Low dose computed tomography-Kidney Ureter Bladder Follow Up in Post Retrograde Intrarenal Surgery Patients for Stone Clearance

Anup Chapagain[1], Chitaranjan Shah[1], Anil Shrestha[1]
[1]Department of Urology, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal

Correspondence

Dr. Anup Chapagain, MS
Department of Urology, National Academy of Medical Sciences , Bir Hospital, Kathmandu

E-mail: achapagaindr@gmail.com

Article received: 22nd Dec, 2020

Article accepted: 21st Jan, 2021

ABSTRACT

Introduction: To evaluate stone free rate (SFR) with low dose computed tomography-Kidney Ureter Bladder (CT-KUB) after retrograde intrarenal surgery (RIRS) and compare the relation of stone clearance with stone volume and Hounsfield Unit (HU).

Materials and Methods: The prospective observational study was conducted in Bir Hospital from January 2019 to January 2020 . A total of 42 patient with renal stone up to 20 mm size included. Lithotripsy was performed using Holmium laser utilizing High frequency Low Power Energy (HiFr-LoPE). Stone clearance was reassessed using low dose CT KUB at 1 month who were stone free on X-ray and ultrasound scan at 2 weeks. Patients were categorized as complete stone free, clinically insignificant Residual Fragment (CIRF) <4 mm and CIRF > 4 mm.

Results: The mean stone volume and HU were 553.37±338.10 and 1063.5±378.07 respectively. Complete SFR was 59% and 35.7% with stone volume <500 and 500-1000 mm^3 (P<0.05) respectively. Similarly, Complete SFR was 66.67% and 33.34% with HU<500 and >1500 (P<0.05) respectively. We achieved complete stone clearance in 18 patients (42.85%), whereas 16 patients (38.09%) had CIRF < 4mm and 8 patients (19.04%) had CIRF > 4mm.Low dose CT KUB detected stones in 57.25% patients who were considered stone free based on X-ray and USG KUB findings.

Conclusion: SFR in RIRS is high for renal stones with lower stone volume and low HU. Low dose CT KUB allows more accurate detection of residual fragments than X-ray and USG KUB during follow up of patients after RIRS.

Keywords: Computed Tomography; Flexible scope; Kidney Stone; Holmium Laser

INTRODUCTION

The prevalence of kidney stone disease has increased over the past 3 decades and lifetime prevalence of approximately 14%.[1] Retrograde intrarenal surgery (RIRS) is an efficient and safe option in the management of stone disease less than 2 cm.[2] Stone free rate (SFR) in RIRS is subject to multiple parameters such as stone burden, stone location, stone composition, calyceal anatomy, surgeon experience and follow up imaging modalities.[3] Non enhanced CT is considered the gold standard imaging study for the detection of upper urinary tract stones.[4] An AUA best practice statement recommends follow-up imaging after endoscopic procedures with USG or Plain X-ray KUB for ureteral stones. Plain film KUB for detecting urolithiasis has a low sensitivity and specificity, with reported sensitivities of 45–66%, while the sensitivity for detecting urolithiasis is 12–93% for USG and 91–96% for plain CT respectively.[5] Comparison with standard CT, the sensitivity of low-dose CT is excellent, at 99% with a specificity of 94% with lower radiation exposure, based on conclusions of a meta-analysis involving 1,061 patients.[6]

There is no established guidelines regarding imaging modalities to follow-up patients after RIRS. In our institute till date we follow up patients with plain X-Ray KUB and USG KUB after 4 weeks of surgery. There is no uniformity regarding the follow up imaging protocol for patients undergoing RIRS, many studies had used X-ray KUB with or without USG KUB, however the sensitivity of X-ray and USG KUB is lower than CT KUB and detection of residual fragments may alter the patient treatment and follow up. Hence, this study was undertaken to assess the role of low dose CT KUB in patients follow up post RIRS.

MATERIALS AND METHODS

The prospective observational study was conducted over the period of 12 months from January 2019 to January 2020 in the Department of Urology, Bir Hospital after approval from Institutional Review Board of National Academy of Medical Sciences. Informed consent was taken from all the patients. Inclusion criteria was all the patients who underwent RIRS and came for DJ stent removal at 2 weeks post surgery with no stones in X-ray KUB and USG imaging. Exclusion criteria were patients not reporting with low dose CT KUB at 4 weeks and patients not consenting for study. Forty two patients completed the follow up.

