were individually checked by the investigator on a twice- daily basis. While after discharge, the patients were called on the 15th day of discharge and check X-ray KUB and USG KUB was done to see stone clearance in patients with residual stone. Stone size (defined stone-free rate [SFR] as the absence of stone particles <3 mm), location, duration of surgery, duration of lithotripsy, clearance of stone, intra-operative complications (mucosal injury, ureteric perforation, avulsion, haematuria) and causes of failure of procedure like retro propulsion, retained stone and need for an alternative procedure like RIRS/PCNL was recorded along with its outcomes.

Statistical Methods: Statistical testing was conducted with the statistical package for the social science system version SPSS 23.0. Continuous variables were presented as mean \pm SD or median (IQR) for non-normally distributed data. Categorical variables were expressed as frequencies and percentages. The comparison of normally distributed continuous variables between the groups was performed using Student's -t test. Nominal categorical data between the groups was compared using Chi-squared test or Fisher's exact test as appropriate. Non- normal distribution continuous variables were compared using Mann Whitney U test. For all statistical tests, a p value less than 0.05 was taken to indicate as statistically significant.

RESULTS

The present study was conducted among 50 upper ureteric calculi patients to evaluate the efficacy of pneumatic lithotripsy with thulium laser lithotripsy.

Table 1: Distribution of study subjects according to gender

Sex	Laser Lithotripsy (LL)		Pneumatic Lithotripsy (PL)		Total
	Freq	%	Freq	%	
Female	9	64.3	5	35.7	14
Male	16	44.4	20	55.6	36
Total	25	50.0	25	50.0	50

Chi-Square=1.58, DF=1,P =0.20

Table 2: Distribution of study subjects according to laterality

Laterality	LL		PL		Total
	Freq	%	Freq	%	
Left	16	59.3	11	40.7	27
Right	9	39.1	14	60.9	23
Total	25	50.0	25	50.0	50

Chi-Square=2.0, df=1, P=0.15

Table 3: Prevalence of DM in study population

DM	LL		PL		Total
	Freq	%	Freq	%	
Yes	2	8.0	5	20.0	7
No	23	92.0	20	80.0	43
Total	25	100.0	25	100.0	50

Table 4: Prevalence of HTN in study population

HTN	LL		PL		Total
	Freq	%	Freq	%	
Yes	5	20.0	6	24.0	11
No	20	80.0	20	76.0	39
Total	25	100.0	25	100.0	50

Table 5: Mean Age of Study Groups

	Groups		
	N=25	N=25	
	Laser Lithotripsy (LL) Mean ± SD	Pneumatic Lithotripsy (PL) Mean ± SD	
Age (Years)	40.56 ±13.6	49.80 ± 13.3	F=0.006 P=0.937

Mean age of LL group patients was 40.56 ±13.6years and PL group was 49.80 ±13.3 years. Both groups were comparable in view of age. (P<0.05)

Table 6: Mean HU of ureteric stones

	Groups		
	N=25	N=25	
	LL Mean ± SD	PL Mean ± SD	
HU	1080.84 ±332.7	979.04 ±345.9	F=0.31, P=0.860

Mean HU of the ureteric stones of LL group patients was 1080.84 ±332.7and PL group was 979.04 ±345.9. Both groups were comparable in view of HU. (P<0.05)

Table 7: Incidence of Unable To Introduce URS

Unable to introduce URS	Freq	Percentage
Yes	9	18.0
No	41	82.0
Total	50	100

Out of 50 patients, 9(18%) patients introduction of URS was difficult. These patients were placed on DJ stent and deferred the procedure for 4 weeks.

Table 8: Incidence of complications

Complications	Procedure				Percent
	LL		PL		
	Freq	%	Freq	%	
Fever	4	66.7	2	33.3	6
Retropulsion	3	37.5	5	62.5	8
No	18	50.0	18	50.0	36
Total	25	50.0	25	50.0	50

Chi-Square =1.16, df=2, P=0.55

Table 9: Need of other procedures

Other procedures	Procedure				Percent
	LL		PL		
	Freq	%	Freq	%	
RIRS	3	37.5	5	62.5	8
Not Required	22	52.4	20	47.6	42
Total	25	50.0	25	50.0	50

Chi-Square=0.59, df=1, P=0.44

Table 10: Asociation between distance from PUJ and procedure

DISTANCE FROM PUJ	Retropulsion				Percent
	YES		NO		
	Freq	%	Freq	%	
3.5-4cm	3	33.3	6	66.7	9
4.5-5cm	1	4.8	20	95.2	21
5-6cm	3	25.0	9	75.0	12
6-7cm	1	16.7	5	83.3	6
7.5-8cm	0	0.0	1	100.0	1
10-12cm	0	0.0	1	100.0	1
Total	8	16.0	42	84.0	50

Table 11: Association between Duration of procedures.

