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Laser Versus Pneumatic Lithotripsy With Semi-Rigid Ureteroscope; A Comparative Randomized Study

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Abstract

Introduction: Ureteral stones are among the most common disorders in the urologic field. Miniaturization of endoscopic devices in urology and extracorporeal shock wave lithotripsy (ESWL) has revolutionized the management of ureteral stones. The aim of this study was to compare the efficacy and results of laser versus pneumatic lithotripsy (PL) with semi-rigid ureteroscope in a randomized prospective clinical trial in removing stones.

Methods: 117 adult patients underwent transurethral lithotripsy (TUL) in a single academic center and by a single surgeon. The patients were randomized in 2 groups: In group 1, 58 patients with ureteral stones underwent ureteroscopy and stone fragmentation was done by Ho: YAG laser lithotripsy (LL) and in group 2, 59 patients underwent PL (Swiss LithoClast) by using the same ureteroscope.

Results: Mean age was 41.77 years and 41.1years in group one and 2 respectively ($P=0.79$), there was no significant difference in male to female ratio and mean stone in both groups. The success rate for stone clearance was 79.31% and 77.96% in group 1 and 2 respectively ($P=0.52$). No difference between complications was seen in both groups, but the duration of operations was different (significantly lower in group 2).

Conclusion: In both techniques, acceptable results were achieved. We have found a significant statistical difference in duration of operation between our results ($P=0.001$) and similar studies, while this was shorter in the pneumatic group in our study, it was longer in other similar ones. This might be a result of more experience in working with PL in our center.

Keywords: Laser lithotripsy; Pneumatic lithotripsy; Ureteroscopy.

Introduction

Ureteral stones are among the most common disorders in the urologic field. In Europe and North America, 5 to 10% of the population develop stone formation during their lives, while; higher frequency of stone formation has been reported from other parts of the world such as Asia.[1] Transurethral lithotripsy (TUL) has traditionally been considered for the surgical treatment of ureteral stones.[2] Miniaturization of endoscopic devices in urology and extracorporeal shock wave lithotripsy (ESWL) has revolutionized the management of ureteral stones. Lithotripsy techniques such as holmium: yttrium-aluminum-garnet (Ho: YAG) laser lithotripsy (LL) and pneumatic lithotripsy (PL) have been introduced as the newest treatment methods, improving the success rate while decreasing complications. Ho: YAG laser is a modality used for the treatment of urinary and biliary stones which can work with frequencies of up to 50 Hz and can be used with very fine fibers of up to 200 microns.[3] Recently, there has been an increase in the use of the Ho: YAG laser for TUL due to its fewer complications and lower incidence of stone upward migration.[4] Although there are many studies that have compared the viability of these 2 methods, there are still many controversies about the results in these comparisons. The aim of this study was to compare the efficacy and results of laser versus PL with semi rigid ureteroscope among samples of Iranian population in a randomized prospective clinical trial.

Methods

The comparative clinical trial study was conducted in the urology department of Yasuj University of Medical Sciences between February 2015 and September 2016. During a prospective randomized clinical trial, 117 eligible patients underwent TUL. They were categorized in 2 groups using pseudorandomization: in group1, 58 patients with ureteral stones underwent ureteroscopy and stone fragmentation was done by Ho: YAG LL which operates at the wavelength of 2100 nm and in group two, 59 patients underwent PL by using the same ureteroscope. Semi-rigid ureteroscope (Wolf Germany) was used for stone access in all of the patients. Patients were placed in

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lithotomy position and lithotripsy was done by semi-rigid ureteroscope Wolf 8-9.8 F and Holmium laser (Auriga) by standard methods. Negative urine cultures were essential in every patient preoperatively. Exclusion criteria were: uncorrected coagulopathy, pregnancy, deformity, and inability to have lithotomy position and inability to access the stone during Ureteroscopy (URS).

After informing patients about the benefits and risks of procedures, written consents were obtained from them. Data analysis was performed using SPSS version 22 by analyzing with the *t* test. All of the procedures were done by the same urologist and in the same center.

