ORIGINAL ARTICLE

COMPARISON OF EMERGENCY AND ELECTIVE INTERVENTION WITH SEMI-RIGID URETEROSCOPIC LITHOTRIPSY FOR PATIENTS WITH URETERAL CALCULI

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Background: Ureteroscopy (URS) is a safe and highly effective treatment option for treatment of ureteral calculi. With the advancement of technology, there is also expansion of its indications including use in early or emergency setting. This study aims to compare safety and efficacy of emergency ureteroscopy (EmURS) versus elective ureteroscopy (ElURS) for ureteral stones. **Methods:** Patients with unilateral single radio-opaque ureteral stone who underwent semi-rigid URS from January 2008 till December 2019 were included. Patients with solitary kidney, uro-sepsis, pregnancy or pre-operative drainage with nephrostomy or JJ stent were excluded. EmURS was defined as URS being performed within 48 hours of presentation, while ElURS was defined as URS performed after failed medical expulsive therapy. Patient, stone and outcome related variables were compared in both groups. Stone free rate was defined as no evidence of stone on plain x-ray KUB after 1 week. **Results:** We compared 132 patients in EmURS group against 264 in ElURS group. Age, gender, comorbidities, stone location, laterality and mean stone size were comparable in both groups. EmURS had a less median operative time (p=0.05). Stone free rate achieved was 90.2% in EmURS and 87.1% in ElURS, respectively (p=0.38). Double J stent was placed in 44.7% and 46.2% of EmURS and ElURS respectively (p=0.89). Ancillary procedures were performed in 9.8% of EmURS and 11.7% of ElURS (p=0.57). Overall complication rates were reported in 7.6% in EmURS and 11.7% in ElURS (p=0.22) and most were Clavien grade 1. **Conclusion:** Emergency URS for ureteral stones is a safe and effective one–stage definitive treatment option for patients with acute renal colic not responding to conservative management.

Keywords: Calculi; Elective; Emergency; Ureter; Ureteroscopy

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INTRODUCTION

Renal colic secondary to obstructing ureteral calculi accounts for approximately 1% of all emergency department visits and hospital admissions.[1] Placement of internal stent or nephrostomy tube has been the classic established treatment option as a 'temporizing measure' when conservative treatment fails. This is followed by definite treatment such as shock wave lithotripsy (SWL) or ureteroscopy (URS).[2] The choice of intervention to be done depends upon several factors such as stone location and size, patient preference, operator experience, availability of equipment and related costs.[3]

With the advancement of technologies such as improvement and miniaturization of endoscopes and introduction of lasers, URS has become a highly effective treatment option with excellent safety profile[4]. This has also expanded the indications for URS including early or emergency URS.[4] This one-stage definitive solution not only reduces patients' suffering but also provide comparable stone free rate with minimal complications[5]. It can minimize the need for further follow-up imaging and outpatient assessments. It can also reduce the growing burden on elective surgery waiting lists. Similarly, patients also benefit in terms of lower number of repeated ureteral colics, emergency visits, readmissions and missed work days.[5] The emergency approach has been recently explored by both American Urological Association (AUA) and European Association of Urology (EAU) stone management guidelines.[6]

Until now, there is limited published data pertaining to role of emergency ureteroscopy in the management of ureteral calculi. These studies are from the countries where healthcare systems differ from that of Pakistan. In the current study, we have evaluated the role of two different approaches in the management of ureteral stones, i.e., emergency ureteroscopy (EmURS) and elective ureteroscopy (ElURS).

MATERIAL AND METHODS

It was a retrospective study of ureteroscopic procedures performed at a university hospital between Jan 2008 to Dec 2019. An institutional review board approval was obtained (approval number 406-SUR-ERC-16). Total number of URS cases done during this time period were 3422 (including 3105 elective URS and 317 emergency URS). Written consent was obtained from all patients who underwent the procedure. For emergency URS, we included all adult patients (≥ 18 years) with single, unilateral, radiopaque ureteral stone on preoperative non-contrast enhanced computerized tomography (NCCT) scan done at our institute. Patients with solitary kidney, congenital urinary tract abnormalities, uro-sepsis, pregnancy and patients requiring pre-procedure urgent decompression with nephrostomy tube or indwelling JJ stent were excluded from the study.

