ASSESSMENT OF FACTORS INFLUENCING OPERATING TIME DURING RETROGRADE INTRARENAL SURGERY FOR RENAL STONE IN TERTIARY CARE HOSPITAL OF NEPAL

Atul Kasaju, Jagdish Lal Baidya, Rajesh Batajoo, Binod Shrestha, Chandra Shekhar Yadav, Nasim Alam

Department of Urology, B&B Hospital, Gwarko, Lalitpur, Nepal

ABSTRACT

Retrograde intrarenal surgery (RIRS) is an effective and safe method for the management of intrarenal stone showing high stone-free rates. Its main advantage is decrease in operative morbidity for the patient, as well as a faster recovery. The current study aimed to study the factors influencing operating time during retrograde intrarenal surgery for renal stone in tertiary care hospital. It is an observational descriptive cross sectional study using purposive sampling method which was conducted among 188 patients who underwent retrograde intrarenal surgery (RIRS) for management of nephrolithiasis in Department of Urology of B&B hospital, Lalitpur, Nepal. The baseline information of the factors affecting operating time were obtained like age, gender, site of renal stone, prestented or not, body mass index (BMI), ureteral access sheath (UAS) use, stone volume and stone density. The mean operating time was high in renal stone with calcium ammonium urate composition. On linear regression analysis, operative times significantly increased with greater stone volumes and also pre-stenting and ureteral access sheath use did significantly difference on operative time. It revealed stone volume to be the most significant predictor of operative time. Thus, the present study provides valuable information regarding the factors influencing operating time during retrograde intrarenal surgery for renal stone.

KEYWORDS

Renal stone, retrograde intrarenal surgery (RIRS), operating time

CORRESPONDING AUTHOR

Dr. Atul Kasaju
Department of Urology,
B&B Hospital,
Gwarko, Lalitpur, Nepal
Email: dratulkasaju1@gmail.com
Orcid No: https://orcid.org/0009-0004-5846-4403
DOI: https://doi.org/10.3126/nmcj.v25i1.53364

***Received on**: September 05, 2022*
***Accepted for publication**: January 06, 2023*

INTRODUCTION

Nephrolithiasis is one of the most common urological disease in Asia with rising prevalence and incidence of the disease over the last several decades. After the initial stone event its recurrence occurs frequently leading to large number of hospital visit. Worldwide its prevalence, incidence and composition varies and are found to be changed in the last several decades, with prevalence ranging from 7% to 13% in North America, 5%–9% in Europe, and 1%–5% in Asia.[1] It can affect all ages, sexes, and races but it is present more frequently in men than in women within the age of 20–49 years and in the absence of metaphylaxis, the relapsing rate of secondary stone formations is estimated to be 10–23% per year, 50% in 5–10 years, and 75% in 20 years of the patient.[2] There are different minimally invasive technologies for the removal of stones from calyx and pelvis system of kidney and from ureter. The different minimally invasive technologies (MIT), such as: extracorporeal shock wave lithotripsy (ESWL), ureterorenoscopic lithotripsy (URS), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotripsy (PNL) are present.[3]

As per the latest guidelines, there has been a paradigm shift in the management of urolithiasis to endourologic procedures, such as retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL).[4] RIRS is regarded as a first-line alternative surgery for percutaneous nephrolithotomy and this method was first reported in 1964 by Marshall, who explored the ureter by using a 9F pediatric flexible cystoscope, without any working channel or active deflection.[5] RIRS has recently become the preferred choice in the management of renal calculi especially for smaller than 20 mm stones and is performed through natural orifice.[6] The complication rate following RIRS is generally low, even less is known about dramatic and fatal complications.[7] It doesn't cause renal parenchymal injury and there is a decreased risk of bleeding. This procedure allows minimally invasive access to renal stones and achieve success not inferior to that of percutaneous approaches.[8] However, a number of factors make surgery more challenging and can have an impact on clinical outcomes. These factors have an effect on the operative time which in turn can influence patient outcome.[9]

Operative time is not only net surgical time but it includes induction of anesthesia, patient positioning, general preparations, procedure time, and emergence from anesthesia after the completion of the operation. Various other factors may influence operative time in endourological procedures like patients and stone characteristics, surgical team expertise with endourological procedures and an endourological oriented operating room.[10] Prolonged operative time could lead to increase in incidence of fever and urosepsis after the procedure.[11] An accurate estimation of the operative time could also significantly help with the financial implications for the institution, and it is important for patient's knowledge.[12] The establishment of high-powered lasers with different techniques for stone fragmentation such as dusting and pop-dusting, allowing larger stones to be treated more efficiently.[13] The use of ureteric access sheaths (UAS) facilitates clearer views in the kidney with low intrarenal pressure and allows repeated re-entry to the kidney to clear fragments in a time-effective manner, in addition to decreasing the infectious complications.[14]

This hospital based cross sectional study aimed to explore factors influencing operating time during retrograde intrarenal surgery for renal stone.

