Original Article

Lithotripsy

Comparison of Mean Operative Time in Patients Undergoing Ho:YAG Laser Lithotripsy and Pneumatic Lithotripsy in Ureterorenoscopy for Ureteric Calculus

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ABSTRACT

Objectives: To compare the mean operative time in patients undergoing Ho:YAG laser lithotripsy and pneumatic lithotripsy for ureteric stones.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Armed Forces Institute of Urology, Rawalpindi from August 2015 to 12 February 2016.

Materials and Methods: The study included 60 patients requiring ureteroscopic lithotripsy for treatment of ureteric calculi. Patients were divided into Ho:YAG lithotripsy group (30) and pneumatic lithotripsy group (30). The operative time in minutes was calculated in all patients from initial cystoscopy till ending of ureteroscopy after the stone fragmentation into small particles. All the information was recorded on a specially designed questionnaire.

Results: The mean age and SD of all patients was 36.90±12.11. The male to female ratio was 49:11. The baseline demographic variables; mean age, gender, side of stone and location of stone were found similar between the two groups ($p>0.05$). The type of intra-ureteral lithotripsy was found a significant predictor of mean operative time taken for the procedure. The average operative time taken for Pneumatic lithotripsy procedure increased by 9.13 minutes as compared to the Ho: YAG laser lithotripsy procedure ($R^2=0.33$, $p<0.001$). The mean operative time was not found significantly different between males and females; age groups; sides of stones and different locations of stones, as a whole, as well as in both groups separately ($p>0.05$).

Conclusion: It is speculated that the Ho:YAG laser lithotripsy is a better procedure compared to the Pneumatic lithotripsy, in terms of the operative time required for the procedure.

Key Words: Laser Lithotripsy, Pneumatic lithotripsy, operative time, ureteric calculi.

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INTRODUCTION

Urolithiasis is the process of forming stones in the kidney, bladder and/or urethra and is one of the commonest urological diseases known since ancient times.[1] The worldwide prevalence of renal stones is between 2 and 20%.[2] Pakistan is part of the Afro-Asian stone forming belt, where the prevalence of calculi ranges from 4% to 20%.[3] The incidence of urolithiasis is increasing globally, with racial, gender and geographic variation in its occurrence.[4] The lifetime risk of having urolithiasis is higher in the Middle East (20–25%) and western countries (10–15%) and is less common in Asian and Africans population.[5]

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The disease occurs more frequently in white populations, and the occurrence rate is two to three times higher in men than in women.[6] Ureteral calculi usually present with acute flank pain and hematuria. The rate of spontaneous resolution and passage of ureteric stones differs according to the stone size. About 80% of the stones smaller than 4mm pass out spontaneously, while only 21% of stones larger than 6mm pass out spontaneously.[7]

The literature has reported that urolithiasis as a multi-factorial recurrent disease, distributed worldwide in urban, rural, non-industrialized and industrialized regions with diverse chemical compositions of analyzed stones in context to various etiological and risk factors, which include "Intrinsic factors" like age, gender and race of patients, "Anatomic and genetic characteristic" and "Extrinsic factors" like geographic preferences, climate, the lifestyle patterns as well as the dietary habits.[8]

Although the pathogenesis of stone diseases has not been fully understood, the systematic metabolic evaluation, medical treatments of causal conditions and modifications in diet and lifestyle are effective in decreasing the incidence and recurrence of stone

disease.[9] Urinary stones can be classified according to the size of stone, location of stone, X-ray characteristics, aetiology of formation, composition, and risk of recurrence.[10]

Calculus composition depends upon the underlying cause that leads to their precipitation. Because of this reason it is particularly significant to know accurately which kind of stone is present, in order to consider the best treatment, and to guide about prognosis and preventive measures.[11]

