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Research Article

AN OBSERVATIONAL STUDY ON CLINICAL AND IMAGING PARAMETERS ON THE OUTCOMES OF URETERORENOSCOPIC LITHOTRIPSY

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A B S T R A C T

Ureterorenoscopy, is the most commonly used modality for treatment of ureteric calculi with excellent post-operative outcomes. Stated complication rates for URS are between 9-25%. We aimed to analyse whether clinical parameters such as gender, body mass index and pre-operative urine culture, along with CT scan parameters - stone, renal and ureteral morphometric parameters could influence the outcomes of URSL in terms of duration of surgery, stone free rate, complication, and auxiliary procedures.

It was noted that larger stone size, proximal location, increased stone density and ureteral wall thickness at the site of stone impaction were significantly associated with complications as well as lower stone clearance and need of auxiliary procedures.

This study emphasises the need for extra care and cautiousness when dealing with patients with the aforementioned factors.

INTRODUCTION

Ureterorenoscopy (URS) is used as the first line of management for ureteral urolithiasis, providing higher stone clearance compared to shockwave lithotripsy (SWL) and lower complication rates compared to percutaneous nephrolithotomy (PCNL).[1]

Its complications include: up-migration of ureteral calculi,[1,2] need for an auxiliary procedure due to incompletely removed stones (specifically in larger stone burden)[1] and ureteral injury.[1,2,3] As per recent guidelines,[4] the overall complication rate after URS is 9–25%. Though most complications are minor and do not require intervention, major complications like ureteral avulsion can still happen (<1%). Various classification systems used in scoring surgical complications include Clavien-Dindo,[5,6] Satava[7] and PULS (Post UreteroscopicLesion Scale).[8] The Clavien–Dindo classification system is the most widely utilised scoring system for surgical complications. On the other hand, Satava and PULS scoring systems are specific for URS.

Patients with impacted calculi, inflamed ureters, larger stone size (>1 cm), proximal location of the stones, and previous failed extracorporeal shockwave lithotripsy are at increased risk of developing complications.[9,10]

Use of computerised tomography (CT) for diagnosing ureteral calculi has increased over the last decade. A non-contrast CT (NCCT) enables measurement of various stone, renal and ureteral morphometric parameters, which is not possible with X-Ray KUB or intravenous pyelogram.

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In our study, we aimed to analyse if clinical parameters such as gender, body mass index and pre-operative urine culture sensitivity and CT imaging parameters would influence the outcomes of URSL, particularly the duration of surgery, stone-free rate, complication, and auxiliary procedure.

We also tried to analyse if it would be possible to identify using these parameters the subgroup of patients with ureteric calculi in whom the complication rate would be higher so that additional precautions can be taken in these patients while performing URSL.

MATERIALS AND METHODS:

This retrospective study was carried out at Sri Ramachandra Institute of Higher Education and Research, Chennai.

One hundred fifty patients who underwent URSL between October 2018 and October 2020 were included in this study.

Inclusion criteria

1. Patients aged 18 years and above
2. Patient undergoing URSL for a solitary unilateral ureteral calculus.

Exclusion criteria: Patients with any of the following factors were deemed unsuitable for inclusion - recurrent stone formation, deranged coagulation profile, pregnancy, congenital anomalies of kidney and ureter, pre-scented ureters and percutaneous nephrostomy.

BMI was categorised as low if BMI was < 18, normal if BMI was between 18-25 and high if BMI was >25.

Non-contrast CT KUB-derived parameters utilised included:

- Stone size - maximum transverse diameter measured in millimetres.
- Stone location - considered proximal if the stone was above the level of iliac vessel crossing and distal if below it.
- Stone density - measured within the centre of the stone in Hounsfield units.
- Ureteral and renal morphometric parameters utilised included:
- Maximum ureteral wall thickness - at the site of stone impaction.
- Proximal ureteral diameter - maximum transverse diameter of the ureter proximal to the stone impaction site, but distal to the pelvic ureteric junction.
- Maximum renal parenchymal thickness - at the level of the renal hilum.
- Maximum renal transverse pelvic diameter - measured in the anteroposterior axis.
- Peri-ureteral stranding - present or absent at the level of impaction of stone.

Universal Viewer Zero Footprint ClientTM by GE Healthcare, USA, was used for carrying out the measurements.

All patients underwent URSL under regional anaesthesia, with the patient in the lithotomy position. A 6/7.5 Fr semirigid ureteroscope with a 5° angle of view was used for all the procedures.