	Groups		P-value
	N=25		
	Mean±SD (minutes)		
LL	26.13 ±8.4		0.43
PL	22.90 ±7.8		

Above table shows the mean duration of the procedures in both groups. In LL group takes little more time to disintegrate the stone compare to PL

group. But this association was statistically not significant. (P>0.05)

Table 12: Association between Incidence of fever and threshold of stone.

	Fever		P-value
	Present (N=6)		
	Yes Mean±SD	Absent (N=44) NO Mean±SD	
HU	1207.50 ±350.1	1005.72 ±335.2	0.088

Above table shows the association between fever and threshold of ureteric stone. As HU increases chances

of post operative fever also increases. But this association was statistically not significant. (P>0.05)

Table 13: stone free rate

Stone free status	Procedure			
	LL		PL	
	Freq	%	Freq	%
Yes	22	88	20	80
No	3	12	5	20
Total	25	100	25	100

P=0.595, df=1, Chi-Square=0.44

Table 14: Fever Rate

Fever	Procedure			
	LL		PL	
	Freq	%	Freq	%
Yes	4	16	2	8
No	21	84	23	82
Total	25	100	25	100

Table 15: Retropulsion rate

Retropulsion	Procedure			
	LL		PL	
	Freq	%	Freq	%
Yes	3	12	5	20
No	22	88	20	80
Total	25	100	25	100

DISCUSSION

The management of stone disease has been revolutionised. The miniaturisation of scopes and sophistication of medical instrumentation is driving urological practice into a high-technological performance with its economic impact, particularly in developing countries.^[16]

URS with lithotripsy is the benchmark treatment ureteric stones. Despite the availability of several energy sources, pneumatic and laser energy are favoured for their high SFRs (>90%) and lower morbidity rates.^[17]

Recently, there has been a trend favouring the use of laser energy to treat ureteric stones. This shift may be driven by the laser's high SFR, capability to fragment all types of stones, lower incidence of stone migration, multi-purpose laser machines installed in medical facilities, and even the marketing effect of

lasers influencing requests by patients. In the absence of objective benefits both for the patient and the community, this represents a huge financial burden. In the present study, comparison between 2 types of lithotripsies revealed that in terms of SFR, MHS and retreatment rate, laser lithotripsy has advantages over PL since stone fragments are less likely to migrate in LL group.

The present study was undertaken among 25 LL procedure and 25 PL procedure patients. 8% of LL procedure and 20% of PL procedure patients had DM. 20% of LL procedure and 24% of PL procedure patients had HTN. Mean age of LL group was 40.56 ±13.6 years and PL group was 49.80 ± 13.3 years.

In present study, out of 50 patients 9(18%) were placed on DJ stent and deferred the procedure for 4 weeks. Among these 9 patients, 8 were males and 1 patient female. Out of this 9 patients, 1 patient got retropulsion.

In present study in both groups out of 25 patients, 7 patients were found with complications i.e., 28%. Fever was major complication in LL group and Retropulsion was more common in PL group. The type of lithotripsy used did not affect the complication rate. In their study, Bapat et al,^[18] and Tipu et al,^[19] reported a significantly lower complication rate in patients undergoing laser lithotripsy, whereas Kassem et al,^[20] and İrer B et al,^[21] reported no significant difference between the two groups in terms of complication

Devarajan et al,^[22] reported a 90% success rate in 300 lithotripsy patients in whom a holmium laser was used with complications observed in 10 patients. Strictures were more commonly seen with impacted calculi in the upper ureter early in the series. Jeon et al,^[23] showed SFR of 96% for a Ho: YAG laser arm and 37.1% in the lithoclast arm ($P<0.05$). Considering MOT, Ho: YAG laser lithotripsy also had advantages over the PL method. The time taken for stones to be fragmented into removable volume might be shorter in PL but usually particles were too large to pass spontaneously and it was necessary to use basket or grasper to remove these fragments.

The results of the mentioned studies were in accordance with our results. In comparison with lithotripsy, Ho: YAG laser was associated with milder injury to the ureter because of superficial penetration depth of laser. MHS in the LL group was significantly shorter than the PL group due to milder injury to ureter in the LL group. The finding of our study was in line with the preceding investigations in the literature about efficacy of ureteroscopic Ho: YAG laser lithotripter.^[24]

In a study conducted by H. H. NOUR et al,^[25] Complications according to the Clavien–Dindo Grading System occurred in 15 patients, seven in Group 1 (LL) and eight in Group 2 (PL). Intraoperative ureteric perforation occurred in two patients, who were treated with insertion of an internal stent, with one of them developing a fever postoperatively that was managed conservatively. In all, 10 patients, five in each group, developed postoperative fever; all 10 patients already had an internal stent and were managed conservatively with an uneventful course. Two patients had persistent gross haematuria for >24 h postoperatively, which resolved with increased diuresis. All complications were Grade <III, with no statistical significance in terms of the number and type of complications between the groups which was similar to present study.

