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Original Article
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Comparative Study Between Holmium Laser versus Pneumatic Ureteroscopic Lithotripsy for Proximal Ureteric Stones Close to Pelvi-ureteric Junction (PUJ) -A Prospective Trial

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Abstract

Objective: *To compare the outcomes of ureteroscopic lithotripsy with pneumatic lithotripter versus Holium:Yttrium-Aluminum-Garnet (Ho:YAG) laser in the management of upper ureteric stones.*

Materials and methods: *Patients who underwent ureteroscopic lithotripsy with pneumatic lithotripter or Ho:YAG laser for upper ureteric stones were reviewed. Patients with urinary tract infection, ,loss of follow-up, concurrent middle or lower third ureteral stones or acute renall failure were excluded. Patient age, stone size and burden (based on KUB or computerized tomography), stone upward migration, double J stent insertion rate, stone free rate and secondary intervention rate for residual stones were compared in both groups.*

Results: *There were 70 patients with upper ureteric stones (35 in pneumatic group and 35 in laser group) meeting the study criteria. Patients' age, gender, stone size and burden were similar in both groups. The Ho:YAG laser lithotripsy group had better stone free rate, less double J stent insertion rate and less upward migration and secondary intervention rate, sepsis as compared with pneumatic lithotripsy (94.2% vs. 60%; 85% vs. 100%; 5.7% vs 40%; 5.7% vs 34.2%; 2.8 vs 2.8 respectively, all* $p < 0.05$*). In patients with stones sizes 8-10 mm, Ho:YAG laser lithotripsy had significantly lower upward migration rate, lower double J stent insertion rate, higher stone free rate and less secondary intervention rate.*

Conclusions: *Ho:YAG laser lithotripsy is better and much effective than pneumatic lithotripsy in the management of upper ureteric stones in terms of, stone free rate and secondary intervention rate for stones of sizes about 8 to 10 mm.Although the access of upper ureter is difficult but our small calibre (4.5 fr) ureteoscope and gentle manuevre have made the procedures safe and successful.*

Keywords: Ho:YAG laser. Laser lithotripsy, Pneumatic lithotripsy, Ureteroscopy.

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Introduction

Treating patient of upper or proximal ureteric stone is common in daily urological practice. There are different treatment methods such as open stone surgery, extracorporeal shock wave lithotripsy (ESWL), ureteroscopic lithotripsy, push back percutaneous nephrolithotomy and laparoscopic urterolithotomy are the recommended therapeutic modalities for impacted upper ureteral stones refractory to medical expulsive therapy. In the early1980s open surgery was the best treatment for ureteric stone,but introducing the small caliber ureteroscope and ESWL resulted in the virtually extinction of open surgery[1]. The main benefit of ureteroscopic surgery is visualization of the ureter that enables detection and treatment of proximal ureteric stones[3]. The outcomes vary according to the size of the stone, degree of obstruction, duration of the symptoms, and the experience of the surgeons. Ureteroscopic lithotripsy with ultrasonic, electrohydraulic, pneumatic, and laser lithotripters has evolved steadily in the past 20 years, resulting in decreased morbidity and better outcomes[1,2]. Pneumatic lithotripsy uses vibrating mechanical force to break the stone. But it is associated with a higher rate of stone push back into the renal pelvis[3]. Holmium Laser lithotripsy now gained popularity and is established as standard modality. With the introduction of holmium YAG laser in the urological armamentarium indications for ureteroscopic stone managements have extended and now it is possible for the urologist to also manage impacted and larger stone sizes[16].

Materials & methods

This prospective observational study among 70 patients of upper ureteric stone just below PUJ who were under went ureteroscopic lithotripsy in CMH Dhaka from 2018-2019. About 8-10mm single stone located just below PUJ were included in this study after approval of concerned department of CMH ,Dhaka. Patients with acute sepsis, solitary kidney with compromised renal function, ureteric stricture, acute renal failure were excluded from this study. Patient age, stone size and burden (based on KUB or computerized tomography), stone upward migration, double J stent insertion rate, stone free rate and secondary intervention rate for residual stones were compared in both groups.

Operative technique

A semirigid 4.5/6 F ureteroscope (Wolf, Knittlingen, Germany) was used for all procedures. Settings for Ho:YAG laser lithotripsy with a 365-ìm fiber were energy 1.2–1.6 J in case of stone fragmentation ; 0.8-1 J for stone dusting and frequency 10–15 Hz. Settings for pneumatic lithotripsy (Swiss Litho Clast Master and Litho Clast 2, EMS, Nyon, Switzerland) were: energy 70-90 and frequency 7-9 Hz. The patient was placed in reverse Trend elenburg position and decreasing water pressure by lowering the water bottle. After lithotripsy, larger stone fragments were removed and placed in a basket and the smaller ones were left for spontaneous passage. At the end of the procedure, a 6-Fr double J stent insertion was considered, depending on the burden of residual stones, ureteral injury, bleeding, and granulation formation at the stone impaction site. Perioperative intravenous third generation cephalosporin with amikacin were given to all patients.

