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Research Article

Prospective Comparison of Single Puncture Mini-Percutaneous Nephrolithotomy (MPNL) with Retrograde Intrarenal Surgery (RIRS) for Renal Stones 10-30mm in Size

Adittya Kumar Sharma[1,2*], Rahul Yadav[1,2], Karamveer Singh Sabharwal[1], Anant Kumar[1]

[1]Department of Urology and Renal Transplant, Max Superspeciality Hospital Saket, New Delhi, India

[2]Department of Urology and Renal Transplant, Rajiv Gandhi Superspeciality Hospital, Dilshad Garden Delhi, India

[*]**Corresponding author:** Adittya Kumar Sharma, Department of Urology and Renal Transplant, Rajiv Gandhi Superspeciality Hospital Tahirpur, Dilshad Garden, Delhi, India. Tel: +91-9015058345; Email: dradityaks@gmail.com

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Abstract

Objectives: Comparing single puncture Mini-Percutaneous Nephrolithotomy (MPNL) and Retrograde Intra-Renal Surgery (RIRS) in the management of renal stones with sizes 10-20mm and 20.1-30mm.

Methods: Hundred patients with renal stones(10-30mm) were given option of MPNL or RIRS (50 each). Cases requiring staged procedure after primary stenting or second puncture during MPNL were excluded. Total 87 patients (42 MPNL & 45 RIRS) qualified for the final analysis. Prospective evaluation of patient Demographics, stone characteristics, perioperative outcomes, and complications were compared between the two groups. Absence of any residual stone fragment >3mm in follow-up was considered stone free. Outcome of both procedures was further analyzed and compared based on stone size (Group A-10-20mm and Group B 20.1-30mm).

Results: No significant difference was observed in patient demographics, stone characteristics and over all stone free rates with MPNL-88.1% (Group-A: 94.4%/ Group-B: 83.3%) and RIRS-93.3% (Group-A: 95.2%/Group-B: 91.7%). In Group a Both procedures had equivalent operative time blood loss though RIRS better tolerated with lesser postoperative pain. In Group B; MPNL had shorter operative time with lesser pain and relatively more blood loss. Overall complication rate and need of auxiliary procedure was equivalent for both procedures.

Conclusions: Both MPNL& RIRS are safe and effective options for renal stones between 10-30mm.RIRS showed better patient tolerance in case for stones 10-20mm size due to less patient morbidity, shorter hospital stay. For larger stones (20.1-30mm) MPNL has shown better patient tolerance with shorter operative time and lesser postoperative pain though associate with comparatively more blood loss.

Keywords: Kidney Stone; Mini Percutaneous Nephrolithotomy (MPNL); Percutaneous Nephrolithotomy (PCNL); Retrograde Intrarenal Surgery (RIRS); Urolithiasis

Abbreviations

MPNL	:	Mini Percutaneous Nephrolithotomy
RIRS	:	Retrograde Intra-Renal Surgery
PCNL	:	Percutaneous Nephrolithotomy
PCN	:	Percutaneous Nephrostomy
DJ Stent	:	Double J Stent
Hb	:	Hemoglobin
Fr	:	French (measurement)
SWL	:	Shock Wave Lithotripsy
SFR	:	Stone Free Rate
VAS	:	Visual Analogue Scale
KUB	:	Kidney Ureter Bladder
USG	:	Ultrasonogram

Introduction

Renal calculous disease may be associated with various degrees of renal dysfunction secondary to a combination of obstruction, urinary infection, frequent surgical intervention, and coexisting medical disease. In many cases, renal dysfunction may be permanent or may further deteriorate even after stone removal. As per the recommendations [1], Percutaneous nephrolithotomy (PCNL) is preferred option for renal stones >2 cm. But conventional PCNL associated with risk of surgical morbidities like bleeding, pain, and urine leakage. With the advent of miniaturization of nephroscopes MPNL is gaining popularity with advantage of lesser Pain, blood loss, perforation and urine leak [2]. The European Association of Urology guidelines [1] recommend RIRS as the standard treatment option for small to medium-sized (≤2 cm) renal stones. As the expertise and durability of scopes is growing, surgeons are reporting promising results for larger (>2.5 cm) renal stones [3].