RIRS was performed by consultant urologist with the average of 110 RIRS performed annually. Prophylactic antibiotic was given before induction of General Anesthesia. After induction patient was placed in lithotomy position, cystoscopy was done and the desired ureter was intubated with 0.035" (Terumo) guide wire. Ureteric Access Sheath (UAS) 9.5/11.5 and 10/12 Fr was inserted over the glide wire into the desired ureter under fluoroscopy guidance. The patients were not stented prior to RIRS. If there was difficulty in passing Access Sheath through Ureteric Orifice (UO) then we did sheathless RIRS with Flex X2s scope. In patients with narrow UO not allowing passage of flexible ureteroscope, planned procedure was terminated with placement of double J stent and RIRS was performed after one week. If the UO admits UAS, then RIRS was continued.

Flexible ureteroscopy was done using Flex-Xc, Flex X2s(Karl Storz) and URF V3(Olympus).Vision during ureteroscopy was maintained by normal saline irrigation under gravity and intermittent use of pressure by the assistant using the Pathfinder. Inspection of all the calyces to assess the location and number of stones together with retrograde pyelogram. If the lower pole anatomy were unfavorable for insitu fragmentation relocation of the stone into the favourable calyx was done using N- circle basket (Cook).Holmium laser (Lumenis, 120 watt) with 200 micron laser fibre used for lithotripsy.Initial dusting of the stone was done with HiFr-LoPE settings of (15-70 Hz: 0.2-0.5 J) and finally pop dusting done to complete the procedure. During the lithotripsy ventilator setting was adjusted by the anesthetist to respiratory rate of 6-8/min with low tidal volume to reduce renal movement during lasing. .At the end of the procedure RPG was done to rule out contrast extravasation as per the institution protocol. JJ stent was kept at the end of the procedure. Patients were discharged on the next day and were followed up in out- patient clinic with X-ray KUB and USG KUB, and in those with no residual stones in USG and X-ray KUB , JJ stent was removed. Those with no residual stone in USG and X-ray KUB were followed up with low dose CT KUB at 4 weeks of surgery patients were categorized as complete stone free, patients with CIRF <4mm and patients with

CIRF >4mm. Re-RIRS was planned for those with residual fragment.

Patient demographics, Stone volume, hounsfield unit, location of stone and stone free rate were assessed.

Statistical analysis

SPSS software package (versions 16.0, SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses. The results were expressed as the mean ± standard deviation and range. Stone free rate was compared using one-way analysis of variance (ANOVA) for continuous variables and the Chi - square test was used for categorical variables. A *P* value < 0.05 was considered statistically significant.

RESULTS

Forty two patients were included in the final analysis. Table 1 shows the pre-operative characteristics of those patients. The mean age was 41.44±13.95years. There were 27 males and 15 females. 22 patients had RIRS on right side and 20 on the left side. The mean stone volume and HU were 553.37±338.10 $mm^3$and 1063.5±378.07 respectively. 6(14.3%), 13(31%), 13(31%) and 10(23.8%) patients has calculus located in upper, middle, lower pole and pelvis respectively.

Table 1. Demographic characteristics

Variables	No.	Percentage (%)
No. of patients	42	
Age - Mean ± SD (years)	41.44±13.95	
Male/Female	27/15	64.3/35.7
Mean stone volume± SD(mm^3)	553.37±338.10	
Laterality: Right/ Left	22/20	52.4/47.6
Hounsfield unit± SD (HU)	1063.5±378.07	
Location		
Upper pole	6	14.3
Mid pole	13	31
Lower pole	13	31
pelvis	10	23.8

The SFR and residual stone rates in plain CT KUB according to pre-operative stone volume and Hounsfield unit are as shown in Tables 2 and 3. We achieved complete stone clearance in 18 patients (42.85%), whereas 16 patients (38.09%) had CIRF < 4mm and 8 patients (19.04%) had CIRF > 4mm. All 16 patients with CIRF < 4mm were managed with conservative medical management whereas among 8 patients with CIRF > 4mm, 2 patients required a relook RIRS procedure and others were managed conservatively. The mean residual stone size with CRIF > 4mm was 4.7 mm (4–6.5 mm range). Complete SFR was 59% and 35.7% with stone volume <500mm^3 and 500-1000mm^3(*P*<0.05) respectively. Similarly, complete SFR was 66.67% and 33.34% with Hounsfield unit <500 and >1500 (*P*<0.05) respectively.

Majority of the patients were discharged the next day. No bleeding or perinephric collection was noted. Fever was noted in 2 patients(4.76%) which was managed with intravenous antibiotics.