The final cases in EmURS group were 132. For elective URS, using the same inclusion and exclusion criteria, a stratified randomized purposive sampling was done by selecting every 9th case from the pool of elective URS, (representative from each year) in a 1:2 fashion for comparison. Thus 132 EmURS cases were compared with 264 ElURS cases.

Emergency URS was defined as procedure performed within 48 hours of presentation to the clinic or emergency department. Reason for performing EmURS was unrelenting pain despite maximum analgesia (NSAIDS and/or opioids), nausea or LUTS such as strangury or where larger stone size and/ or proximal location made spontaneous passage unlikely and at the decision of attending consultant urologist. Elective URS was defined as procedure performed following initial failed medical expulsive therapy (MET) after 4 weeks.

All patients received pre-operative prophylactic antibiotic. Ureteroscopy was performed under general anesthesia using a 6.4/ 8- Fr semi-rigid Karl Storz® ureteroscope with little variation between different surgeons with regard to technique. Intra-corporeal lithotripsy was performed using the Swiss LithoClast® Master (EMS, Nyon, Switzerland) with the aid of fluoroscopy. Stone fragments were retrieved with graspers. Placement of JJ stent was reserved for selected cases which were removed later after 3–4 weeks. Postoperative X-ray KUB was done at the end of 1 week. Patients with no stone fragments on postoperative X-ray KUB were rendered as stone free. Peri/ post-operative complications were reported and standardized according to modified Clavien grade.

Results were analysed using SPSS version 20. Frequency and percentages were compared using Chi square or Fisher's exact test. Continuous variables were expressed as median and interquartile range and compared using Mann Whitney-U test. A p-value <0.05 was taken as statistically significant. Logistic regression analysis was done to determine the possible association between various demographic, clinical and stone related variables with stone free-status and complications.

The primary objective was to determine the clinical outcome of two interventions in terms of stone free status and peri/post-operative complications.

RESULTS

The mean age of patients was 38.43±12.91 (range 18–78) years. No significant difference was found between the two groups with regard to age, gender and laterality. Stone distribution with respect to location in ureter was almost equal at proximal, mid, distal ureter and UVJ (p=0.708). Majority of our patients were younger and had ASA score 1 and 2, however a significant higher proportion of patients (60.3%) in ElURS group were ASA 2 compared to EmURS (26.5%) (p<0.001).

Around 2/3rd of stones in both groups were located in distal ureter and uretero-vesical junction (UVJ). The median stone diameter was 7.0 mm (6.0–9.0) which was comparable between EmURS 7.0 mm (5.0–9.0) and ElURS 7.0 mm (6.0–8.0). Stones in the proximal ureter were larger in both EmURS and ElURS as compared to distal ureter.

Median operative time (insertion of cystoscope to placement of catheter) was shorter in EmURS 33.0 min (24.25–44.75) as compared to ElURS 35.0 min (24.0–50.0). This difference was statistically significant (p=0.05). The mean duration of surgery was longer for larger and proximal ureteral calculi in both groups. All of the emergency URS patients were admitted as inpatients while 92% (243/264) elective URS patients were admitted as day care cases (p<0.001). (Table-1)

Overall stone free rate (SFR) was comparable between both emergency and elective URS groups (90.2% vs. 87.1%) (p=0.38). Stone free rate was highest at UVJ for both emergency and elective URS groups (95.1% vs. 92.3%) followed by distal ureter. The SFR was lowest in the proximal ureter for both groups (78.9% vs.

81.3%) respectively. Larger stone size in the proximal ureter, stone migration into the kidney and failed access were the reasons for low SFR in proximal ureter.

There was no difference between emergency and elective groups for indwelling JJ stent insertion after URS (44.7% vs. 46.2%, p=0.89). In the remaining patients, placement of ureteral catheter for 24h was on the discretion of the operating surgeon. Our inability to reach the stone and fragment it in first attempt was defined as failed access which was same in both groups. The reasons for failed access were tight ureter, impacted stone, mucosal oedema/ abrasions and haematuria. In case of failed access, a JJ stent was placed followed by definite procedure later. Overall complication rate was low in emergency URS group compared to elective group though it was not statistically significant (7.6% vs. 11.7%, p=0.224). Most common complication was gross haematuria (Clavien grade 1) which was more common in elective group likely attributed to mucosal oedema and stone impaction due to longer duration (p=0.05). Other complications like blood transfusion, UTI and stone migration were less common in both groups. None of our patients in either group had ureteral perforation or avulsion, peri-nephric hematoma or required conversion to open procedure.