Both ESWL is effective option for stones upto 1.5 cm (upto 1cm inferior calyceal stone) with <1000HU density. PCNL is effective treatment option with moderate cost with increased risk of bleeding. MPNL is shown to reduce complications of standard PCNL. RIRS is minimally invasive modality with excellent stone clearance but generally most costly. Next generation urologist, still face difficulty in choosing one best option for stones between 10-30 mm size and especially in stones over 20mm due to increasing acceptance of RIRS even in bigger stones (i.e. > 20mm) across the world. As there is enormous literature evidence to support both the procedures. It is very important to know most suitable treatment option, as most patients in urban setup demand complete stone clearance in single sitting with minimal morbidity. Objective of this study to compare the efficacy of single puncture Mini-Percutaneous Nephrolithotomy (MPNL) and Retrograde Intrarenal Surgery (RIRS) in the management of renal stones of size 10-20 mm and 20.1-30 mm subgroups in a single sitting. Patients were compared in terms of Demography, pain score, additional analgesics requirement, postoperative complications and final stone clearance at the end of 3 months.

Methods

A total 100 adult patients with renal stones (10-30 mm) were given option of MPNL or RIRS (50 each) from February 2014 to May 2016. Each group further divided between two groups; 10-20 mm (A) and 20.1-30mm (B) (Figure 1).

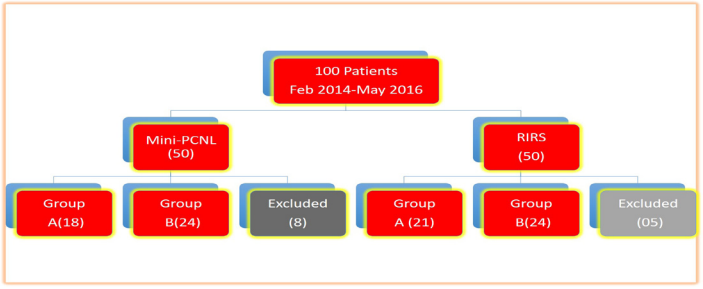

Figure 1: Study Design. (PCNL: Percutaneous Nephrolithotomy, RIRS: Retrograde Intrarenal Surgery).

Patient and stone characteristics, perioperative factors, complications and outcome is prospectively evaluated and compared between the two groups. Patients requiring staged RIRS after primary stenting due to tight ureter (in RIRS group) or second puncture (in MPNL group) were excluded. Patients requiring staged RIRS after primary stenting due to tight ureter (in RIRS group) or second puncture (in MPNL group) were excluded. Multistage RIRS increases cost of procedure hence were excluded. Need for multiple puncture during PNL is proven to increase postoperative pain and associated complications therefore such cases were excluded to give as level playing field for MPNL against RIRS which has single access point. Success was defined, as no residual fragment on postoperative plain computed tomography after 3 months. Procedure Costs were matched for both procedures to remove bias.

Operative Method- MPNL

Cystoscopy & Ureteric catheterization (6 Fr.) done and patient turned in prone position. Standard fluoroscopic guided puncture taken using 18 G disposable two-part needle (Cook Medical, Bloomington, IN, USA) with the Eye of Needle Technique (i.e.

Bulls eye technique) [4] Tract dilated over 0.035 hydrophilic guide wire and guide rod with Alken's sequential telescopic metal dilators up to 18 Fr. followed by 18 Fr. Amplatz sheath placement. A 15-Fr. Nephroscope/ Flexible Cystoscope (Richard Wolf, Knittlingen, Germany) used for stone access, visualization and mobilization. Stones fragmentation done with Holmium: YAG laser using a 550- µm SlimLine EZ 550 fiber (Lumenis Ltd. Yokneam Israel) at power 20-30W. Fragments were removed using a 4-Fr grasping forceps (Richard Wolf) 6-Fr double J stent (cook Medical) and 16 Fr. Foley catheter left indwelling.