Statistical analyses

The Student *t* test and Chi-square test were used for comparison between laser and pneumatic lithotripsy groups. A p value < 0.05 was regarded as statistically significant.

Result

Table-I: ***Comparison of patient demographics, stone characteristics, and outcomes between the laser and pneumatic liotripsy groups.***

No of pts	Laser	Pneumatic	P value
Total 70	35	35	< 0.05
Age	18-65	18-65	< 0.05
Sex,M/F	20/15	24/11	< 0.05
Stone Size	8-10mm	8-10mm	< 0.05

Table-II: *Comparative outcomes in patients within two groups*

Characteristics	Laser	Pneumatic	P value
Stone free rate	33 (94.2%)	21(60%)	< 0.05
Stent placement	30 (85%)	35(100%)	< 0.05

Table –III: *Comparison of upward migration in the laser and pneumatic groups.*

Characteristics	Laser-35	Pneumatic-35	P value
Upward migration	2(5.7%)	14(40%)	< 0.05
Secondary operation	2(5.7%)	12(34.2%)	< 0.05

Table-IV: *Comparison of post operative minor complications*

Characteristics	Laser	Pneumatic	P value
Sepsis	1(2.8%)	1(2.8%)	< 0.05
Stricture	-	-	
Hematuria	-	-	