On postoperative day 1, a combined KUB and US protocol was used to evaluate the presence of residual stones and calculate the SFR. A fragment of ≥ 4 mm was defined as a significant residual stone.

In present study stone free rate was 88% in LL group which was high compare to PL group i.e., 80%. But this association was statistically not significant. ($P<0.05$)

In a study by H. H. NOUR et al,^[25] Using KUB and US protocol, the SFR was 94% in Group 1 and 92.5%

in Group 2, with no statistical significance between the groups; the same was also found at 30- days postoperatively. In the presence of residual fragments and the absence of complications, it was the surgeon's decision as to whether or not to perform an immediate auxiliary procedure or to re-evaluate the patients 2 weeks later.

In present study mean operation duration was more in LL group (26.13 ± 8.4 minutes) compare to PL group (22.90 ± 7.8 minutes). But this association was statistically not significant. ($P<0.05$) Similar to these findings, in a study by H. H. NOUR et al, Operative time was significantly longer when pneumatic lithotripsy was used, which was discordant with most published literature.^[26]

We believe this difference is related to the combined fragmentation/ dusting technique used with the laser, these results in smaller fragments, thus reducing the need for fragment retrieval in comparison to pneumatic lithotripsy in which additional time is needed for retrieval of relatively larger stone fragments. Due to the small laser fiber size compared with the pneumatic probe, better irrigation and consequently vision can be achieved.

Upward migration of a ureteric stone is a common complication when using a pneumatic energy source,^[27] and is one of the arguments favouring the use of laser lithotripsy. In present study retropulsion rate in LL group was 12.0% and PL group 20%. In a study by H. H. NOUR et al,^[28] no difference was found in the rate of stone migration between the groups. Stone migrations occurred in four patients (two in each group).

We acknowledge that our present study has some limitations. A larger number of patients are needed to confirm the results. Patients with previous stone treatment were not included in our present study. The study design did not include stone density and we used high-power laser machines, which may have higher running costs in comparison to lower energy ones. Furthermore, the relationship between stone burden and stone migration was not analysed. The economic aspect discussed evaluated only the costs of service provided without taking into consideration the benefits and costs needed for a physician to learn and acquire new techniques and technologies.

CONCLUSION

It was concluded that

- Stone free rate was high in LL procedure.
- Fever rate and retropulsion rate was high in PL procedure
- Procedure duration was more LL group.
- Mean threshold of stone was more in LL group patients compare to PL group. But these associations were statistically not significant. ($P>0.05$)

