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A COMPARATIVE STUDY BETWEEN MINI-PCNL AND RIRS FOR RENAL STONES MEASURING 1-2CMS.

Urology

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ABSTRACT

Introduction: Retrograde intrarenal surgery (RIRS) and mini percutaneous nephrolithotomy (Mini-PCNL) are viable options for the treatment of renal stones 1-2cm. Both the above surgeries have their own advantages and disadvantages. We aimed to evaluate them in an economically challenged setting. **Methods:** 44 patients who underwent Mini-PCNL (22) or RIRS (22) for renal stones 1-2cm were included in this study. Cases were statistically compared on various parameters like the duration of surgery, hemoglobin drop, hospital stay, stone free rate, pain score, fluoroscopy timing and complications. **Results:** Patient and stone parameters did not differ in both the procedures. The duration of surgery was lesser in the RIRS group. Fluoroscopy time and hemoglobin drop was lesser in RIRS group. Hospital stay was prolonged in Mini-PCNL group. Complications observed in both the groups were not of the serious type. **Conclusion:** Both Mini-PCNL and RIRS are equally effective option for renal stones of 1-2cms. Both Mini-PCNL and RIRS have high stone clearance rate with minimal complications. Given the fact that all parameters were very similar with regards to stone parameters and patient, choosing the option comes down to other factors like, surgeons' choice, patient preference, availability of infrastructure.

KEYWORDS

Mini-PCNL, RIRS, Renal stones, Operative parameters.

INTRODUCTION

There has been an attempt to reduce the perioperative morbidity of standard percutaneous nephrolithotomy (PCNL) through the introduction of miniaturized PCNL (Mini-PCNL) [1,2]. The belief is that if the diameter of the PCNL tract is small, the injury to the renal parenchyma will be less [3–5].

On the other hand, flexible ureterorenoscopy (fURS) has developed tremendously through the advancement of laser technology, the reduction of scope diameter with simultaneously offering working channels large enough to accommodate all necessary accessories, enhanced digitalized image quality, and enhanced mechanical capabilities such as deflection and durability. This has greatly expanded the use case of retrograde intrarenal surgery (RIRS) by means of fURS[6–8].

It is well established in international guidelines that most renal calculi >2 cm in largest dimension should be treated with PCNL and those with a diameter <1–2 cm with RIRS. But mini-PCNL constitutes a viable and effective minimally invasive treatment option for ever smaller stones, whereas the limits of RIRS are continuously pushed towards ever larger stones.

Both methods have their pros and cons, but also vary in costs.

METHODS

Study Design: During a period of 12 months, 44 cases who either underwent mPCNL or RIRS for a renal calculus less than 2cm in their largest diameter were included in our prospective study. They were informed about the treatment options, possible complications and the potential need for a staged or ancillary procedure to achieve stone clearance. All patients were operated by the same experienced urologist.

Inclusion Criteria

1. Renal calculus less than 2cm in the renal collecting system.

Exclusion Criteria

1. Abnormal renal anatomy.
2. Pregnant ladies.
3. Coagulopathies.
4. Malignancies.
5. Renal failure.

Pre-treatment Assessment:

All patients underwent a routine preoperative workup with urinalysis, urine culture, complete blood count, serum creatinine and coagulation profile. Preoperative imaging included USG-KUB, IVU, CT-KUB in all cases to assess the anatomy of the collecting system and determine the exact stone size and the location of the stone.

Data Collection

Patient demographic data was recorded which included age, gender, BMI, clinical history. Stone parameters included size of the stone, location, side. Complications were classified according to the Clavien classification system.

Procedure:

RIRS was performed in lithotomy position under general anesthesia. Initially a semi rigid URS with a 6.5Fr diameter (Karl Storz) was used to confirm that the ureter is free of any pathology or stones. A guidewire 0.035”x150cm was inserted into the pelvicalyceal system under fluoroscopic guidance. A ureteric access sheath was then inserted over it.

RIRS was performed using a flexible reusable URS. The stone was fragmented using a full dusting technique with a thulium laser fiber. After dusting a 6Fr x 26cm DJ stent was placed in the renal collecting system and patient was usually discharged on post operative day 2. Foleys catheter, either 14Fr or 16Fr was placed in the bladder and removed on first post operative day if urine was clear.