There has been a revolutionary change in the treatment of urolithiasis with the advent of minimally invasive endoscopic techniques.[12] These new modalities for urolithiasis treatment include Laparoscopic lithotomy, Ureteroscopic lithotripsy, Shock wave lithotripsy (SWL), and percutaneous nephrolithotomy. Nowadays with the help of small caliber ureteroscopes and advance in intraureteral lithotripsy has resulted in higher rates of successful and safe endoscopic treatment of ureteral calculi.[13] Keeping in view the high success rate of ureteroscopic lithotripsy, open ureterolithotomy is not considered as a valid option in most of the cases in a well equipped endourological centre.[13] There are currently a number of devices for intracorporeal lithotripsy, which include electrohydraulic, ultrasonic, pneumatic and laser lithotripters.[14] Technological advances and progress has been made in terms of evolution of lithotripsy techniques such as holmium: yttrium-aluminium-garnet (Ho: YAG) laser lithotripsy (LL) and pneumatic lithotripsy (PL), which have improved the success rates and decreased the complication.[15]

There are a large number of patients presenting to us with ureteric stones requiring ureteroscopic lithotripsy. We have much experience regarding the use of both pneumatic lithotripsy and Ho: YAG laser lithotripsy for treating the ureteric calculi. The literature so far in our country and internationally shows variable results regarding the efficacy of Ho: YAG laser lithotripsy and pneumatic lithotripsy in terms of operative time, stone fragmentation rate and early stone free rate. The aim of this study was to determine mean operative time in patients undergoing Ho: YAG laser lithotripsy and Pneumatic lithotripsy in the setting of Armed Forces Institute of Urology, Rawalpindi, Pakistan. It can help to anticipate and manage operative list in a better way according to the time slots available in the operation theatre.

MATERIALS AND METHODS

This was a Comparative Cross-sectional study conducted at Armed Forces Institute of Urology, Rawalpindi, within a period of six months (from 12 Aug 2015 to 12 Feb 2016)

Sample Selection: Patients who were aged between 18 to 60 years of both gender, patients having ureteric stones requiring ureteroscopic intervention, patients having ureteral stone located in the proximal, middle or lower ureter, which has not passed in 3 weeks and patients having the hydronephrosis stone size less than 1.5 cm were included in the study. Whereas, patients having uncorrected bleeding disorders (having deranged values of PT/APTT/I.N.R, platelets <50,000/ml), patients having skeletal abnormalities making the procedure technically difficult, Serum creatinine level >1.5 mg/dL, solitary kidney, ureteral tumor or stricture, patients who have undergone prior ureteroscopy or ureteral surgery and patients having congenital anomalies of urogenital system were excluded from the study.

Sample size was calculated by using the WHO calculator. At 5% level of significance and power of test as 80%, the sample size calculated was 60 patients (30 patients in each group). The data was collected by using Non-probability consecutive sampling technique.

Data Collection Procedure: Before starting the data collection procedure, first of all permission was taken from the concerned authorities and ethical committee of Armed Forces Institute of Urology, Rawalpindi. Informed consent was taken from all patients by giving them the written inform consent form and they were asked to sign it.

All patients diagnosed to have ureteric stones requiring ureteroscopic lithotripsy for treatment after detailed history and physical examination were underwent lab investigations including CBC, serum creatinine and imaging consisting of ultrasound and x-ray of kidney, ureter and bladder. An IVU (Intravenous urogram) or a CT urogram was performed in selected cases. Patients were divided randomly into two groups. The patients undergoing Ho: YAG lithotripsy were included in group I. The patients undergoing pneumatic lithotripsy were included in group II. All surgeries were performed by consultant urologist and were assisted by the principal investigator. The complete diagnosis, stone characteristics and history of previous surgery were recorded for all patients. The operative time in minutes was calculated in all patients from initial cystoscopy till ending of ureteroscopy after the stone fragmentation into small particles (less than 2mm fragments). All the information was recorded by researcher on a specially designed questionnaire.