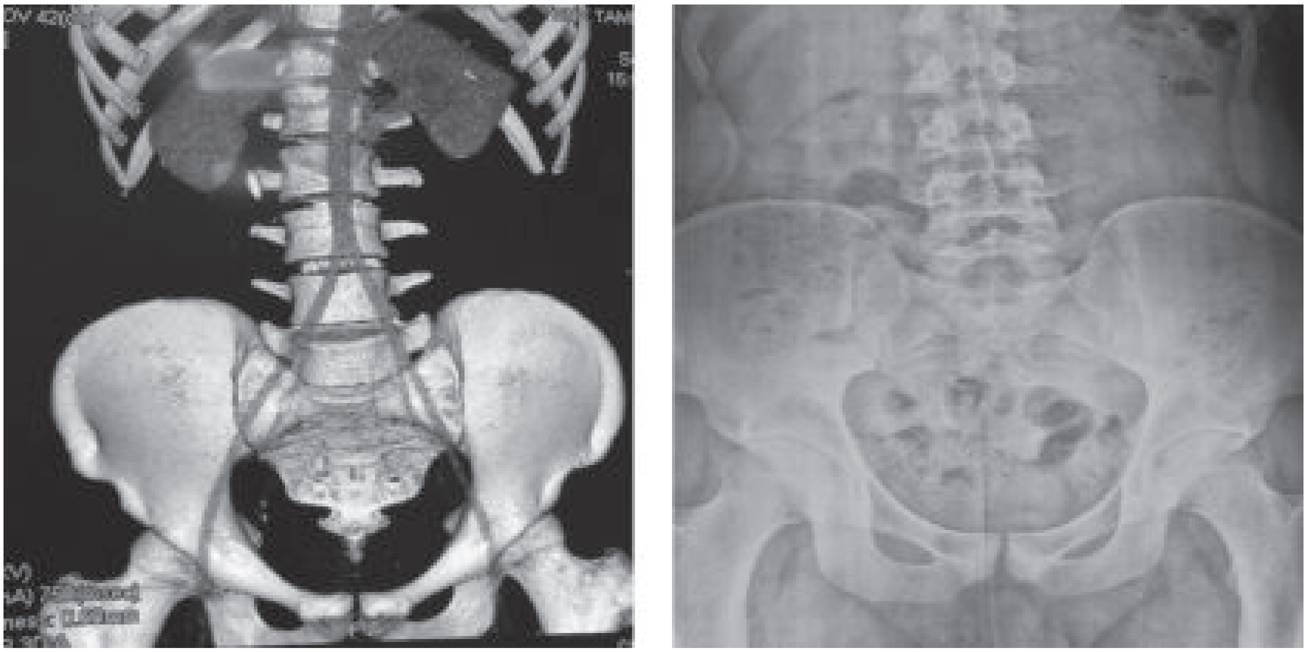

Fig.-1: *Pre-operative film shows about 10 mm stone at proximal ureter*

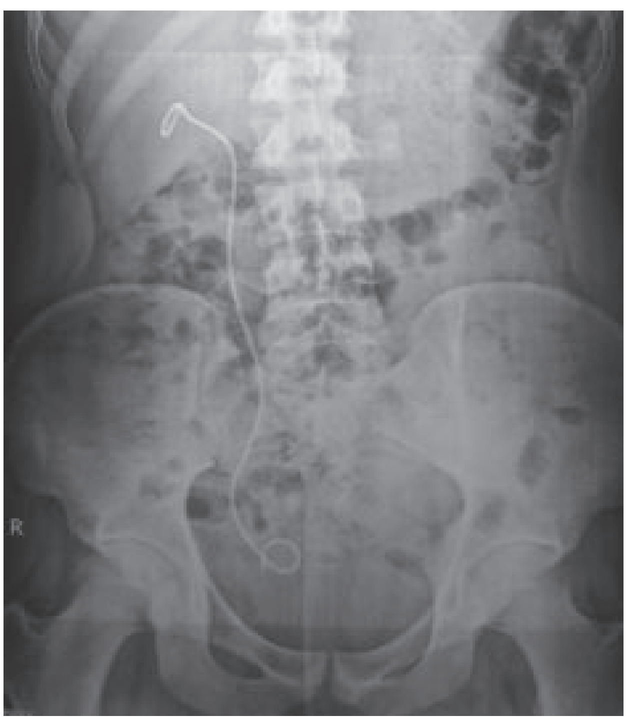

Fig.-2: Post laserlithotripsy plain X-ray KUB showing only Rt Dj stent but no radio-opaque shadow /stone

Discussion

Two decades ago, difficult access to the proximal ureter by large and rigid ureteroscopes made extracorporeal shock wave lithotripsy and urterolithotomy the first-line treatment modality for upper ureteric stone[2]. Improvements in ureteroscope design (semirigid and small diameter scopes) have resulted in better outcomes. The two most commonly used ureteroscopic modalities for stone disintegration are pneumatic and laser lithotripsy[4].

The mechanism of pneumatic lithotripsy is similar to that of a pneumatic jackhammer, with the pushing force on the stone leading to more likelihood of stone upward migration. Laser lithotripsy decomposes stones by a photothermal mechanism and causes less oscillation of targeted stones[5]. These different mechanisms affect the stone-free and upward migration rates. Many studies have shown that laser lithotripsy has a better stone-free rate[6]. Results of our study are in agreement with those of these reports. Perez Castro et al[2] reported median stone-free rates of 84% and 81% for stones < 10 mm and > 10 mm, respectively. In our setting, the diameter of laser fiber was 300 ìm and the energy setting was 1.2–1.6 J. In this study, a large percentage (40 %) of procedures for PUJ stones resulted in stones being pushed back into the kidney during pneumatic lithotripsy. A higher rate of stone upward migration was seen for larger stones about 10 mm in the pneumatic group but not in the laser group. Our results are in agreement with those of a comparative study by Garg et al[7] which also reported a higher stone upward migration rate in the pneumatic group than in the laser group. The retropulsion rate was reported in 2–17% of ureteral stone treatments and was related to an inability to trap a ureteral stone in a capacious ureter[8]. Ways to prevent stone retropulsion include placing the patient in reverse Trendelenburg position, decreasing water pressure, and the use of stone trapping or ureteral occluding devices[9]. Delvecchio et al[10] reported the use of a 0.8-mm pneumatic lithotripsy probe placed through a 4.8-Fr hollow LithoVac (Taipei, Taiwan) suction probe[11] The suction device prevented stone migration and helped maintain a clear endoscopic view. Whether or not to stent postoperatively has been an issue debated for years[5]. Stent-related morbidities including flank discomfort and bladder pain during urination, which have been reported to decrease the quality of life. However, ureteral stenting can prevent obstruction by stone fragments, blood clots, ureteral mucosal swelling, and may result in less postoperative complications. Studies revealed that there was no increase in postoperative obstruction after uncomplicated ureteroscopy[12,13,14], Patients with extensive ureteral edema, intraoperative ureteral injury, solitary kidney, renal insufficiency, sizable residual stone fragments and bilateral proceduees were indicated for postoperative stenting[15]. The decision on whether or not to stent was also based on surgeon's intra-operative assessment. In our study, the double J insertion rate was lower in the laser lithotripsy group. A lower double J insertion rate may improve the patients' quality of life, and there is no need for an additional procedure to remove the stent.

Laser lithotripsy has its advantages. In our study, we found no difference in late stricture rates in both groups. Demir et al[1] reported that laser lithotripsy was more effective than pneumatic lithotripsy in terms of stone-free rate and operative time. However, the cost was lower in the pneumatic group.1 In our study, the difference of outcomes in both treatment groups was 94.2% & 60% respectively. Therefore, laser lithotripsy may be considered for stones at proximal ureter close to PUJ .

The reported complication rate of ureteroscopic lithotripsy is low. The Clinical Research Office of Endourological Society Ureteroscopy Global Study showed that most complications were minor (Clavien Grade I–II, 2.7 %). The Clavien Grades III, IV, and V complication rates were 0.5%, 0.1%, and 0.02%, respectively[17] which is similar to our study. The study concluded that ureteroscopic lase lithotripsy was safe and effective, with minor complications including sepsis, hematuria, or stent-related discomforts. In our study, there were no major complications needing auxiliary surgical intervention.

Conclusion

Ho:YAG laser lithotripsy is a safe procedures for upper ureteric stones close to PUJ with few minor complications. Laser lithotripsy resulted in a higher stone-free rate and lower double -J insertion rate. Laser lithotripsy is recommended for better outcome, as it caused less stone upward migration. However, holmium YAG laser requires more expertise and it is a costly alternative.

Limitation of the study: Difficult access to the proximal ureter by semi-rigid ureteroscopes for every urologist.

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