Operative Method- RIRS Method

Patient position-Lithotomy. Cystoscopy done, and guide wire coiled in Pelvicalyceal system through 6Fr. ureteric catheter. Balloon dilatation of ureteric orifice followed by ureteric dilatation with sequential ureteric dilators up to 14Fr. Ureteral access sheath 12/14 Fr. (Cook Medical) inserted. For stone access and visualization, a 6.5 Fr. Digital chip-on-tip flexible Ureterorenoscope (KARL STORZ GmbH & Co. Tuttlingen Germany) used. Stones fragmentation done with Holmium: YAG laser using a 200-µm SlimLine EZ fiber (Lumenis Ltd. Yokneam Israel) at power ranging from 20-30W. Fragments were removed using a 3 Fr. Nitinol N-gage Basket (cook medical). 6-Fr double J stent and 16 Fr. Foley catheter left indwelling. All patients had preoperative sterile urine cultures and were given standard one dose of intravenous Ceftriaxone injection 30 minutes preoperatively and 12 hours postoperatively. All patients were given standard dose of 75mg Diclofenac injection postoperatively and repeated at bedtime. Further analgesic requirement was SOS.

Postoperatively after both procedures, all external tubes (Foley/ PCN) were removed next morning. Double-J Stent was removed after 1-2 weeks from discharge. Both procedures compared for following parameters

- Patients parameters: Age, sex, comorbidity, Body mass Index.
- Stone characteristics: Size, number, location, and Hounsfield units.
- Intraoperative parameters: Operative time, complications and drop in hemoglobin.
- Postoperative parameters: Pain score, additional analgesic requirement, hospital stay, need for auxiliary procedures.

Patients who did not display any residual fragment (≥4mm) on postoperative plain computed tomography after 3 months were considered "stone-free". Complications were graded according to Modified Clavier Classification system [5].

Statistical Analysis

Data were processed using the statistical software SPSS ver. 17.0 (IBM, Armonk, NY, USA). For continuous variables independent t-test or Mann- Whitney U-test were used. For categorical variables Chi-squared test or Fisher's exact test were used. $P<0.05$ was considered statistically significant.

Results

Total 87 patients (42 MPNL& 45 RIRS) qualified for final analysis. Eight patients in MPNL group were excluded due to need of 2nd puncture and 5 patients from RIRS group were excluded, as they required primary DJ stenting due to difficult ureteral access followed by staged RIRS. There was no statistical difference in patient or stone parameters in two groups with respect to Patient age, sex, comorbidity, stone size, stone number, location, HU value (Table 1, 2).

Variable	Group-A (39)		P	Group B (48)		P
	MPNL (18)	RIRS (21)	(A)	MPNL (24)	RIRS (24)	(B)
Mean Age years(±sd)	42.4(±9.5)	38.2(±7.8)	0.24	44(±9.9)	41.8(±10.5)	0.26
Diabetes	6	5	0.74	11	9	0.62
Hypertension	8	5	0.32	12	13	0.8

Table 1: Patient parameters.

Variable	Group-A (39)		P	Group B (48)		P
	MPNL (18)	RIRS (21)	(A)	MPNL (24)	RIRS (24)	(B)
Stone Size (mm) (±sd)	14.4(±0.18)	15.2(±0.15)	0.22	26.4(±0.25)	24.7(±0.22)	0.32
Number (mean)	1.3	1.1	0.35	1.8	2.1	0.15
Stone HU Location	1008.8	968.8	0.21	981.3	931.3	0.2
Pelvic	6	5	0.74	9	7	0.12
Upper calyx	5	9	0.75	3	8	0.52
Middle	3	5	0.99	5	3	0.77

Lower	4	2	0.75	5	5	0.76
Staghorn	0	0	----	2	1	0.85

Table 2: Stone Parameters.

Intraoperative parameters: Duration of surgery was equivalent for stones of subgroup A (10-20 mm) for MPNL and RIRS, while it was significantly more for RIRS in group B (>20 mm) compared to MPNL (Table 3).