MATERIALS AND METHODS

This is an observational descriptive cross sectional study using purposive sampling method which was conducted among all the patients who underwent Retrograde intrarenal surgery (RIRS) for management of nephrolithiasis. The study period was from April 2021 to July 2021 in Department of Urology of B&B hospital, Lalitpur, Nepal. Ethical approval was taken from Institutional Review Committee (IRC) of Nepal Medical College and Teaching Hospital. The total sample size were 188 after using an appropriate statistical formula ($N=z^2pq/d^2$). During this study, all age group patients with unilateral renal stone planned for RIRS were included in this study. However, those patients with bilateral renal stones, staged procedure or complete stone fragmentation not achieved, patient planned for other concurrent endourological procedures and RIRS in pregnant patients were excluded in this study. Study participants in this study were explained about the purpose of the interview and consent was obtained. The baseline information were obtained like age, gender, laterality, number and site of renal stone, prestented or not, body mass index (BMI), stone volume and stone density.

Retrograde intrarenal surgery procedure: All RIRS procedures were performed under general anesthesia in the low dorsolithotomy position. As per hospital microbial culture and sensitivity pattern, all patients were given single dose of Piperacillin – tazobactum 4.5gm IV were given as antibiotic prophylaxis at the time of induction of anesthesia. Ureteroscopy was first performed using a semi-rigid 6.5/7-Fr ureteroscope (Karl Storz, Germany), with a flexible 0.035-inch guide wire inserted into the renal collecting system. A 9.5 Fureteral access sheath (Cook Medical, Bloomington, IN, USA) was then inserted into the proximal ureter along the guide wire under fluoroscopy guidance. A 7.5F flexible ureteroscope (PUSEN, China) was then advanced through the UAS. Stones were identified and fragmented by 100 W holmium: yttrium-aluminum garnet laser lithotripsy. Stones were dusted and later fragments were pop-dusted. Small store fragment was retrieved by basketting at the end of the procedure and sent for store analysis. A 6-Fr double-J ureteral stent was placed at the completion of surgery. Procedure were conducted by consultants with at least three years of experience in endourology. Timing of the procedure (time of anesthesia, time of start of surgery, time of start of fragmentation, time of finishing fragmentation, time of end of surgery) were documented by the anesthetic nurse. Stones that were composed of >60% of the major constituent were designated accordingly. Rest were labelled as mixed.

Statistical Analysis: The collected data were entered in Excel sheet and cleaned as per necessary. For the analysis of the data SPSS version 16 was used. Frequency and percentage were calculated for the categorical variables and mean and median with inter quartile range was calculated for quantitative variables. Linear regression models were used to evaluate predictors of OR time. Multivariable stepwise regression was used to evaluate the most significant predictors of OR time.

RESULTS

A total 188 patients who underwent RIRS following inclusion criteria were interviewed during the study period. As shown in Table 1, out of 188 study population 129 (68.6%) were male. Mean age of the participants was 41.64 ± 12.23 years, mean BMI was 26.05 ± 3.96 kg/^{m2} and mean operative time 64.83 ± 22 min. UAS was used in 69.1 % of the cases, pre-operative stents were placed in 29.8 % of cases. Location of stone at lower pole was present among 36.7%. The mean stone density was 1086.11± 243.2 HU. The median stone volume was 949mm3 (IQR 709.25-1314).

As depicted in Table 2, there were six different types of stone composition in which mixed type consisting of calcium oxalate and calcium phosphate was 73 (38.8%) and was followed by calcium oxalate monohydrate 63 (33.5%). The mean operating room time was more of calcium ammonium urate. The mean fragmentation time and mean stone density was high of mixed type consisting of calcium oxalate and calcium phosphate.