The calculus was fragmented using a laser (for stones >+1000 HU) or pneumatic lithotripter. Settings for Ho: YAG laser lithotripsy with a 365 μ–mm fibrewere: 0.8–1.2 J and 10–15 Hz. Settings for pneumatic lithotripsy were energy at 4 bar and frequency of 5–10 Hz.

6 French, 26 cm double J stent and a foley catheter was placed in all cases. A post-operative X-ray KUB was performed in all cases.

In patients with fragment up migration or those in whom access to the ureter was difficult, the procedure was terminated after placing a Double J stent. Patients underwent repeat imaging at the end of two weeks to localise the stone and decide on the need for an auxiliary procedure.

The double j stent was removed after two weeks provided the patient was ”stone-free.” “Stone-free” state was defined as no residual fragment more than 4 mm in size. Auxiliary procedures for residual calculi were documented, along with any complications.

RESULTS

Data of 150 patients who underwent URSL and Double ’J ‘ stenting between October 2018 and October 2020 for solitary ureteral calculus fulfilling the inclusion and exclusion criteria were analysed.

Clinical parameters: gender, BMI, pre-operative urine culture and CT imaging parameters: stone size, location, density, maximum ureteral wall thickness, maximum renal parenchymal thickness, maximum proximal ureteric diameter, maximum transverse renal pelvic diameter and periureteric stranding were analysed. The impact of these factors on: the duration of surgery, stone-free rate, complications and the need for an auxiliary procedure was statistically analysed.

Complications occurred in 32 (21.3%) of 150 patients. The most common complications included mucosal injury (n=7, 21.9%), up migration (n=7, 21.9%), incomplete fragmentation (n=5, 15.6%), fever with UTI (n=5, 15.6%), ureteral perforation (n=4, 12.5%), hematuria (n=2, 6.2%) and post operative LUTS (n=2, 6.2%). (Table 1)

Table 1

All Parameters	Mean ± SD || Median (IQR) || Min-Max || Frequency (%)
Age (Years)	41.55 ± 13.85 || 40.00 (31.00-52.00) || 18.00 - 80.00
Gender	
Male	109 (72.7%)
Female	41 (27.3%)
BMI (Kg/m2)	27.38 ± 3.27 || 27.50 (24.00-30.00) || 21.00 - 35.00
BMI	
<25 Kg/m2	41 (27.3%)
≥25 Kg/m2	109 (72.7%)
Urine C/S (Positive)	28 (18.7%)
Stone Size (mm)	8.30 ± 3.19 || 8.00 (6.00-10.00) || 3.00 - 20.00
Stone Size	
≤10 mm	124 (82.7%)
All Parameters	**Mean ± SD || Median (IQR) || Min-Max || Frequency (%)**
>10 mm	26 (17.3%)
Location	
Distal	84 (56.0%)
Proximal	66 (44.0%)
Density (HU)	822.15 ± 314.77 || 807.00 (565.50-1017.50) || 108.00 - 1703.00
Density	
≤1000 HU	110 (73.3%)
>1000 HU	40 (26.7%)
MUWT (mm)	4.20 ± 0.66 || 4.00 (3.70-4.80) || 3.00 - 5.80
Periureteric Stranding (Present)	78 (52.0%)
MPUD (mm)	16.49 ± 2.42 || 17.00 (15.00-18.00) || 10.27 - 22.77
Renal Parenchymal Thickness (mm)	16.86 ± 2.44 || 17.50 (15.05-18.65) || 10.45 - 20.90
Renal Transverse Pelvic Diameter (mm)	23.46 ± 2.36 || 23.53 (22.56-24.56) || 16.89 - 29.66
Technique Used	
Laser	79 (53.0%)
Pneumatic	70 (47.0%)
Surgery Duration (Minutes)	34.28 ± 2.62 || 34.00 (33.00-35.00) || 27.00 - 45.00
Stone Clearance	
Complete	138 (92.0%)
Incomplete	12 (8.0%)
Complications (Present)	32 (21.3%)
Details of Complications	
Mucosal Injury	7 (21.9%)
Upmigration	7 (21.9%)
Fever+UTI	5 (15.6%)
Incomplete fragmentation	5 (15.6%)
Ureteral perforation	4 (12.5%)
Hematuria	2 (6.2%)
Post operative LUTS	2 (6.2%)
Auxiliary Procedure (Required)	12 (8.0%)
Auxiliary Procedure Details	
RELOOK URS	5 (41.7%)
ESWL	4 (33.3%)
Mini PERC	3 (25.0%)

Clinical parameters had no association with complications. However, the imaging parameters: stone size, location of the calculus, stone density, and maximum ureteral wall thickness were directly responsible for complications ($p<0.05$). (Table2)

Both clinical and CT imaging parameters were not significantly associated with the occurrence of individual complications or with the duration of surgery (Table 3).