Table 2. Stone free rate according to stone volume in plain CT KUB

Stone volume (mm3)	Number of patients(%)	Number of patients with complete stone free rate(%)	Number of patients with CIRF<4mm	Number of patients with CIRF>4mm
<500	22(52.4)	13(59.09)	6(27.27)	3(13.6)
500-1000	14(33.3)	5(35.7)	7(50)	2(14.2)
>1000	6(14.3)	-	3(50)	3(50)

Table 3. Stone free rate according to hounsfield unit in plain CT KUB

Hounsfield unit	Number of patients(%)	Number of patients with complete stone free(%)	Number of patients with IRF <4mm	Number of patients with IRF >4mm
<500	3(7.1)	2(66.67)	1(33.34)	-
500-1000	18(42.9)	10(55.56)	5(27.78)	3(16.67)
1001-1500	18(42.9)	5(27.78)	9(50)	4(22.23)
>1500	3(7.1)	1(33.34)	1(33.34)	1(33.34)

DISCUSSION

Treatments such as extracorporeal shock wave lithotripsy (ESWL), ureteroscopic lithotripsy, retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL) are first-line interventional therapies for urolithiasis according to the European Association of Urology (EAU) guidelines.[7] The role of RIRS in treating renal calculi less than 2 cm is becoming more prominent with continuous technical improvements. Stone clearance has always been a matter of debate for RIRS as compared to PCNL. Majority of the studies used CIRF of < 4 mm size as a predictor of clearance.[3] Accurate detection and measurement of residual stone is essential for further guiding management decisions. A plausible explanation is that fine debris, undetectable by KUB radiography or USG , persists after RIRS and tends to settle in the most dependent calices, acting as nidi for formation of stones. It is for these reasons that small residual stones, although not considered of immediate clinical relevance, are likely to become bothersome for the patient in the long term. In our study complete stone clearance was defined as absence of stone in low dose CT KUB and those with residuals on CT were divided into those with , CIRF <4mm and CIRF >4 mm size.

Muniasamy et al performed a prospective observational study of RIRS in 47 patients and found overall success rate was 88.9% with X-ray KUB and USG on second and 6 weeks follow up.[8] Lim et al retrospectively reviewed 66 patients who underwent RIRS with postoperative follow-up on plain x-rays or CT scan on 1 month after surgery and defined Stone-free as no visible stones and CIRF <3 mm on postoperative imaging.[9] Regarding imaging follow up, their study was not homogeneous because they use plain X-rays or CT scan which have different sensitivity. We conducted a study with such group of patients who were 100% stone free on X-ray KUB and USG imagings. Complete stone clearance in Low dose CT KUB was only 42.8% at one month follow up.

Guohua Zeng et al conducted a multicentre, prospective, randomised, unblinded controlled study where Stone-free status was defined as no residual fragments of ≥ 3 mm on computed tomography at 3-months follow up with SFR 82.5%[10] where the results was similar to our study if we define CIRF <4 mm. Hyams et al. achieved 63% SFR when a stone-free state was defined as no residual stones or only CIRF <2mm. If the SFR was defined as no residual stone fragments of <4 mm, the SFR increased to 83%[11], which was similar to our study where we achieved complete stone clearance in 42.8% of patients at one month follow up. If we define stone-free as no visible stones or only CIRF <4 mm, the SFR was 80.95%. Parikh et al conducted a study evaluating SFR in RIRS in relation to stone burden, location and number with a 1 month follow up in CT KUB with overall SFR of 76%.[3] In contrast, Zilberman et al reported only a 19% SFR following the first attempt at RIRS, with 30% of patients still having small residual stones that did not require further intervention. Among their patients who had residual stones, most were located in the lower pole.[12] In our study also majority of the residual stones were located in the lower pole and were managed conservatively. Rabindra BS et al compared miniperc and RIRS for the management of renal stone <1.5 cm with regard to stone clearance rates and follow up with NCCT was not routinely in their study citing radiation hazards and economic implications.[13]

In our study, complete SFR was 59% and 35.7% with stone volume <500 and 500-1000 mm^3 (P<0.05) respectively. Similarly, complete SFR was 66.67% and 33.34% with HU<500 and >1500 (P< 0.05) respectively. We achieved complete stone clearance in 18 patients (42.85%), whereas 16 patients (38.09%) had CIRF < 4mm and 8 patients (19.04%) had CIRF > 4mm. Low dose CT KUB detected stones in 57.25% patients who were considered stone free based on X-ray and USG KUB findings. There is no consensus yet on the follow up imaging modalities regarding RIRS. We commonly use X-ray KUB and USG which showed low sensitivity regarding small residual stones. Regarding CT scan it's a matter of economic implications in a country like ours. So, follow up imaging should be addressed in the upcoming guidelines and is a burning issue regarding stone clearance in RIRS.