Table 1: Demographics and clinical outcomes of the study population (n=188)

Demographic and clinical outcomes	Results
Male	129 (68.6%)
Female	59 (31.4%)
UAS used	130 (69.1%)
Prestented	56 (29.8%)
Lower pole location	69 (36.7%)
Mean age, years ± SD	41.64 ± 12.23
Mean BMI, kg/m^2 ± SD	26.05 ± 3.96
Mean operative time, mins ± SD	64.83 ± 22
Mean stone density HU ± SD	1086.11 ± 243.2
Median stone volume, mm3 (IQR)	949 (709.25-1314)
Median laser energy use, kJ (IQR)	0.8 (0.8-0.9)

Table 2: Mean value of OR time, stone volume and stone density among different composition of stone

Composition	n (%)	Mean OR time (mins ± SD)	Mean stone volume (mm3 ± SD)	Mean stone density (HU ± SD)	Mean fragmentation time (mins ± SD)
Calcium ammonium urate	10 (5.3%)	67.6±19.1	873.6±229.89	784±316.76	50.60±21.43
Calcium oxalate dihydrate	38 (20.2%)	63.74±24.7	1029.72±670.75	1083.42±259.75	50.89±25.88
Calcium oxalate monohydrate	63 (33.5%)	62.84±23.59	930.79±487.51	1093.46±174.43	51.24±21.77
Calcium phosphate	2 (1.1%)	66.5±2.12	775±7.07	363±24.04	40
Mixed (Calcium oxalate + Calcium phosphate)	73 (38.8%)	66.81±20.23	1294.17±506.1	1144.37±220.76	56.12±21.07
Mixed (Calcium phosphate + Ammonium urate)	2 (1.1%)	63.5±2.12	786±8.48	1040±14.14	50
Total	188 (100%)	64.86±22	1085.64±546.87	1086.4±242.64	52.9±22.15

As shown in Table 3, significant predictors of operative time were stone volume and age. Stepwise regression revealed stone volume to be the most significant predictors of operative time.

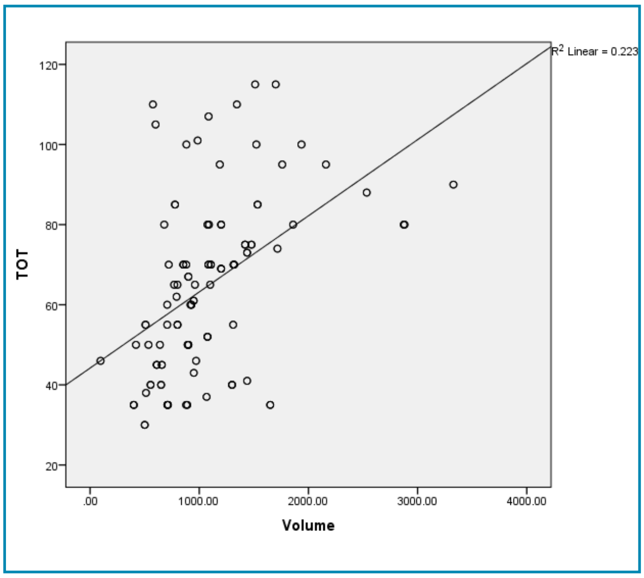

Fig. 1: Univariate linear regression analysis of stone volume relative to total operating time. On linear regression analysis, operative times significantly increased with greater stone volumes (Fig. 1, y = 0.019x + 44.196, r2 = 0.223, $p < 0.01$).

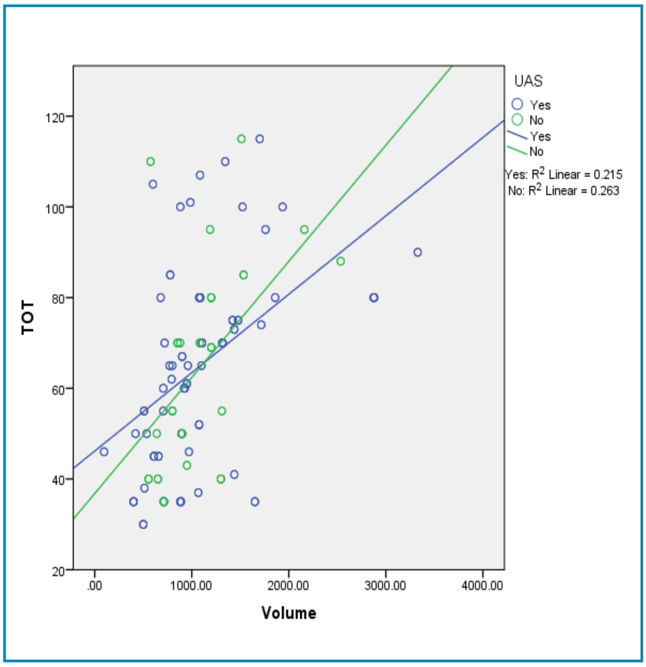

Fig. 2: Linear regression analysis of operative time relative to stone volume by use of an access sheath. The blue line represents the patients with a UAS (y = 0.017x + 46.269, r2 = 0.215). The green lines represents the patients who did not have a UAS (y = 0.026x + 36.817, r2 = 0.263). Ureteral access sheath use did significantly increase operative time ($p < 0.001$)