Results

Mean age was 41.77 (±13.2) years and 41.1 (±12.8) years in group 1 and 2 respectively ($P=0.79$). As shown in Table 1, there was no significant difference in male to female ratio in both groups (62% male in group 1 vs 67% male in group 2, p-value: 0.56). The success rate for stone clearance was 79.31% and 77.96% in group 1 and 2 respectively ($P=0.52$).

Table 2 showed preoperative stone data in patients in both groups. Various characteristics of ureteral stone were compared in both groups including stones' size, laterality, location, quantities, diameter and duration of stone compactions. These stone's characteristics achieve no significant difference in both groups (all *P* values were more than 0.05).

Patients' intra- and postoperative data were seen in Table 3. No significant morbidity and no mortalities were encountered in patients of both groups. The significant difference was observed between the mean operation time of 2 groups (36.4 [± 10.25] minutes in group 1 vs 25.47 (±8.55) minutes in group 2, *P* value was <0.001). Mean hospital stay was the same in both groups (1.2 days). No significant differences were seen in intra- and postoperative complications between 2 groups.

Table 1. Demographic and Clinical Characteristics of Patients

Group	Laser (58)	Pneumatic (59)	*P* Value
Mean age ± SD, y	41.77 (± 13.2)	41.1(±12.8)	0.79
Male, n (%)	36 (62%)	40 (67%)	0.456

Table 2. Preoperative Stone Data in Patients in Both Groups

Group	Laser (58)	Pneumatic (59)	*P* Value
Mean stones size (mm)	9.29(± 4.1)	9.77(± 4.7)	0.45
Stone laterality			
Right side	24	26	0.41
Left side	34	33	
Stone location			
Proximal	14	16	0.91
Middle	6	5	
Distal	38	38	
Stone numbers			
One	51	54	0.86
Two	3	4	
More than two	4	1	
Stone diameter			
<7 mm	7	7	0.50
7-10 mm	43	42	
> 10mm	8	10	
Duration of stone impaction			
<7 days	14	13	0.88
7-21 days	42	43	
>21 days	2	3	

Discussion

Ureteral stones are among the most common disorders in the urologic field which necessitate the therapeutic procedures. There are many alternatives for the treatment of ureteral stones when there is an indication for surgical intervention. ESWL, TUL, percutaneous antegrade URS, laparoscopy, and open surgery are available techniques at the present time. Improvement in intracorporeal and extracorporeal lithotripsy technologies mostly lead to successfully access and treat virtually any stones within the ureter.

According to some studies, PL used for TUL requires a wider straight working channel, and upward migration of the stones is a major drawback, especially for upper ureteral calculi[5]; therefore, it can be used only within a rigid probe. There is no electricity and little heat energy is produced which cause no adverse thermal damage to ureteral mucosal layer.[6]

Dolowy et al in their study concluded that this therapeutic technique was a versatile tool in all field of urology. Due to its viability, by reducing its cost, laser equipment will become a mandatory and indispensable asset in all urology wards.[7] Fallah Karkan et al in their study about the clinical potency of the Ho: YAG laser on ureteral stones, based on its fiber caliber, concluded that all 3 types of laser caliber (200 Mm, 365 Mm, and 500 Mm fibers) had great efficacy in stone fragmentation, however; by increasing the laser caliber, the stone-free rate would significantly increase.[8]

By working with the photo-thermal mechanism, Ho: YAG laser can fragment stones into the crater and small pieces, thus; the risk of upward migration of stone

Table 3. Patients' Intraoperative and Postoperative Data

Group	Laser (58)	Pneumatic (59)	*P* Value
Mean operation time (min)	34.6 (± 10.25)	25.47(±8.55)	<0.001
Complications			
Mucosal damage	1	2	0.4
Residual or escaped stones	10	10	0.7
Mean hospital stay (day)			0.68
Out patient	20	22	
One	28	28	
More than one	10	9	

fragments through the lumen could be lowered.[9] Despite encountering this complication in our procedures, no significant statistical outcome was seen between the 2 groups.