Variable	Group-A (39)		P	Group B (48)		P
	MPNL (18)	RIRS (21)	A	MPNL (24)	RIRS (24)	B
Mean Operative time min. (±SD)	76.1(±4.8)	69.5 (±4.2)	0.22	99.6 (±5.5)	136.8 (±7.4)	0.03
Mean Drop in Hb.gm/dl (±SD)	0.69(±0.10)	0.38(±0.12)	0.10	0.98(±0.15)	0.55 (0.09)	0.04
Add. Analgesic req (No. of Pt.)	8	4	0.03	8	13	0.02
Stone free rate	94.40%	95.20%	0.62	83.3	92.30%	0.19

Table 3: Intra & Post-operative data.

There was no significant difference in hemoglobin drop in both procedures for stone < 20 mm while it was statistically significant after MPNL for >20 mm stones. Postoperative pain and analgesic requirement was lower for RIRS in-group A and higher in group-B and statistically significant. MPNL and RIRS had an overall stone free rate of 88.1% (A-94.4%/B-83.3%) and 93.3% (A-95.2% / B-91.7%) respectively.

Discussion

For renal stones <2 cm, European Association of Urology guidelines [1] recommend SWL (Shock wave lithotripsy) as the first-line treatment within the renal pelvis and upper or middle calices, but PCNL or RIRS for only lower pole because the efficacy of SWL is limited. Breda et al [3]. Reported in a systematic review the literature. RIRS for large (>2.5 cm) renal stones 441 patients (10 studies) mean stone size of 2.9 cm Average of 1.6 procedures SFR 89.9% Major complication 1.9% In a global multicenter study [6] on PCNL conducted at 96 centers with 5,803 patients. 1-month SFR was 75.7%and 14.5% complication rate. Modified Clavien grades I (11.1%), II (5.3%), IIIa (2.3%), IIIb (1.3%), IVa (0.3%), IVb (0.2%), and V (0.03%). Mishra et al [7]. reported that MPNL represents a similar efficacy and is superior in terms of safety profile compared with standard PCNL. From same center in another prospective comparative study, Sabnis et al [8] reported SFR (defined as no stone visible on X-ray KUB and ultrasonography) was 100% and 96.88% for MPNL and RIRS. Therefore, lesser invasive procedures- MPNL and RIRS have recently gained popularity as attractive treatment modalities for small to medium-sized renal stones. In this study, we compared MPNL and RIRS for renal stones 10mm-30mm in a single session. Since getting stone free with minimal interventions is the ultimate goal of patients and the operating surgeon so upper limit of 3 cms is deliberately set for standard PCNL as treatment of choice for stones >3cms at our center due to better visualization and stone clearance rates. Also, drawbacks of retrograde access like requirement of flexible scopes, small size of fragments retrieval, limited visualization and need for flexible baskets favor PCNL in stone burden greater than 3 cms [9].

Stone free rate in our comparative study of the treatment of medium or large renal stones; both MPNL and RIRS were feasible and effective modalities with acceptable SFR in single setting. For stones 10-20 mm (Group A) MPNL and RIRS had SFR of 94.4% and 95.2%, respectively. For stones 20.1-30 mm (Group B) MPNL and RIRS had SFR of 83.3% and 92.3%, respectively. In both groups SFR difference was statistically insignificant. (Table 3, Figure 2d) In the present study, for group A, we observed no significant difference in mean operation time for MPNL& RIRS (76.1 and 69.5 minutes; P=0.22). Operative time was significantly more for RIRS for group B with larger calculi. After stone fragmentation the time taken for stone pickup increased the total operative duration in case of RIRS. In our experience, stone burden seems to influence operation times. Mean stone size and number were greater in the MPNL group, but differences were not significant. In single puncture MPNL operative time didn't increase too much with the increase in stone size as compared to RIRS (Figure 2a).