Stone size and location were found to impact stone clearance and were directly proportional to stone-free rates. Large size and proximal location were both associated with incomplete stone clearance. (Table 4)

Table 2

Parameters	Complications		p value
	Present (n = 32)	Absent (n = 118)	
Age (Years)	43.28 ± 15.06	41.08 ± 13.53	0.480[1]
Gender			0.094[2]
Male	27 (24.8%)	82 (75.2%)	
Female	5 (12.2%)	36 (87.8%)	
BMI (Kg/m2)	26.69 ± 3.24	27.57 ± 3.27	0.173[1]
BMI			0.057[2]
<25 Kg/m2	13 (31.7%)	28 (68.3%)	
≥25 Kg/m2	19 (17.4%)	90 (82.6%)	
Urine C/S (Positive)	8 (28.6%)	20 (71.4%)	0.300[2]
Stone Size (mm)* **	10.41 ± 3.19	7.73 ± 2.96	<0.001[1]
Stone Size* **			0.004[2]
≤10 mm	21 (16.9%)	103 (83.1%)	
>10 mm	11 (42.3%)	15 (57.7%)	
Location* **			0.048[2]
Distal	13 (15.5%)	71 (84.5%)	
Proximal	19 (28.8%)	47 (71.2%)	
Density (HU)* **	974.94 ± 334.32	780.72 ± 297.40	0.005[3]
Density* **			0.044[2]
≤1000 HU	19 (17.3%)	91 (82.7%)	
>1000 HU	13 (32.5%)	27 (67.5%)	
MUWT (mm)* **	4.64 ± 0.65	4.08 ± 0.61	<0.001[1]
Periureteric stranding (Present)	15 (19.2%)	63 (80.8%)	0.513[2]
MPUD (mm)	16.42 ± 2.45	16.50 ± 2.42	0.758[1]
Renal Parenchymal Thickness (mm)	16.94 ± 2.56	16.83 ± 2.41	0.712[1]
Renal Transverse Pelvic Diameter (mm)	23.04 ± 2.63	23.58 ± 2.28	0.383[1]