Mini-PCNL was performed in prone position under general anesthesia. A ureteral catheter 6Fr x 70cm was placed in the pelvicalyceal system. The tract was created using fluoroscopic guidance using a single step dilator. Amplatz sheath of 16Fr was used. A 14Fr nephroscope was used in all cases. At the end of the procedure the entire collecting system was visualized by direct endoscopy and fluoroscopy to confirm complete stone clearance. A 6Fr x 26cm DJ stent was placed in the renal collecting system and patient was usually discharged on post operative day 3. Foleys catheter, either 14Fr or 16Fr was placed in the bladder and removed on second post operative day if urine was clear.

Patient Follow Up:

Follow up imaging included USG or Xray KUB at 2 weeks' time. DJ stent was removed on POD-14 if complete stone clearance was documented. Otherwise, the patient was scheduled for an ancillary procedure.

Statistical Analysis:

Data were analyzed using the Chi-square test and Fisher's exact tests of association to compare proportions. The student's t-test was used to compare the means of two groups. A p-value of <0.05 was considered statistically significant.

RESULTS

The demographic and stone characteristics of two groups, Mini-PCNL and RIRS were compared in this study. RIRS had an average age of 49.13 years ± 10.27, while Mini-PCNL had an average age of 43.5 years ± 15.83, showing no significant difference (p=0.169). Gender distribution showed 12 males and 10 females in RIRS, compared to 14 males and 8 females in Mini-PCNL, with no significant difference observed. Body Mass Index (BMI) was slightly lower in RIRS (25.08 kg/m2 ± 4.52) compared to Mini-PCNL (26.05 kg/m2 ± 3.30), but this difference was not statistically significant (p=0.085). Lateral site distribution of stones showed no significant difference between the groups (p=1), with similar proportions of stones located on the right or left. However, the average stone size in RIRS group was 13.9mm ± 3.13, while Mini-PCNL had an average stone size of 15mm ± 3.18, showing no significant difference (p = 0.25). Overall, the study highlights that there is no difference in patient parameters and stone size between the two groups, with no potential implications for treatment strategies and outcomes.

Table 1 : Demographics and Stone Parameters

	RIRS	Mini-PCNL	P-value
Age(Years)	49.13 ± 10.27	43.5 ± 15.83	0.169
Gender			
Male	12	14	0.53
Female	10	8	
Literalities'			
Right	13	13	1
Left	9	9	
Stone size (mm)	13.9 ± 3.13	15 ± 3.18	0.25

Table 2 presents the surgical features comparison between RIRS and Mini-PCNL. RIRS had a shorter average operation time (64.09 minutes ± 17.97) compared to Mini-PCNL (82.27 minutes ± 19.92), with a statistically significant difference (p=0.002). Similarly, the fluoroscopy time was significantly longer in Mini-PCNL (126.5 seconds ± 39.65) compared to RIRS (13.82 seconds ± 4.8) (p<0.0001). Haemoglobin levels decreased post-operation in both groups, with a greater reduction observed in Mini-PCNL (0.76g/dL ± 0.79) compared to RIRS (0.31 g/dL ± 0.47) (p=0.02). Stone-free rates (SFR) was 96% in RIRS group compared to 100% in the Mini-PCNL group. Mini-PCNL had a higher visual analogy scale (VAS) pain score (5.72 ± 1.16) compared to RIRS (2.5 ± 1.16) (p=0.0001). Hospital stay was significantly longer in Mini-PCNL (48 ± 12 hours) compared to RIRS (36 ± 12 hours) (p<0.001). Overall, these findings underscore the differences in surgical outcomes and interventions between the two groups, potentially influencing post-operative recovery and patient satisfaction.

Table 2 : Perioperative Parameters

	RIRS	Mini-PCNL	P-value
Operation time (minutes)	64.09 ± 17.97	82.27 ± 19.92	0.002
Hemoglobin drop (g/dl)	0.31 ± 0.47	0.76 ± 0.79	0.02
Fluoroscopy time (Seconds)	13.82 ± 4.8	126.5 ± 39.65	<0.0001
VAS	2.5 ± 1.16	5.72 ± 1.16	0.0001
Hospital-stay (hours)	36 ± 12	48 ± 12	0.0019
Stone free rates	96%	100%	
Dosage (mGy)	2.55 ± 1.29	27.96 ± 4.41	<0.0001

Table 3 summarizes the complications encountered in both RIRS and Mini-PCNL. Overall, both groups had similar rates of complications, with fever being the common complication in RIRS and pelvic perforation being common in Mini-PCNL. This highlights the importance of monitoring and managing post-operative complications in patients undergoing surgical interventions for urolithiasis.