Table 3: Multivariable linear regression analyzing various stone factors

	Multivariable linear regression			Multivariable stepwise regression		
	Coefficient	**SE**	**p value**	**Coefficient**	**SE**	**p value**
Volume	0.016	0.003	0.000	0.018	0.003	0.000
Age	0.313	0.124	0.012	0.254	0.118	0.033
BMI	-0.058	0.386	0.882			
Gender	-1.840	3.151	0.560			
UAS	1.593	3.277	0.627			
Presented	3.237	3.27	0.327			
Location	1.931	1.015	0.059			
Composition	-1.715	1.116	0.126			
Density	0.006	0.007	0.386			

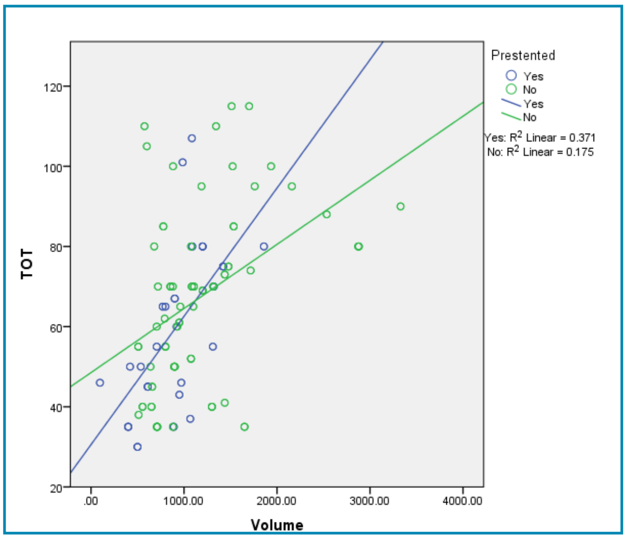

Fig. 3: Linear regression analysis of operative time relative to stone volume by pre-operative stenting. The blue line represents the patients who were pre-stented (y = 0.032x + 30.64, r2 = 0.371). The green lines represents the patients who were not pre-stented(y = 0.016x + 48.593, r2 = 0.175). Pre-stenting make a significant difference on operative time (p <0.001)

DISCUSSION

The study conducted by Danilovic *et al*[15] showed 65.2% of the patients were female. The mean age was 46.8 ± 14.1 and mean BMI was 28.1 ± 4.8 kg/m^2. The study also showed that commonest stone location was at inferior calyx, the mean stone volume and density were 435.5 ± 472.7 mm^3 and 989.4 ± 330.2 HU respectively whereas the mean operative time was 54. 5± 26.7 minutes. In the similar study conducted by Kim *et al*,[8] mean patient age was 56.64 ± 13.91 years, and both genders were evenly distributed. In this study, more than half (51.4%) of the renal stones were located at the lower pole and mean operation time was 74.50 ± 42.56 minutes. In this study 68.6% of the study population were male. Mean age of the participants was 41.64 ± 12.23 years, mean BMI was 26.05 ± 3.96 kg/m^2 and mean operative time 64.83 ± 22 min. The location of stone at lower pole was present among 36.7% and mean stone density and mean stone volume were 1086.11± 243.2 HU and 949 mm^3, respectively.

In the study conducted by Sorokin *et al*,[16] the mean operating time and stone volume was high in the renal stone with Uric acid composition and the stone density was high in renal stone with Brushite composition. On linear regression analysis, operative times significantly increased with larger stone volumes (y = 0.022x + 38.2, r2 = 0.363, p < 0.01). Pre-operative stenting was not associated with operative times (p = 0.63). Use of a UAS did have a significant increase on operative times (p < 0.001). In this study, the mean operating time was high in renal stone with calcium ammonium urate composition. The stone volume and stone density was high in renal stone with mixture of calcium oxalate and calcium phosphate composition. On linear regression analysis, operative times significantly increased with greater stone volumes (y = 0.019x + 44.196, r2 = 0.223, p <0.01) and also pre-stenting (p <0.001) and ureteral access sheath use did significantly difference on operative time.

In the study conducted by Kuroda *et al*,[17] multivariate linear regression analysis and stepwise selection was performed and it showed unstandardized coefficient of presenting, stone volume, stone density, gender are 4.68, 0.02, 0.02 and 10.44, respectively. The standard error of unstandardized coefficients of presenting, stone volume, stone density, gender are 3.31, 0.00, 0.00 and 3.41, respectively. It revealed stone volume and density volume to be the most significant predictors of operative time. In this similar study, the unstandardized coefficient of presenting, stone volume, stone density, gender are 3.237, 0.016, 0.006 and -1.840 respectively. The standard error of unstandardized coefficients of presenting, stone volume, stone density, gender are 3.27, 0.003, 0.007 and 3.151 respectively. It revealed stone volume to be the most significant predictors of operative time.