CONCLUSION

Low dose CT KUB is better than X-ray and USG KUB to detect residual fragments during follow up of patients with RIRS.

Abbrevations

RIRS - retrograde intrarenal surgery

CIRF - clinically insignificant renal stone

SD- standard deviation

CT KUB - computed tomography -kidney ureter bladder

FURS - flexible ureterorenoscope

SRF - stone free rate

SPSS- Statistical Package for the Social Sciences

Conflict of interests : There is no conflict of interest

Author's Contribution:Protocol development, Data collection and analysis, Manuscript writing and editing.

REFERENCES

1. Geraghty RM, Jones P, Somani BK (2017) Worldwide Trends of Urinary Stone Disease Treatment Over the Last Two Decades: A Systematic Review. J Endourol 31 (6):547-556. doi:10.1089/end.2016.0895

2. Ho CC, Hafidzul J, Praveen S, Goh EH, Bong JJ, Lee BC, Zulkifli MZ (2010) Retrograde intrarenal surgery for renal stones smaller than 2 cm. Singapore Med J 51 (6):512-515

3. Parikh KP, Jain RJ, Kandarp AP (2018) Is retrograde intrarenal surgery the game changer in the management of upper tract calculi? A single-center single-surgeon experience of 131 cases. Urol Ann 10 (1):29-34. doi:10.4103/ua.ua_118_17

4. Sheafor DH, Hertzberg BS, Freed KS, Carroll BA, Keogan MT, Paulson EK, DeLong DM, Nelson RC (2000) Nonenhanced helical CT and US in the emergency evaluation of patients with renal colic: prospective comparison. Radiology 217 (3):792-797. doi:10.1148/radiology.217.3.r00dc41792

5. Middleton WD, Dodds WJ, Lawson TL, Foley WD (1988) Renal calculi: sensitivity for detection with US. Radiology 167 (1):239-244. doi:10.1148/radiology.167.1.3279456

6. Niemann T, Kollmann T, Bongartz G (2008) Diagnostic performance of low-dose CT for the detection of urolithiasis: a meta-analysis. AJR Am J Roentgenol 191 (2):396-401. doi:10.2214/ajr.07.3414

7. Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, Knoll T (2016) EAU Guidelines on Interventional Treatment for Urolithiasis. Eur Urol 69 (3):475-482. doi:10.1016/j.eururo.2015.07.041

8. Muniasamy S PV, Krishnamoorthy S, Kumaresan N, Ramanan V (2017) Comparative Study of Stone Free Rate, Morbidity and Need for Retreatment Procedures between Various Surgical Modalities for 10-20 mm Upper Urinary Tract Calculi. Int J Sci Stud 4 (10):37-43. doi:10.17354/ijss/2017/08

9. Lim SH, Jeong BC, Seo SI, Jeon SS, Han DH (2010) Treatment outcomes of retrograde intrarenal surgery for renal stones and predictive factors of stone-free. Korean J Urol 51 (11):777-782. doi:10.4111/kju.2010.51.11.777

10. Zeng G, Zhang T, Agrawal M, He X, Zhang W, Xiao K, Li H, Li X, Xu C, Yang S, de la Rosette JJ, Fan J, Zhu W, Sarica K (2018) Super-mini percutaneous nephrolithotomy (SMP) vs retrograde intrarenal surgery for the treatment of 1-2 cm lower-pole renal calculi: an international multicentre randomised controlled trial. BJU Int 122 (6):1034-1040. doi:10.1111/bju.14427

11. Hyams ES, Munver R, Bird VG, Uberoi J, Shah O (2010) Flexible ureterorenoscopy and holmium laser lithotripsy for the management of renal stone burdens that measure 2 to 3 cm: a multi-institutional experience. J Endourol 24 (10):1583-1588. doi:10.1089/end.2009.0629

12. Zilberman DE, Mor Y, Duvdevani M, Ramon J, Winkler HZ (2007) Retrograde intra-renal surgery for stone extraction. Scand J Urol Nephrol 41 (3):204-207. doi:10.1080/00365590601016321

13. Sabnis RB, Ganesamoni R, Doshi A, Ganpule AP, Jagtap J, Desai MR (2013) Micropercutaneous nephrolithotomy (microperc) vs retrograde intrarenal surgery for the management of small renal calculi: a randomized controlled trial. BJU Int 112 (3):355-361. doi:10.1111/bju.12164