Table 3

Parameters	Details of Complications							p value
	Mucosal Injury (n = 7)	Up migration (n = 7)	Fever+UTI (n = 5)	Incomplete Fragmentation (n = 5)	Perforation (n = 4)	Hematuria (n = 2)	Post operative LUTS (n = 2)	
Age (Years)	48.43± 17.94	35.71± 11.51	48.40± 15.11	36.60 ± 10.57	44.50± 21.00	49.50± 7.78	47.00± 22.63	0.646[1]
Gender								
Male	6 (22.2%)	6 (22.2%)	5 (18.5%)	4 (14.8%)	3 (11.1%)	1 (3.7%)	2 (7.4%)	0.789[2]
Female	1 (20.0%)	1 (20.0%)	0 (0.0%)	1 (20.0%)	1 (20.0%)	1 (20.0%)	0 (0.0%)	
BMI (Kg/m2)	28.00± 4.12	26.43 ± 2.51	24.60± 2.51	26.20 ± 2.86	28.00± 4.90	28.00± 1.41	25.50± 2.12	0.631[1]
BMI								
<25 Kg/m2	2 (15.4%)	2 (15.4%)	4 (30.8%)	2 (15.4%)	2 (15.4%)	0 (0.0%)	1 (7.7%)	0.523[2]
≥25 Kg/m2	5 (26.3%)	5 (26.3%)	1 (5.3%)	3 (15.8%)	2 (10.5%)	2 (10.5%)	1 (5.3%)	
Urine C/S (Positive)	2 (25.0%)	2 (25.0%)	1 (12.5%)	2 (25.0%)	1 (12.5%)	0 (0.0%)	0 (0.0%)	1.000[2]
Stone Size (mm)	10.94± 4.83	9.56 ± 2.29	8.84 ± 2.17	13.10 ± 3.05	10.50± 1.73	10.00± 0.00	8.90± 4.38	0.353[1]
Stone Size								
≤10 mm	4 (19.0%)	6 (28.6%)	4 (19.0%)	2 (9.5%)	2 (9.5%)	2 (9.5%)	1 (4.8%)	0.616[2]
>10 mm	3 (27.3%)	1 (9.1%)	1 (9.1%)	3 (27.3%)	2 (18.2%)	0 (0.0%)	1 (9.1%)	
Location								
Distal	3 (23.1%)	0 (0.0%)	2 (15.4%)	2 (15.4%)	2 (15.4%)	2 (15.4%)	2 (15.4%)	0.064[2]
Proximal	4 (21.1%)	7 (36.8%)	3 (15.8%)	3 (15.8%)	2 (10.5%)	0 (0.0%)	0 (0.0%)	
Density (HU)	808.43± 334.95	804.57± 334.54	1273.40± 363.71	979.80± 186.28	1126.50± 293.13	850.50± 211.42	1217.00± 258.80	0.172[1]
Density								
≤1000 HU	4 (21.1%)	6 (31.6%)	1 (5.3%)	4 (21.1%)	2 (10.5%)	2 (10.5%)	0 (0.0%)	0.116
1000 HU	3 (23.1%)	1 (7.7%)	4 (30.8%)	1 (7.7%)	2 (15.4%)	0 (0.0%)	2 (15.4%)	
MUWT (mm)	4.64± 0.61	4.19 ± 0.45	4.28 ± 0.94	5.06 ± 0.54	4.78 ± 0.32	5.20 ± 0.28	5.30± 0.42	0.063[1]
Periureteric stranding (Present)	1 (6.7%)	5 (33.3%)	2 (13.3%)	3 (20.0%)	3 (20.0%)	1 (6.7%)	0 (0.0%)	0.222[2]
MPUD (mm)	15.75± 2.72	16.20 ± 3.27	15.53± 2.56	16.20 ± 1.48	17.20± 1.05	17.94± 2.74	19.20± 1.14	0.477[1]

Parameters	Details of Complications							p value
	Mucosal Injury (n = 7)	Up migration (n = 7)	Fever+UTI (n = 5)	Incomplete Fragmentation (n = 5)	Perforation (n = 4)	Hematuria (n = 2)	Post operative LUTS (n = 2)	
Renal Parenchymal Thickness (mm)	16.61± 2.98	15.60 ± 2.00	17.73± 3.10	17.21 ± 3.08	17.80± 1.76	18.39± 2.11	17.06± 3.54	0.607[1]
Renal Transverse Pelvic Diameter (mm)	22.50± 2.77	23.35 ± 3.42	22.27± 3.19	23.18 ± 1.64	22.62± 2.36	26.45± 0.00	22.78± 0.47	0.638[1]

Table 4

Parameters	Stone Clearance		p value
	Complete (n = 138)	Incomplete (n = 12)	
Age (Years)	42.02 ± 14.03	36.08 ± 10.64	0.178[1]
Gender			0.513[2]
Male	99 (90.8%)	10 (9.2%)	
Female	39 (95.1%)	2 (4.9%)	
BMI (Kg/m2)	27.47 ± 3.32	26.33 ± 2.53	0.267[1]
BMI			0.736[2]
<25 Kg/m2	37 (90.2%)	4 (9.8%)	
≥25 Kg/m2	101 (92.7%)	8 (7.3%)	
Urine C/S (Positive)	24 (85.7%)	4 (14.3%)	0.238[2]
Stone Size (mm)* **	8.06 ± 3.10	11.03 ± 3.09	0.002[1]
Stone Size			0.223[2]
≤10 mm	116 (93.5%)	8 (6.5%)	
>10 mm	22 (84.6%)	4 (15.4%)	
Location* **			0.004[3]
Distal	82 (97.6%)	2 (2.4%)	
Proximal	56 (84.8%)	10 (15.2%)	
Density (HU)	817.33 ± 317.64	877.58 ± 286.02	0.584[1]
Density			0.517[2]
≤1000 HU	100 (90.9%)	10 (9.1%)	
>1000 HU	38 (95.0%)	2 (5.0%)	
MUWT (mm)	4.17 ± 0.66	4.55 ± 0.65	0.065[1]
Periureteric stranding (Present)	70 (89.7%)	8 (10.3%)	0.289[3]
MPUD (mm)	16.51 ± 2.41	16.20 ± 2.58	0.617[1]
Renal Parenchymal Thickness (mm)	16.91 ± 2.43	16.27 ± 2.51	0.300[1]
Renal Transverse Pelvic Diameter (mm)	23.48 ± 2.33	23.28 ± 2.72	0.600[1]