The study showed that the amongst the main stone factors in RIRS, stone volume, presenting and ureteral access sheath use has the strongest impact on operative time. The mean operating time was high in renal stone with calcium ammonium urate composition. Patients who are interested about the time of procedure may get benefitted during pre-operative counseling.

Conflict of interest: None

Source of research fund: None

REFERENCES

1. Liu Y, Chen Y, Liao B, Luo D, Wang K, Li H, Zeng G. Epidemiology of urolithiasis in Asia. *Asian J Urol* 2018; 5: 205–14.
2. Alelign T, Petros B. Kidney Stone Disease: An Update on Current Concepts. *Adv Urol* 2018;2018:3068365. doi: 10.1155/2018/3068365. PMID: 29515627; PMCID: PMC5817324.
3. Kutluev MM, Safiullin RI, Mochalov KS. Time to recurrence after complete removal of calculi from different parts of the urinary system. Five-year follow-up study. *Urologiia* 2018; 1: 20-4.
4. Kuroda S, Ito H, Sakamaki K *et al*. A new prediction model for operative time of flexible ureteroscopy with lithotripsy for the treatment of renal stones. *PLoS ONE* 2018; 13: e0192597.
5. Marshall VF. Fiber optics in urology. *Urol* 1964; 91: 110-4.
6. Turk C, Neisius A, Petrik A *et al*. EAU guidelines on Urolithiasis. *European Association of Urology Guideline* 2020; 1126.
7. Cindolo L, Castellan P, Scoffone CM *et al*. Mortality and flexible ureteroscopy: analysis of six cases. *World J Urol* 2016; 34: 305-10.
8. Kim DS, Yoo KH, Jeon SH, Lee SH. Risk factors of febrile urinary tract infections following retrograde intrarenal surgery for renal stones. *Medicine (Baltimore)* 2021; 100: e25182. doi: 10.1097/MD.0000000000025182. PMID: 33787599; PMCID: PMC8021282.
9. Lane J, Whitehurst L, Hameed BZ, Tokas T, Somani BK. Correlation of Operative Time with Outcomes of Ureteroscopy and Stone Treatment: a Systematic Review of Literature. *Curr Urol Rep* 2020; 21: 17.
10. Li Z, Lai C, Shah AK *et al*. Comparative analysis of retrograde intrarenal surgery and modified ultra-mini percutaneous nephrolithotomy in management of lower pole renal stones (1.5–3.5 cm). *BMC Urol* 2020; 20: 7.
11. Chuang TY, Kao MH, Chen PC, Wang CC. Risk factors of morbidity and mortality after flexible ureteroscopic lithotripsy. *Urology Sci* 2020; 31: 253-7.
12. Katafigiotis I, Sabler IM, Heifetz EM *et al*. Factors Predicting Operating Room Time in Ureteroscopy and Ureterorenoscopy. *Curr Urol* 2019; 12: 195-200.
13. Pietropaolo A, Jones P, Whitehurst L *et al*. Role of 'dusting and pop-dusting' using a highpowered (100 W) laser machine in the treatment of large stones (15 mm): prospective outcomes over 16 months. *Urolithiasis* 2019; 47: 391–4.
14. Traxer O, Wendt-Nordahl G, Sodha H *et al*. Differences in renal stone treatment and outcomes for patients treated either with or without the support of a ureteral access sheath: the clinical research office of the endourological society ureteroscopy global study. *World J Urol* 2015; 33: 2137–44.
15. Danilovic A, Rocha BA, Torricelli FCM *et al*. Size is Not Everything That Matters: Preoperative CT Predictors of Stone Free After RIRS. *Urology* 2019; 132: 63-8. doi: 10.1016/j.urology.2019.07.006. *Epub* 2019. PMID: 31310774.
16. Sorokin I, K D, Grau C *et al*. Stone volume is best predictor of operative time required in retrograde intrarenal surgery for renal calculi: implications for surgical planning and quality improvement. *Urolith* 2016; 44: 545-50.
17. Kuroda S, Ito H, Sakamaki K *et al*. A new prediction model for operative time of flexible ureteroscopy with lithotripsy for the treatment of renal stones. *PLoS One* 2018; 13: e0192597. doi: 10.1371/journal.pone.0192597. PMID: 29438410; PMCID: PMC5811000.