The post-operative readmission rate was comparable between two groups, i.e., 4.5% in emergency vs. 3.8% in elective (p=0.739). Emergency URS group had lower rate of ancillary procedures without any statistical significance. Ancillary procedures were carried out for pushed back stones, migrated ureteral stone fragments or after failed access. These included SWL, secondary URS, and secondary URS followed by SWL. None of these patients had any complications and stone was completely cleared after ancillary procedure. (Table-2)

On Logistic regression analysis, stone size (p=0.003), stone location (p=0.005) and failed access (p<0.001) were found to be the significant factors associated with stone clearance on univariate analysis however, stone location at proximal ureter was the only factor found to be significantly associated on multivariate analysis. Stone size (p=0.043), right sided procedures (p=0.05), stone migration (p=0.04) and failed access (p=0.05) were the factors found significant for complications on univariate analysis while stone size (p=0.05), right sided procedures (p=0.05) and failed access (p=0.02) were significantly associated with complication on multivariate analysis. Both emergency and elective URS were not found to be significantly different in terms of stone clearance or complications on uni or multivariate logistic regression.

Table 1: Basic demographic and clinical characteristics of patients who underwent emergency and elective semi-rigid ureteroscopy.

Variable	Emergency URS (n = 132)	Elective URS (n = 264)	*p*-value
Age (years) Median (IQR)	36.5 (28.0-46.0)	38.0 (28.25-47.0)	0.541
Gender			
Male	95 (72.0%)	197 (74.6%)	
Female	37 (28.0%)	67 (25.4%)	0.572
BMI (kg/m^2) Median (IQR)	28.33 (24.08-31.14)	26.62 (22.93-29.68)	0.01
ASA score			
I	95 (72.0%)	97 (36.7%)	
II	35 (26.5%)	159 (60.3%)	
II	2 (1.5%)	8 (3%)	<0.001
Mode of admission			
Day-care	0 (0%)	243 (92%)	
Inpatient	132 (100%)	21 (8%)	<0.001
Length of hospital stay (days) Median (IQR)	2.0 (2.0-3.0)	1.0 (1.0-1.0) ± 0.66	0.001
Serum Creatinine (mg/dl) Median (IQR)	1.10 (0.90-1.40)	0.9 (0.80-1.10)	<0.001
Stone size (mm) Median (IQR)	7.0 (5.0-9.0)	7.0 (6.0-8.0)	0.244
Stone location			
Proximal	38 (28.7%)	80 (30.3%)	
Middle	12 (9.1%)	33 (12.5%)	
Distal	41 (31.1%)	73 (27.7%)	
UVJ	41 (31.1%)	78 (29.5%)	0.708
Operative time (min) Median (IQR)	33.0 (24.25-44.75)	35.0 (24.0-50.0)	0.05

URS: Ureteroscopy, IQR: Interquartile range, BMI: Body mass index, ASA: American society of anaesthesiologist
UVJ: Uretero-vesical junction

Table-2: Comparison of outcome data for both emergency and elective semi-rigid ureteroscopy.

	Emergency URS (n = 132)	Elective URS (n = 264)	*p*-value
Stenting			
Yes	124 (93.9%)	246 (93.2%)	
No	8 (6.1%)	18 (6.8%)	0.833
Type of Stent			
JJ Stenting	59 (44.7%)	122 (46.2%)	
Open ended catheter	65 (49.2%)	124 (47.0%)	0.897
Failure of access	9 (6.8 %)	30 (11.4 %)	0.210
Reason for failed access			
Tight ureter	7	22	
Mucosal oedema	2	5	
Haematuria	--	2	
Impacted stone	--	1	
Stone free rate	119 (90.2%)	230 (87.1%)	0.379
Complications	10 (7.6%)	31 (11.7%)	0.224
Type of Complications (MCG Grade)			
Hematuria >24 hours (MCG 1)	5 (3.8%)	24 (9.1%)	0.05
Blood transfusion (MCG 2)	1 (0.8%)	1 (0.38%)	0.58
UTI (MCG 2)	2 (1.5%)	1 (0.38%)	0.22
Stone migration (MCG 3)	2 (1.5%)	5 (1.9%)	0.77
Ancillary Procedures	13 (9.8%)	31 (11.7%)	0.57
Type of Ancillary procedure	10 (7.5%)	22 (8.3%)	0.77
SWL			0.057
Secondary URS	0 (0%)	7 (2.7%)	
Sec. URS + SWL	3 (2.3%)	2 (0.7%)	0.174

URS: Ureteroscopy, JJ: Double J, UTI: Urinary tract infection, SWL: Shockwave lithotripsy, MCG: Modified Clavien grading

Table-3: Uni-variate and Multivariate logistic regression analysis for effect of different variables on stone clearance and complications in elective and emergency ureteroscopy.