Data Analysis: All the data was analyzed using SPSS version 16.0. An Independent Samples t-test was used to compare the mean age of patients in Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group. To compare the other demographic and clinical characteristics of patients (including gender, side of stone and location of stones) in Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group, the Chi-Square test for Independence was used.

The null hypothesis of this study was tested by using, the Independent Samples t-test to compare the mean operative time among Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group.

The Independent Samples t-test was also used to compare mean operative time between Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group for different age groups, gender, sides of stones and locations of stones.

The Multiple Linear Regression Analysis was done to measure the association between the types of intra-ureteral lithotripsy technique and average operative time taken for the procedure. The possible confounders, age, gender, side of stone and location of stone were controlled by including them in the model.

The P-value <0.05 was considered as showing statistically significant results for all statistical tests.

RESULTS

A total number of 60 patients were included in this study; 30 (50%) in Ho: YAG laser lithotripsy group and 30 (50%) in Pneumatic lithotripsy group. The total male patients were 49 (81.7%), while the female patients were 11 (18.3%). The mean age (in years) ± SD of all patients was 36.90 ± 12.11. The minimum age of patients was 18 years and maximum age was 60 years. The mean age ± SD of Ho: YAG Laser lithotripsy group was 35.00 ± 12.59 and the mean age ± SD of Pneumatic lithotripsy group was 38.80 ± 11.51.

Comparison of Demographic and Clinical Data: The demographic and clinical profile i.e., Gender, side of stone and the location of stone between the Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group was compared by using Chi-Square test for Independence, and the age between the two groups was compared by using Independent-Samples t-test, which revealed that the two groups are more or less similar and statistically no significant difference was observed between Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group in terms of age, gender, side of stone and the location of stone (Table 1)**..**

Table No.1: Statistical Significance of Demographic and Clinical Data

Patient Characteristics	Ho: YAG laser Lithotripsy Group	Pneumatic Lithotripsy Group	p-value	Significance
Mean Age ± SD	35.00 ± 12.59	38.80 ± 11.51	0.207*	Insignificant
Gender: Male Female	23 (76.7%) 7 (23.3%)	26 (86.7%) 4 (13.3%)	0.317**	Insignificant
Side of Stone: Right Left	15 (50%) 15 (50%)	15 (50%) 15 (50%)	1.00**	Insignificant
Stone Location Proximal Ureter Mid Ureter Lower Ureter	 13 (43.3%) 9 (30%) 8 (26.7%)	 12 (40%) 8 (26.7%) 10 (33.3%)	0.852**	Insignificant

* Independent-Samples t-test ** Chi-Square test for Independence

Table No. 2. Independent Samples t-test for comparison of mean operative time between two groups

	Type of Intra-ureteral Lithotripsy	Mean ± SD	95% C.I		t-value (df)	p-value
			Lower Bound	Upper Bound		
Operative Time (in minutes)	Ho: YAG laser Lithotripsy	25.48 ± 6.99	22.87	28.09	-5.00 (58)	< 0.001
	Pneumatic Lithotripsy	34.83 ± 7.47	32.04	37.62		

Table No.3: Stratification between Ho: YAG laser lithotripsy and Pneumatic lithotripsy groups with respect to mean operative time in males and females, age groups, sides of stones and different locations of stones