REFERENCES

1. Ramello A, Vitale C, Marangella M. Epidemiology of nephrolithiasis. *J Nephrol.* 2000;13:45-50.

2. Segura JW, Preminger GM, Assimos DG, Dretler SP, Kahn RI, Lingeman JE, Macaluso JN. Ureteral stones clinical guidelines panel summary report on the management of ureteral calculi. *The Journal of urology*. 1997 Nov;158(5):1915-21.
3. Anagnostou S, Tolley D. Management of ureteric stones. *Eur Urol*. 2004;45:71421.
4. AUA/EAU clinical guidelines 2017. Available at: <http://www.auanet.org/content/guidelines-andquality-care/clinical-guidelines/main-reports/uretercal07/chapter1.pdf>. Accessed on 20 April 2022.
5. Watson GM, Wickham JE. Initial experience with a pulsed dye laser for ureteric calculi. *Lancet* 1986;1:1357e8.
6. Denstedt JD, Razvi HA, Sales JL, Eberwein PM. Preliminary experience with holmium:YAG laser lithotripsy. *J Endourol* 1995;9:255e8.
7. Shroff S, Watson GM, Parikh A, Thomas R, Soonawalla PF, Pope A. The holmium:YAG laser for ureteric stones. *Br J Urol* 1996;78:836e9.
8. Blackmon RL, Case JR, Trammell SR, Irby PB, Fried NM. Fiberoptic manipulation of urinary stone phantoms using holmium: YAG and thulium fiber lasers. *J Biomed Opt* 2013;18:28001. <https://doi.org/10.1117/1.JBO.18.2.028001>.
9. Blackmon RL, Irby PB, Fried NM. Holmium:YAG (lambdaZ2120 nm) versus thulium fiber (lambdaZ1908 nm) laser lithotripsy. *Laser Surg Med* 2010;42:232e6.
10. Blackmon RL, Irby PB, Fried NM. Thulium fiber laser lithotripsy using tapered fibers. *Laser Surg Med* 2010;42:45e50.
11. Hardy LA, Wilson CR, Irby PB, Fried NM. Thulium fiber laser lithotripsy in an in vitro ureter model. *J Biomed Opt* 2014;19:128001. <https://doi.org/10.1117/1.JBO.19.12.128001>.
12. Fried NM. Thulium fiber laser lithotripsy: an in vitro analysis of stone fragmentation using a modulated 110-watt thulium fiber laser at 1.94 microm. *Laser Surg Med* 2005;37:53e8.
13. Keller EX, De Coninck V, Doizi S, Daudon M, Traxer O. Thulium fiber laser: ready to dust all urinary stone composition types? *World J Urol* 2021;39:1693e8.
14. Martov AG, Ergakov DV, Guseinov MA, Andronov AS, Dutov SV, Vinnichenko VA, et al. [Initial experience in clinical application of thulium laser contact lithotripsy for transurethral treatment of urolithiasis]. *Urologiia* 2018;112e20. [Article in Russian].
15. Minevich E, DeFOOR WI, Reddy P, Nishinaka K, Wacksman J, Sheldon C, Erhard M. Ureteroscopy is safe and effective in prepubertal children. *The Journal of urology*. 2005 Jul;174(1):276-9.
16. Geraghty RM, Jones P, Somani BK. Worldwide trends of urinary stone disease treatment over the last two decades: a systematic review. *J Endourol*. 2017;31:547-556
17. Sancak EB, Kılınç MF, Yücebaş SC. Evaluation with decision trees of efficacy and safety of semirigid ureteroscopy in the treatment of proximal ureteral calculi. *Urol Int*. 2017;99:320-325.
18. Bapat SS, Pai KV, Purnapatre SS, Yadav PB, Padye AS. Comparison of holmium laser and pneumatic lithotripsy in managing upper-ureteral stones. *Journal of endourology*. 2007 Dec 1;21(12):1425-8.
19. Tipu SA, Malik HA, Mohhayuddin N, Sultan G, Hussain M, Hashmi A, Naqvi SA, Rizvi SA. Treatment of ureteric calculi-use of Holmium: YAG laser lithotripsy versus pneumatic lithoclast. *JPMA*. 2007 Sep;57:440-3.
20. Kassem A, ElFayoumy H, ElSaied W, ElGammal M, Bedair A. Laser and pneumatic lithotripsy in the endoscopic management of large ureteric stones: a comparative study. *Urologia Internationalis*. 2012 Mar 21;88(3):311-5.
21. İrer B, Şen V, Erbatu O, Yıldız A, Ongün Ş, Çınar Ö, Cihan A, Şahin M, Şahin MO, Üçer O, Kızılay F. Comparison of efficacy and complications of holmium laser and pneumatic lithotripters used in the ureterorenoscopic treatment of proximal ureter stones, a multi-center study of society of urological surgery aegean study group. *Journal of Urological Surgery*. 2018 Sep 1;5(3):158.
22. Devarajan R, Ashraf M, Beck RO, Lemberger RJ, Taylor MC. Holmium: YAG lasertripsy for ureteric calculi: an experience of 300 procedures. *Br J Urol*. 1998;82(3):342-347.
23. Jeon SS, Lee KS, Won HS, Park KH, Lee SW, Choi HY, Chai SE. A comparison of holmium: YAG laser with Lithoclast lithotripsy in ureteral calculi fragmentation. *Korean Journal of Urology*. 2000 Mar 1;41(3):375-80.
24. Razzaghi MR, Razi A, Mazloomfard MM, GolmohammadiTaklimi A, Valipour R, Razzaghi Z. Safety and efficacy of pneumatic lithotripters versus holmium laser in management of ureteral calculi: a randomized clinical trial. *Urol J*. 2013;10(1):762-766.
25. Nour HH, Kamel AI, Elmansy H, Badawy MH, Shabana W, Abdelwahab A, Elbaz A, Eleithy T, Rushdy M. Pneumatic vs laser lithotripsy for mid- ureteric stones: Clinical and cost effectiveness results of a prospective trial in a developing country. *Arab Journal of Urology*. 2020 Jul 2;18(3):181-6.
26. Khoder WY, Bader M, Sroka R, Stief C, Waidelich R. Efficacy and safety of Ho: YAG laser lithotripsy for ureteroscopic removal of proximal and distal ureteral calculi. *BMC urology*. 2014 Dec;14:1-7.
27. Sen H, Bayrak O, Erturhan S, Urgan G, Kul S, Erbagci A, Seckiner I. Comparing of different methods for prevention stone migration during ureteroscopic lithotripsy. *Urologia Internationalis*. 2014 Jul 4;92(3):334-8.
28. Abedi AR, Razzaghi MR, Allameh F, Aliakbari F, FallahKarkan M, RanjbarA. Pneumatic lithotripsy versus laser lithotripsy for ureteral stones. *Journal of Lasers in Medical Sciences*. 2018;9(4):233.