Table 3: Complication Grades

Complication Grades	RIRS	Mini-PCNL
I	3	1
II	0	0
IIIA	0	0
IIIB	1	2
IVA	0	0
IVB	0	0
V	0	0

DISCUSSION

The lower pole of the kidney has a steep risk of calculus formation rate and presents problems due to anatomical disadvantages as compared to other areas in the kidney. ESWL provides favourable stone-free rates (SFR) for lower pole calculus up to 1 cm. But, for calculus lesser than 2 cms, there are several uncertainties involved. These include the possibility of incomplete stone fragmentation and the threat of fragments not being removed from the calyx [9].

Presently, the most effective treatment options known for renal calculus greater than 2 cm are PCNL and/or mini-PCNL. For all types of renal calculus, including the lower pole, a SFR of 85% to 100% is possible. But, the procedure has the risk of blood loss, injury to adjacent organs, and damage to the renal parenchyma. Mini-PCNL has been invented to mitigate the problems of conventional PCNL [10].

The recent advances in flexible scopes has made it convenient to access the most challenging calyx of the lower pole using RIRS. This is due to the 270-degree bending capabilities, better picture quality, particularly for upper urinary tract calculus. Recent guidelines suggest that flexible ureterorenoscopy (fURS) is an option for upper urinary tract calculi that are lesser than 2 cms which do not respond to ESWL [9]. For this particular category of calculus, the SFR are higher when using this method compared to ESWL. The review of literature seem to prefer using RIRS for some patients with large calculus, either to solve the potential complications associated with PCNL procedures or due to the high risk that PCNL poses to the patient. High risk patients for mini-PCNL surgery, such as those with coagulopathies, morbid obesity, musculoskeletal system deformities, anterior calyx calculus that are difficult to access with Mini-PCNL, calculus that require multiple access, and calculus located in a solitary kidney or in the upper ureter it is better to consider RIRS instead of Mini-PCNL. It is important to consider body habitus, renal calyceal anatomy, cost and patient preference when deciding the treatment plan. [11,12].

Today, there has been a rise in urologists' interest for native tract surgery. To guide our urologist colleagues, we conducted this research to compare the surgical outcomes between Mini-PCNL and the current trend of RIRS for renal calculus measuring 1-2 cms. In comparison to Mini-PCNL, the effectiveness of the flexible URS for treating lower calyx calculus depends on anatomical parameters of the kidney [13]. Retrograde intrarenal surgery (RIRS) has been shown to achieve SFR ranging from 60% to 93% for lower calyx calculus in cases that meet the favourable criteria [14,15]. Mini- PCNL has been shown to achieve SFR ranging from 90% to 97% for lower calyx calculus [15]. The experience of the surgeon is pivotal in enhancing the success of both surgeries. When analysing multiple studies comparing routine percutaneous nephrolithotomy (PCNL) with retrograde intrarenal surgery (RIRS) for lower calyx calculi measuring 2 cm, [11,12,15-19] it was determined that PCNL outperformed RIRS in terms of hospital-stay, morbidity, haemoglobin drop, and use of fluoroscopy. RIRS was seen as a viable substitute for invasive PCNL in this specific population of patients with calculi. It is important to know that achieving satisfactory results with RIRS for lower pole calculi may need multiple sessions and the use of other modalities for calculus clearance[14,20].

In a retrospective study conducted by Li et al., mini-PCNL (16 F amplatz sheath, 10 F nephoscope) was compared with RIRS for the treatment of lower calyx calculi measuring 1.5-2.5 cms. The study showed that RIRS had advantages over Mini-PCNL in terms of shorter hospital-stay and cheaper cost [21]. The results indicated that the average duration of surgery and the overall SFR were similar for both procedures. They showed that RIRS could be a feasible alternative to mini-PCNL for lower pole calculi.