Table 5

Parameters	Auxiliary Procedure		p value
	Required (n = 12)	Not Required (n = 138)	
Age (Years)	36.08 ± 10.64	42.02 ± 14.03	0.178[1]
Gender			0.513[2]
Male	10 (9.2%)	99 (90.8%)	
Female	2 (4.9%)	39 (95.1%)	
BMI (Kg/m2)	26.33 ± 2.53	27.47 ± 3.32	0.267[1]
BMI			0.736[2]
<25 Kg/m2	4 (9.8%)	37 (90.2%)	
≥25 Kg/m2	8 (7.3%)	101 (92.7%)	
Urine C/S (Positive)	4 (14.3%)	24 (85.7%)	0.238[2]
Stone Size (mm)* **	11.03 ± 3.09	8.06 ± 3.10	0.002[1]
Stone Size			0.223[2]
≤10 mm	8 (6.5%)	116 (93.5%)	
>10 mm	4 (15.4%)	22 (84.6%)	
Location* **			0.004[3]
Distal	2 (2.4%)	82 (97.6%)	
Proximal	10 (15.2%)	56 (84.8%)	
Density (HU)	877.58 ± 286.02	817.33 ± 317.64	0.584[1]
Density			0.517[2]
≤1000 HU	10 (9.1%)	100 (90.9%)	
>1000 HU	2 (5.0%)	38 (95.0%)	
MUWT (mm)	4.55 ± 0.65	4.17 ± 0.66	0.065[1]
Periureteric Stranding (Present)	8 (10.3%)	70 (89.7%)	0.289[3]
MPUD (mm)	16.20 ± 2.58	16.51 ± 2.41	0.617[1]
Renal Parenchymal Thickness (mm)	16.27 ± 2.51	16.91 ± 2.43	0.300[1]
Renal Transverse Pelvic Diameter (mm)	23.28 ± 2.72	23.48 ± 2.33	0.600[1]

Stone size and location were also significantly associated with the need for an auxiliary procedure. (Table 5) Amongst patients undergoing auxiliary procedures, relook URS was the most commonly deployed modality. The need for a second procedure was higher in patients with increased maximum ureteral wall thickness and larger stones on imaging (Table 6)

Table 6

Parameters	Auxiliary Procedure Details			p value
	Relook URS (n = 5)	ESWL (n = 4)	Mini PERC (n = 3)	
Age (Years)	36.60 ± 10.57	36.25 ± 5.50	35.00 ± 18.73	0.857[1]
Gender				
Male	4 (40.0%)	3 (30.0%)	3 (30.0%)	1.000[2]
Female	1 (50.0%)	1 (50.0%)	0 (0.0%)	
BMI (Kg/m2)	26.20 ±2.86	26.25 ±2.87	26.67 ± 2.52	0.961[1]
BMI				
<25 Kg/m2	2 (50.0%)	1 (25.0%)	1 (25.0%)	1.000[2]
≥25 Kg/m2	3 (37.5%)	3 (37.5%)	2 (25.0%)	
Urine C/S (Positive)	2 (50.0%)	2 (50.0%)	0 (0.0%)	0.576[2]
Stone Size (mm)* **	13.10 ± 3.05	8.22 ± 1.18	11.33 ± 2.31	0.018[1]
Stone Size				
≤10 mm	2 (25.0%)	4 (50.0%)	2 (25.0%)	0.253[2]
>10 mm	3 (75.0%)	0 (0.0%)	1 (25.0%)	
Location				
Distal	2 (100.0%)	0 (0.0%)	0 (0.0%)	0.288[2]
Proximal	3 (30.0%)	4 (40.0%)	3 (30.0%)	
Density (HU)	979.80± 186.28	680.75± 138.24	969.67± 485.32	0.090[1]
Density				
≤1000 HU	4 (40.0%)	4 (40.0%)	2 (20.0%)	0.697[2]
>1000 HU	1 (50.0%)	0 (0.0%)	1 (50.0%)	
MUWT (mm)* **	5.06 ± 0.54	4.12 ± 0.39	4.27 ± 0.60	0.040[1]
Periureteric Stranding (Present)	3 (37.5%)	3 (37.5%)	2 (25.0%)	1.000[2]
MPUD (mm)	16.20 ± 1.48	14.90 ± 2.81	17.93 ± 3.52	0.351[1]
Renal Parenchymal Thickness (mm)	17.21 ± 3.08	16.36 ± 2.04	14.60 ± 1.76	0.276[1]
Renal Transverse Pelvic Diameter (mm)	23.18 ± 1.64	25.14 ± 3.46	20.97 ± 1.50	0.142[1]

DISCUSSION

Despite URSL being a minimally invasive endoscopic procedure it is associated with its share of complications. These can be minor, such as: minor bleeding, mucosal injury, false passage and ureteric perforation. Occassionally major complications like ureteric avulsion may occur.