	Stone Clearance								Complications							
Variables	**Univariate Analysis**				**Multivariate analysis**				**Univariate Analysis**				**Multivariate analysis**			
	OR	**95% CI**		***p***	**OR**	**95% CI**		***p***	**OR**	**95% CI**		***p***	**OR**	**95% CI**		***p***
Type of URS																
Emergency	0.739															
Elective *	1								0.616							
		0.371	1.45	0.381					1	0.292	1.3	0.20				
Age	1.01	0.99	1.03	0.323					1.01	0.986	1.035	0.43				
Gender	1.084															
Female	1		2.145						0.45							
Male*		0.548		0.817					1	0.183	1.102	0.081				
				0.424												
BMI	0.976	0.919	1.036						1.006	0.95	1.07	0.828				
Length of stay	1.19	0.92	1.54	0.185					0.942	0.687	1.292	0.711				
Mode of hospital admission																
In patient	0.984								0.478							
Day care*	1	0.526	1.84	0.96					1	0.227	1.006	0.06				
												0.09				
Serum Creatinine									1.38	0.941	2.03					
Location of stone																
Proximal	3.36	1.44	7.86	**0.005**	0.378	0.158	0.907	**0.029**	1.20	0.53	2.72	0.661				
Mid	3.0	1.05	8.56	**0.04**	0.393	0.136	1.139	0.085	1.37	0.48	3.91	0.554				
Distal	1.05	0.38	2.89	0.929					0.76	0.31	1.89	0.561				
UVJ*	1								1							
Side of Stone																
Right	1.104								1.984							
Left*	1	0.6	2.03	0.75					1	1.007	3.91	**0.05**	1.97	0.991	3.93	**0.05**
Stone size	1.175	1.056	1.307	**0.003**	1.224	1.077	1.390	**0.002**	1.147	1.005	1.31	**0.043**	1.15	0.99	1.32	**0.05**
Operating time	1.008	0.994	1.02	0.253					1.01	0.996	1.025	0.142				
Failed access																
Yes									3.047							
No*									1	1.33	6.98	**0.05**	2.63	1.13	6.08	**0.02**
Stone migrated																
Yes									2.346							
No*									1	1.041	5.28	**0.04**				

OR= Odds ratio, CI= Confidence interval, Univariate analysis Significant at *p*-value <0.05, Multivariate analysis Significant at *p*-value <0.05, Multivariate analysis Marginally Significant at *p*-value = 0.05

DISCUSSION

Medical expulsive therapy has been traditionally used for treatment of ureteral stone with need for definitive treatment such as URS or SWL in cases of failure[7]. However, failed MET leads not only to delayed recovery of renal function but a prolonged path to care including more cost of health care resources[8]. This approach has disadvantage of waiting for stone passage 'sometime' in the future with patients requiring extra office visits, suffering from recurrent pain, loss of work and poor quality of life.[8]

Emergency URS provides both immediate decompression of urinary unit as well as relief of pain by disintegration and removal of the obstruction caused by stone. Until recently, there was lack of recommendation for emergency approach to URS in international guidelines with only few studies supporting this strategy. Recently, EAU guidelines 2018 have proposed emergency stone removal as a feasible first line treatment option in select patients with symptomatic ureteral stones.[9]

Emergency URS approach saves the patient from prolonged use of analgesics, repeated clinic or emergency department visits and/or hospitalization, less duration of stone-related symptoms and morbidity and lesser loss of productivity and social activities[10]. This approach also leads to decreased burden on elective operating list. Another advantage of EmURS compared to MET or even SWL is shorter time to achieve stone free status.[3] Sarica *et al.*[11] reported that EmURS cause significantly less stone related distress and thus has better impact on health-related quality of life.