Khoder et al revealed that Ho: YAG laser was an adequate tool for fragmenting the ureteral stones independent of their locations. Additionally, they suggested a combination of the semi-rigid and flexible ureteroscope could likely improve the stone-free rates for proximal stones regardless of their sizes.[10] Jhanwar et al conducted another study by analyzing the outcomes of Ho: YAG LL and PL in children and concluded that both techniques were equally efficacious; however, holmium laser required more expertise and was a costly alternative and comparatively more advantageous in impacted calculus.[11]

Maghsoudi et al showed that Ho: YAG laser had more advantages over PL due to a higher efficacy of stone-free rate and a lower rate of upward displacement of ureteral stones, while their complications were the same and very rare.[12] Razzaghi et al conducted a review of the literature on laser application in Iran and revealed that this technology has not yet found its position in Iran, especially in the field of urology, it might be due to problems in accessibility of laser devices and inadequacy of knowledge about this technology.[13]

In our study, the duration of operation among PL group was shorter and the cost was less than Ho: YAG LL group, which may be a result of more experience in working with PL in our center. However, Li et al, in a prospective randomized control trial, declared that Ho: YAG LL group showed significant benefits compared with the PL group in terms of mean operative time (about 15 minutes shorter with $P=0.001$). on the other hand, they showed that Ho: YAG LL group seems to have to face the increased risks of postoperative stricture (24 postoperative cases in LL group versus 5 postoperative cases in PL group, $P=0.02$).[14] Several studies approved these findings as well.[15,16]

In contrast to previous ones, in a study done in China, no significant difference was found between the operation time for the 2 groups (55.9 ± 16.5 minutes in Ho: YAG LL group versus 62.4 ± 17.6 minutes in PL one).[17] In a survey conducted among 349 patients, Jou et al found that using Ho: YAG could be time-consuming to disintegrate a very large stone.[18] Thus, it may be essential to use it with other powerful and appropriate intracorporeal lithotripter in patients with very huge ureteral stones.

Akdeniz et al compared the efficacies of both methods and concluded that no differences were seen between operative time and stone-free rate, except hospitalization period in both groups (hospitalization period was shorter in LL group). They also mentioned that LL was more expensive than PL and these findings were in accordant to ours.[19] In another study about the application of both of these technologies in renal and ureteral stones in pediatric age groups, Marcin et al concluded that Ho: YAG laser reduced the operation time and increased the efficacy of treatment, especially in renal calculi in comparison to LL.[20]

Yin et al in their meta-analysis found that Ho: YAG LL had significant superiority in comparison to PL in terms of early stone-free rate, delayed stone-free rate, shorter operative time and lower stone migration rate, but not yet in the postoperative hematuria rate and the ureteral perforation rate.[4] They did not have any comparison between the costs of these procedures. On the other hand, their final sample sizes were not enough to have a definite consideration about their results.

Mostly, Ho: YAG LL group experienced fewer complications compared with the PL one. In a study conducted in Korea, Jeon et al observed that laser was better than PL in terms of stone-free rates as well complication rates.[21] Related complications occurred in less than 1% in LL group and there was no evidence of renal deterioration after that. Bapat et al revealed that the complications and the need for auxiliary procedures were significantly less for Ho: YAG in comparison with PL.[22] Recently Abedi et al declared that slightly higher stone-free rate was found in the LL group compared to PL group in treating ureteral stones.[23] However, we found that there were no major complications between the 2 groups with no statistical significance.

Our study has some strength. All procedures were administered by one surgeon in one center which removed the technical bias in our results. Besides prospective nature of the study, recording the detailed information of patients and various characteristic of ureteral stones in patients helped to the comprehensiveness of our study. Some limitations of our study should be noticed too. Maybe more sample size would have a roll in the diversity of results compared to other studies. Our study was conducted among Iranian patients and maybe further studies with the population with different races would contribute to different results.

In conclusion, according to our results, by using both techniques, acceptable results were achieved. However, in the pneumatic group, the duration of operation was shorter and the cost was less than LL. There was no major complication with any statistically significant differences between the 2 groups.

Ethical Considerations

This study was confirmed in Yasuj University of medical sciences' committee of research in biomedical sciences by the letter number: P/23/2/837:1397.06.11.

Conflict of Interests

The authors declare no conflict of interest.

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