Patients' Characteristics		Ho: YAG laser Lithotripsy Group		Pneumatic Lithotripsy Group		p-value*
		N	Mean Operative Time (in minutes) ± SD	N	Mean Operative Time (in minutes) ± SD	
Gender	Male	23	26.61 ± 7.22	26	35.00 ± 7.83	<0.001
	Female	7	21.79 ± 4.97	4	33.75 ± 5.14	0.004
Age Groups	18 – 23	5	25.30 ± 11.0	2	35.25 ± 14.5	0.36
	24 – 29	8	23.87 ± 6.49	5	34.50 ± 9.23	0.03
	30 – 35	5	26.70 ± 10.0	7	38.21 ± 8.18	0.053
	36 – 41	3	25.00 ± 4.50	5	32.70 ± 5.07	0.07
	42 – 47	3	25.83 ± 0.76	3	38.17 ± 3.21	0.003
	48 – 53	2	27.00 ± 4.95	4	29.25 ± 6.50	0.69
	54 – 60	4	25.48 ± 6.99	4	34.88 ± 7.19	0.15
Side of Stone	Right	15	23.67 ± 7.59	15	35.23 ± 7.11	<0.001
	Left	15	27.30 ± 6.05	15	34.43 ± 8.05	0.01
Stone Location	Proximal	13	24.35 ± 5.65	12	34.25 ± 8.02	0.002
	Mid	9	27.78 ± 9.77	8	34.63 ± 7.26	0.13
	Lower	8	24.75 ± 5.41	10	35.70 ± 7.68	0.004

* Independent Samples t-test

Hypothesis Testing: An Independent-Samples t-test revealed that there was a statistically significant difference between the Ho:YAG laser Lithotripsy group (Mean=25.48, SD=6.99) and Pneumatic Lithotripsy group (Mean=34.83, SD=7.47); t(58) = -5.00, p<0.001, two-tailed) in terms of the operative time in minutes. The magnitude of differences in the means (mean difference= -9.35, 95% CI of the difference: 13.09 to 5.61) was very large η^2=0.301 (according to Cohen's criteria, 1988).

Among both genders, in age groups 24 – 29, 36 – 41, 42 – 47, among patients having stones on right and left side of ureter, and among patients having stones at proximal and lower location, the mean operative time was found significantly different between Ho:YAG laser lithotripsy groups and Pneumatic lithotripsy group, p < 0.05 (Table 3).

Multiple Linear Regression Analysis: The Multiple Linear Regression was calculated to predict the mean operative time taken for the intra-ureteral lithotripsy of patients based on the type of intra-ureteral lithotripsy technique used, patients' age, gender, laterality of stones and location of stones. The type of intra-ureteral lithotripsy technique was coded as 1 = Ho: YAG laser Lithotripsy, 2 = Pneumatic Lithotripsy; gender was coded as 1 = Male, 2 = Female; Stone location was coded as 1 = Proximal, 2 = Mid and 3 = Lower; Side of Stone was coded as 1 = Right and 2 = Left side. The age of patients was measured in years.

A significant regression equation was found (F (5, 54) = 5.410, p<0.001), with an R^2 of 0.334. The type of intra-ureteral lithotripsy technique was found a significant predictor of mean operative time taken for the procedure. The average operative time taken for Pneumatic lithotripsy procedure increased by 9.13 minutes as compared to the Ho: YAG laser lithotripsy procedure, after controlling for all other variables of the model. However, the age, gender of patients, side of stone and location of stone were not found as significant predictors of operative time taken for the procedure (Table 4)

Table No.4: Multiple Linear Regression analysis of factors associated with the mean operative time taken for the intra-ureteral lithotripsy procedure

Independent Variables	B	S.E	t	p-value
Type of Intra-ureteral lithotripsy	9.13	1.93	4.72	0.000
Age of Patient	-0.035	0.08	-0.42	0.674
Gender of Patient	-3.33	2.52	-1.32	0.191
Stone Location	0.16	1.17	0.14	0.893
Side of Stone	1.44	1.94	0.74	0.462