The meta-analysis conducted by Gao et al. showed that mini-percutaneous nephrolithotomy (mini-PCNL) had a better success rate than retrograde intrarenal surgery (RIRS) for treating lower calyx calculi, as measured by SFR [22]. But, RIRS was associated with shorter hospital-stays and lower drop in haemoglobin levels. The study showed that the SFR for short tract operations like ultramini- and micro-PCNL were similar to those of RIRS.

In prospective randomized study, Fayad, et al. conducted a comparison between tube-free mini-PCNL and RIRS for lower calyx calculi that were lesser than 2 cm [23]. The study showed that mini-PCNL had a longer hospital-stay, but lesser operative time than RIRS. Regarding SFR, mini-percutaneous nephrolithotomy (mini-PCNL) achieved a better success rate compared to retrograde intrarenal surgery (RIRS), with rates of 92.72% and 84.31% for mini-PCNL and RIRS, respectively. The study also showed a greater incidence of fever following RIRS.

Jiao, et al. showed that mini-PCNL was more efficient than RIRS for treating lower calyx calculi measuring 1-2 cm [24]. But, the patients who underwent mini-PCNL had a longer hospital-stay and a higher rate of hematoma formation. Both approaches yielded identical results in measuring postoperative pain and surgery time.

In a prospective and randomized controlled trial conducted by Lee et al., it was determined that both RIRS and mini-PCNL procedures were equally efficient in terms of stone-free rate (SFR), surgical duration, amount of haemoglobin drop, and duration of hospital-stay for renal calculi greater than 1 cm [25] .But, the RIRS group endured severe postoperative VAS scores and had more analgesic needs.

Wilheim, et al. conducted a study between ultramini-PCNL and RIRS for the treatment of calculi ranging in size from 10-35 mm [26]. Both the UM-PCNL and RIRS procedures showed similar success rates (92% vs. 96%) for medium and large renal calculi. But, RIRS had the advantage of lesser hospital-stays.

Gross et al. showed the effectiveness of RIRS (retrograde intrarenal surgery) for lower pole calculi when conducted by a skilled urologist[27]. They showed that this procedure had low rates of complications and was better than invasive percutaneous procedures in terms of morbidity.

De, et al. conducted a meta-analysis study and showed that RIRS was superior to minimally invasive PCNL in terms of SFR for calculi smaller than 2 cm [28]. According to their statement, RIRS had advantage of shorter hospital-stays compared to PCNL procedures. But, it was observed that RIRS had more complication rates and higher hemoglobin drop.

Jiang, et al. conducted a meta-analysis comparing RIRS with mini-PCNL, analysing 13 papers. They showed that the SFR for renal calculi was statistically greater with mini-PCNL [29].

Pelit, et al. conducted a retrospective study to assess the effectiveness of RIRS and mini-PCNL in treating renal calculus patients with an average calculus size of 2 cm [30]. The duration of surgery, fluoroscopy duration, and hospital-stay were longer for mini-PCNL compared to other procedures. But, when alternative methods were used, the final SFR were 90.6% and 91.1% for RIRS and mini- PCNL. In both approaches, no significant complications, as classified by the Clavien Dindo system, were encountered.

Ramon and his associates conducted a comparison between mini-PCNL and RIRS. Mini-PCNL showed higher haemoglobin drop levels [31], increased need for analgesics, and longer hospital-stays. On the other hand, RIRS required many sessions for treating big volume stones, longer duration for surgical procedures, and increased costs for hospital-stays. After a single session of mini-percutaneous nephrolithotomy (mini-PCNL), the success rate of 82.3% at the end of the first month climbed to 93.75% after three months with the addition of alternative treatments such as extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy (URS). Considering these principles, for cases that have favourable anatomical conditions and calculi of 1-2 cm, we believe that mini PCNL could serve as a feasible alternative to invasive RIRS procedures.

Our study revealed a complication rate of 18.8% in cases with RIRS, and a complication rate of 13.6% in cases with Mini-PCNL. Most issues associated with Mini-PCNL in the literature are classified as grade 1, with the maximum cases falling below grade 3. Reported frequencies of these issues range from 11.9% to 37.9%. In comparison with previous research, our Mini-PCNL group did not show any grade 4 or 5 problems, as reported in the literature [10,29].