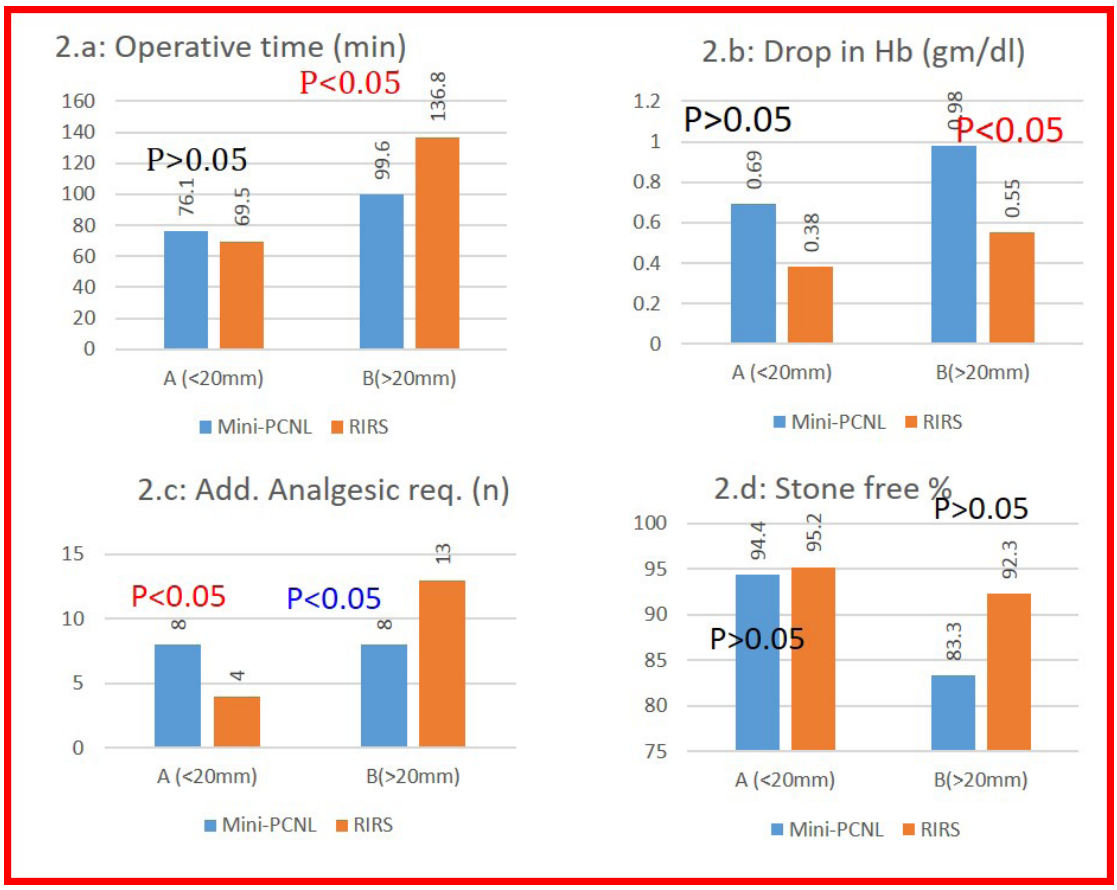

Figure 2: Important comparative outcomes; **2a**: Operative Time; **2b**: Drop in Hb (Hemoglobin); **2c**: Additional Analgesic Requirement; **2d**: Stone Free Rate.

Complications

Kumar et al [10] in a prospective, randomized study of SWL, RIRS, and MPNL for 1-2 cm radiolucent lower calyceal stones reported higher Clavien I to II complications for MPNL compared to SWL and RIRS (24.3%, 7.1%, and 9.3%, respectively). Blood transfusion (13.3%) occurred in only MPNL group. In another study [11] a higher complication rate for MPNL than for RIRS has been described, with a blood transfusion rate of MPNL group of 7.2%. In our experience, MPNL and RIRS were equally safe, as **c**omplication rates were statistically comparable for both procedures under both groups (Table 4).

Variable	Group-A (39)		Group B (48)		P
	MPNL (18)	RIRS (21)	MPNL (24)	RIRS (24)	
Auxiliary Procedure	1	1	4	2	
SWL	0	0	1	0	
Mini-PCNL	0	0	1	0	}>0.05
RIRS Complications	1	1	2	2	
Bleeding requiring Transfusion	0	0	1	0	
PCS injury	1	0	2	0	
Ureteric Injury	0	0	0	1	}>0.05

UTI	1	3	1	2	
Perinephric collection	0	0	0	1	

Table 4: Auxiliary procedures and Complications.