DISCUSSION

A large population of world is suffering from ureteric stones and kidney stones, which are formed due to the deposition of phosphates, calcium, and oxalates.[1] Indications of surgical intervention include failure of conservative treatment, intractable pain, urosepsis, solitary obstructed kidney, and patient's choice.[1] Urologic armamentarium for the treatment of ureteral calculi consists of ureteroscopic lithotripsy, extracorporeal shock wave lithotripsy (ESWL), open ureterolithotomy and laparoscopic ureterolithotomy. The choice of treatment depends upon stone location, size of stone, availability of endourological facilities and patient's preference.[16] For intracorporeal lithotripsy, electrohydraulic, pneumatic, and laser lithotriptors can be used. Currently, laser and pneumatic lithotriptors are most frequently used, and acceptable methods in the endoscopic management of ureteral stones.[17] Over the last decade, lasers have been increasingly used for intracorporial lithotripsy.[18]

This study revealed that there was a significant difference in mean operative time of Ho: YAG laser lithotripsy technique and Pneumatic lithotripsy technique. The less mean operative time was observed with Ho: YAG laser lithotripsy compared to the Pneumatic lithotripsy technique in which the mean operative time was greater. With the possibility that a similar beneficial effect might be achieved with Ho: YAG laser lithotripsy, a number of national and international studies were carried out with variable results.

The results of this study are coherent with the results of a study conducted by Yin et al[19], Demir et al[20], and Linjin et al[21] in which the Holmium: YAG laser lithotripsy showed significant benefits compared to the pneumatic lithotripsy in terms of mean operative time, with p values <0.05. However, there were several similar studies in which the results were contradictory to the results of this study. The results of a study conducted by Tipu et al[22], Degirmenci et al[15] and Razzaghi et al[17], were contradictory with the current study, which revealed that the mean operative time in Laser Lithotripsy group was significantly greater as compared to the Pneumatic Lithotripsy group with p-values <0.05.[22]

In contrary to the results of this study in which there was a significant difference observed between the Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group in terms of mean operative time, the study carried out by Akdeniz et al[23] and Feng et al[24] revealed no statistically significant difference between Ho: YAG Laser lithotripsy group and Pneumatic lithotripsy group in terms of mean operative time, with p value >0.05.

In the current study, the baseline demographic and clinical characteristics of all patients including the mean age, gender, side of stone (right or left) and location of stone (Proximal ureter/mid ureter/lower ureter) were found similar and no statistically significant difference was observed between Ho: YAG laser lithotripsy group and Pneumatic lithotripsy group in terms of all these characteristics.

Similar to the findings of this study, the studies of Tipu et al[22], Degirmenci et al[15] and Linjin et al[21], Razzaghi et al[17] and Akdeniz et al[23] revealed that the baseline demographics of patients and the stone characteristics were similar in both Ho:YAG laser lithotripsy group and Pneumatic lithotripsy group.

In the current study, the overall mean operative time in minutes and SD in patients having stone in proximal ureter was 29.10 ± 8.42, in mid ureter was 31.00 ± 9.12 and in the lower ureter was 30.83 ± 8.64, with p-value 0.728, which shows that the mean operative time was

not statistically significantly different among different locations of the stone.

In patients having proximal and lower ureteric stones, the mean operative time was significantly different between Ho: YAG laser lithotripsy and Pneumatic lithotripsy groups ($p<0.05$). However, the mean operative time was not significantly different between Ho: YAG laser lithotripsy and Pneumatic lithotripsy groups in patients having mid ureteric stones ($p>0.05$). In the study of Khoder et al, the mean operative time for Ho: YAG laser lithotripsy for proximal ureteric stones was 81.3 ± 4.5 min and for distal ureteric stones was 65.7 ± 3.8 min, which was significantly different between the two groups, with p value = 0.017.[25]

CONCLUSION

In conclusion of this study, it is speculated that the Ho: YAG laser lithotripsy is a better procedure as compared to the Pneumatic lithotripsy, in terms of the operative time required for the procedure. Hence, it is recommended that the Ho: YAG laser lithotripsy procedure should be adapted when there is a long list of patients requiring ureteroscopic lithotripsy, in order to manage the operative list in a better way according to the time slots available in the operation theatre.

Conflict of Interest: The study has no conflict of interest to declare by any author.

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