For retrograde intrarenal surgery (RIRS), most complications have a severity level not greater than Clavien 3. Out of the complications associated with RIRS, 13.63% were classified as grade 1 complications, specifically urosepsis. Preoperative factors like the size of the calculus, the presence of postoperative residue, and comorbidities like diabetes mellitus and cardiovascular disease, contribute to higher rates of postoperative complications in both RIRS and Mini-percutaneous nephrolithotomy (PCNL) procedures. In Mini-PCNL, the pressure during the entire surgery remains below 20 mmHg, whereas in RIRS procedures, it can exceed 40 mmHg. Increased intrarenal pressure during surgery can lead to a greater risk of urosepsis following RIRS. Following mini- percutaneous nephrolithotomy (mini-PCNL), there was a higher drop in haemoglobin levels and a need for blood transfusion compared to retrograde intrarenal surgery (RIRS). Mini-PCNL results in a more significant drop in haemoglobin levels compared to RIRS. According to reports, the rates of blood transfusion and embolization requirement with mini-PCNL range from 0.85% to 3% [20, 29]. Among our patients, there was no need for blood transfusion.

In their meta-analysis, Jiang et al. showed that the complication rate for RIRS was lower than that of mini-PCNL. They observed equal rates of Clavien grade 1 and 3 complications between the two procedures, but RIRS had lesser grade 2 issues compared to mini-PCNL. The incidence of bleeding was shown to be greater with mini- percutaneous nephrolithotomy (mini-PCNL) [29].

In a meta-analysis conducted by Jones, it was discovered that there was a complication rate of 15.2% following mini-PCNL. Based on the Clavien classification, they documented that 44% of the cases had Grade 1 problems, 28% had Grade 2 complications, and another 28% had Grade 3 complications. None of the cases showed Clavien grade 4 or 5 problems [10]. Fluoroscopy is employed throughout all stages of percutaneous nephrolithotomy (PCNL) to guide the insertion of the nephoscope into the renal collecting system and provide visual imaging of the calculus. But, it poses an implicit health hazard for the clinician, patient, and surgical staff involved in the procedure. Both our research and review of literature have found that mini-PCNL is less favourable compared to RIRS in this aspect [29].

Presently, there are authors who can achieve the same results of surgical success without using fluoroscopy. Using ultrasonography as the first step for making the tract for Mini-PCNL can marginally reduce the amount of exposure to fluoroscopy. Our study focused on the evaluation of Visual Analog Scale (VAS) scores within the first 12 hours after surgery. Our findings indicate that Retrograde Intrarenal Surgery (RIRS) demonstrated a statistically significant benefit over Mini Percutaneous Nephrolithotomy (Mini-PCNL), aligning with most of the previous research. Pain is a condition that prolongs hospital stay and necessitates the administration of narcotic analgesics and anti-inflammatories. The use of a nephrostomy tube, urethral with ureteral catheter, and invasive entrance into the muscle group in the flank area and the renal capsule-parenchyma causes a greater sensation of pain during Mini-PCNL in comparison to RIRS. Alongside the pain score, the RIRS group showed lesser analgesic usage compared to mPCNL patients, both in terms of the range of drugs used and the duration of usage. Although RIRS shows benefits in terms of perioperative pain, it is important to note the lower urinary tract issues due to DJ stent after being discharged. Most patients have lower urinary tract system issues, and a few of them opt to have the stent removed at the earliest.

Hospital-stay for Mini-PCNL was exponentially prolonged in the study.

A meta-analysis conducted by Kang showed that RIRS (retrograde intrarenal surgery) was associated with a lesser hospital-stay compared to other treatments. The mean difference in stay was 2.21 days, with a 95% confidence interval of 0.49 to 3.93 days (P=0.12) [19]. Due to the fact that RIRS is performed through the natural path, each step of the surgery is carried out with visual guidance and has a reduced risk of complications. As a result, it is projected that the period of hospital stay for RIRS will be shorter than that for PCNL.

The primary constraint of our study is the comparatively small sample sizes in both groups. One major limitation of RIRS is the extravagant expenses associated with flexible URS, equipment, and laser lithotripsy, particularly in a developing nation like India.

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