Grade 1 complication for MPNL patients was 9.5% (minor pelvic perforation- 3, Perinephric collection- 1) and 4.4% for RIRS (Minor ureteral perforation-1, Perinephric collection-1). Grade 2 complication for MPNL patients was 7% (Significant bleeding requiring transfusion-1, UTI-2 patients) and 6.7% for RIRS (UTI-3 patients) There was 2.38% (Clavien ≥III) complication in MPNL group in the form of bleeding requiring transfusion in one patient (group B), while no such complication was recorded in RIRS (Table 4). In our study, mean hemoglobin decline did not show significant differences between the MPNL and RIRS groups (0.69 and 0.38 g/dL, P=0.10) in Group A. MPNL showed significant Hb. Decline compared to RIRS in group B (0.98 and 0.55 g/dL, P=0.04) though it didn't require and specific intervention barring one case requiring transfusion (Figure 2b). There was significantly lower pain VAS at 4 hour and 24 hours postoperatively after RIRS in group-A compared to the MPNL. However, mean pain VAS in the RIRS group was significantly more than MPNL in group-B with larger stones (Figure 2c).

We believe postoperative pain was directly proportional to duration of surgical procedure and renal distension by irrigation fluid. In-group A (10-20mm), one patient after MPNL and one patient after RIRS showed large residual calculi (failure) and both these patients underwent RIRS for complete clearance in second sitting. Under Group B (20.1-30mm), 4 patients after MPNL and 2 Patients after RIRS showed residual calculi on follow-up. Out of 4 patients who failed after MPNL 1 each underwent ESWL and re-look MPNL and 2 patients underwent RIRS for complete stone clearance. Both failed cases after RIRS underwent repeat RIRS for complete clearance. (Table 4) Though practices of hospital admission differ globally, patients are routinely kept for a day or more after PCNL while RIRS patients were usually discharged after few hour of observation same day or at the maximum next day morning.

Reduction in hospital stay leads to decrease in work loss of patient and overall cost of treatment which many a times lead to more acceptance of RIRS procedure by the patients compared to PCNL. Due to these reasons acceptance of RIRS is growing across the world even with bigger stones of more than 2 to 2.5cms. Other factors like anatomic abnormalities, obesity, coagulopathies favor, RIRS compared to PCNL.

Our Study has Several Merits

like being a prospective case control study comparing RIRS with MPNL. Patient demographics were not statistically different even between subgroups and they were well matched according to stone size. Plain CT scan was used to confirm stone free rate which eliminates the false positivity and negativity of XRAY KUB or USG KUB or a combined study. Our study tried to fill the gap in the literature regarding treatment of stone according to the size, especially of range 20.1-30mm which is a many a times a difficult decision by an urologist.

Demerits

Operative procedure done by more than one surgeon leading to operator bias though the experience of each surgeon was well above the learning curve of both the procedure. Also, the study was not randomized leading to selection and observer's bias. Desirably larger patient groups will help in elaborating on statistical insignificance of several evident observations. MPNL and RIRS are safe and feasible surgical options to manage renal stones 10 mm-30 mm. RIRS should be preferred in case for stones 10-20mm size due to less patient morbidity, reduced hospital stay and overall less cost of treatment compared with MPNL. Since stone free rate is the main parameter while evaluating efficacy of surgical stone procedure, further head to head comparison of Minimally invasive Percutaneous procedures (i.e. Mini and Micro PCNL)with RIRS are required in an environment of larger, well conducted, randomized control trials to actually establish the role of both in stone size greater than 20mm.Till the time, evidence grew more stronger favoring one modality over the another in stone size of 20.1-30mm, both surgeries (RIRS/MPNL) should be offered after discussion of advantages and disadvantages of each to finally tailor the best treatment according to patient expectations.

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