In a study by Abdelrahim *et al* [11] on the factors related to intra-operative complications during rigid ureteroscopy, complications occurred in 27.4% of cases, comparable to our study (21.3%) Approximately 24% of males and 12% of females developed complications in our study, although the association between gender and complication rate was insignificant (P = 0.09) Data on complications from Özsoy *et al*[12] is in concurrence with our observations.

Drăguţescu *et al*[13] analyzed the impact of BMI on URSL complications and found no significant correlation between the two. The same was confirmed by our study as well. Although BMI was not an independent risk factor, our experience shows that some young obese males have tight ureters making URSL difficult.

Pricop *et al*[14] evaluated the association between preoperative urine culture and postoperative infective complications. A positive culture was associated with an increased risk of postoperative infection in patients undergoing URSL. However, we could not demonstrate a similar association in the current study, which may be because any patient found to have a positive culture was started on antibiotics a day before the procedure and continued for at least 2 to 3 days postoperatively. This highlights the importance of ensuring sterile preoperative urine in reducing infective complications of URSL.

El-Nahas *et al*'s[15] study found an increased risk of complications in cases where the mean transverse diameter of the stone was 8 mm or more. This study concluded that the width of the calculus was a critical factor leading to difficulty in stone extraction. Our data also confirms the association of complications with stone size, which was statistically significant.

Georgescu *et al*[16] looked at data from more than 8000 semi-rigid ureterorenoscopies and failed to demonstrate a statistically significant correlation of SFR with gender, stone density, proximal ureteral diameter, renal parenchymal thickness, and transverse pelvic diameter. However, they observed a positive association between stone size and clearance rates. As in our study, fragments of large calculi migrated proximally into the kidney during the URSL procedure. We observed that large stones are likely to have tight impaction to the ureteric wall. Attempting to achieve complete clearance of these fragments in a single sitting could lead to ureteric injury/perforation.

A study by Perez Castro et [17] al looked at the stone clearance rates depending upon the level of the calculus. Clearance was maximum in case of distally located stones (94%) and least for proximally located stones (84%). Our study had similar stone clearance rates, maximum for distally located stones (97.6%) compared to proximally located stones (84.8%). The proximally located stones or their fragments easily up-migrated into the kidney leading to incomplete clearance in our study, highlighting that the level of the calculi is a significant factor in achieving complete stone clearance.

On comparing our data to a study of 320 cases done by Schuster *et al* [18], we noted that the mean duration of surgery in our group was significantly shorter (34.28 +/- 2.62 mins vs 67 +/- 3.6 mins). Their study also found a direct correlation between the duration of surgery and the complications, something our study failed to demonstrate. The difference in operating time and complications may be due to advancements in techniques of surgery as well as the availability of better and smaller-sized equipment in recent times.

We noticed that patients with a large calculus in the proximal ureter had an increased chance of requiring an auxiliary procedure. Yu *et al* [19] also highlighted the same for impacted calculus which was large in dimension. Fong *et al* [20] reported similar findings with increasing stone size (>5 mm).

Our study also found that maximum ureteral wall thickness (>4mm) is independently associated with the need for relook procedures. According to Mishra *et al* [21] patients with MUWT > 4.8 mm were at an increased risk for the requirement of an auxiliary procedure. Kim *et al* [2] proposed that MUWT is a preoperative predictor of the difficulty level difficulty for patients with impacted ureteric calculi.

CONCLUSION

Our study concluded that larger stone size, proximal location, increased stone density and maximum ureteral wall thickness at the site of impaction (CT imaging parameters) were significantly associated with complications. Increased stone size and proximal location are also associated with decreased stone clearance rates and the need for auxiliary procedures. Emphasis should be paid to the need for extra care and cautiousness in such patients to avoid complications. Counselling regarding the expected complications and the need for auxiliary procedures if the above features are present is of utmost importance.

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