Removing a ureteral calculus by EmURS however has a disadvantage of a lesser chance given for conservative and spontaneous passage of stone which might be possible without any exposure to anaesthesia and surgery and thus could lead to overtreatment.[3]

Serica *et al.*[10] published first report regarding emergency URS approach. They reported similar stone free rate compared to our study with significantly less ureteral stenting (14.5%) in EmURS compared to ElURS (65%). Guercio et al.[5] in a randomized controlled trial found emergency URS to be equal in terms of safety and efficacy to scheduled URS with significantly lesser rate of ureteral stenting. Picozzi *et al.*[4] did a mata-analysis of 6 studies involving 681 patients who underwent emergency URS and found an overall stone free rate of 89.5 % with a break up of 94.7%, 87.3% and 81.9% respectively for distal, mid and proximal location and an overall low complication rate of 7.6%.

The outcome from current study is very much similar to what is reported in previously published series.[10,12,13] Both groups in our study did not show any statistical differences for stone size and location. The overall stone free rate at 1 week was 90.2% in EmURS patients and 87.1% in ElURS patients. Majority of these studies used X-ray KUB at the end of 1–4 weeks to assess stone free status. Only Guerco *et al.*[5] used NCCT at the end of first week to assess stone free status. Our inability to achieve an SFR of 100% may be attributed to the use of mechanical energy source, unavailability of stone cone, semi-rigid URS and shorter follow-up period.

Despite of using semi-rigid URS with pneumatic lithoclast, we fortunately had a low incidence of stone migration however failed access to stone was 6.8% and 11.4% respectively in emergency and elective groups mainly for the stones located in proximal ureter.

In both groups there was no difference in the rate of JJ stenting with 44.7 % of patients requiring JJ stent in EmURS. The results are comparable with those reported by Matani *et al.*[14] with 55.7% stent placement in EmURS while Al-Ghazo *et al.*[15] reported a much higher rate (72.5%) of JJ stenting in EmURS.

Al Ghazo, *et al.*[15] reported an overall treatment failure rate of 9.4%. They used only semi-rigid instruments and the Swiss LithoClast® Master. Matani *et al.*[14] reported an initial treatment failure rate of 21.3% in emergency URS patients and 11 % in elective URS patients which was statistically significant (p=0.031). They also used semi-rigid ureteroscope and the Swiss LithoClast® Master. However, the reasons for treatment failure were not mentioned. Zargar-Shoshtari *et al.*[12] reported a treatment failure rate of 26.4% in their retrospective series of emergency URS using flexible URS with holmium laser.

The reported complications in emergency URS range from 4.4 to 14.4%.[12,13,16] In our study complication rate was statistically lower in EmURS group as compared to ElURS group (7.6% and 11.7% respectively). Stone impaction, mucosal oedema and failed access may be the reasons for higher complications in the elective URS group.

We did not attempt to analyse the direct and indirect costs of procedure which in our university hospital setup involves professional fees, medications, investigation (laboratory and radiology) charges, operating room charges etc. However, we believe that EmURS being a single stage treatment is cost effective due to a smaller number of days involved in care of patients with decrease requirement for analgesia, follow up imaging and clinic visits.

We did not include other treatment modality such as emergency or elective disintegration of stone with SWL. We did not measure health related quality of life in our patients and neither calculated the amount of analgesia requirement in either group but for obvious reason, the total duration and number of analgesic requirements were higher in the elective group. We also did not have a look at mean number of clinic visits and number of renal colics in the ElURS group.

Our study is limited by its retrospective design, relatively smaller number of patients and use of semi-rigid URS for management of proximal ureteral stone due to non-availability of flexible URS and laser in emergency setting at odd timings. However, this study has shown feasibility of performing EmURS after onset of ureteral colic.

CONCLUSION

Our study has shown that emergency ureteroscopy with removal of stone is a feasible, safe and effective treatment comparable to elective procedure. It can be considered as the first line treatment option.

Conflict of interest: The authors declare that there is no conflict of interest

AUTHORS' CONTRIBUTION

MB: Conception, Study design, Data analysis, literature search, Manuscript writing. **SMN:** Conception, Study design, Data analysis, literature search, Manuscript writing, Supervision, proof reading & final approval. **NK:** Conception, Data collection and analysis, Manuscript writing. **OG:** Data collection and analysis, Manuscript writing. **SN:** Data collection and analysis, Manuscript writing.

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