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IS MINI-PCNL AN ALTERNATIVE TO RIRS (HOLMIUM LASER) IN SMALLER HOSPITALS FOR RENAL STONES <2CM?

Urology

Nabajeet Das Assistant professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India.

Alum Kaman* Professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India. *Corresponding Author

Sasanka Kumar Barua Professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India.

Pushkal Kumar Bagchi Professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India.

Mandeep Phukan Associate professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India.

Debanga Sarma Associate professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India.

Hiranya Deka Professor, Department of Urology and renal transplantation, Gauhati medical college, Guwahati, Assam, India.

ABSTRACT

Background: Recent technological advancements have significantly influenced the management of kidney stones, with the development of minimally invasive techniques like percutaneous nephrolithotomy (PCNL) and retrograde intrarenal surgery (RIRS). The management of renal calculi measuring 1–2 cm shows comparable safety and efficacy between two techniques: RIRS and mPCNL. The aim of the present study was to compare the efficacy and safety of mini-PCNL and RIRS in the treatment of nephrolithiasis. **Methods:** A 12-month single-center, prospective, and observational study was conducted at GMCH including 200 patients divided into RIRS (n=100) and mPCNL (n=100) groups. Demographic details, stone parameters, pre-surgical procedures, and surgical outcomes were recorded. A $p < 0.05$ was considered to be significant. **Results:** A total of 200 patients were included in this study. The mean age for RIRS was 48.3 years and for mPCNL was 51.22 years. Stone-free rates were comparable, except for the lower calyx, where mPCNL showed higher efficacy (97.0% vs. 80.0%, p=0.02). The drop in mean hemoglobin (Hb) was more pronounced in MPCNL (0.7 g/dl vs. 0.1 g/dl, p= 0.001). Regarding the duration of hospital stay, RIRS demonstrated superiority with a shorter duration (1.17 days vs. 1.7 days). **Conclusion:** The mPCNL was more effective for lower calyceal stones, while RIRS showed advantages in lesser hemoglobin drop and shorter hospital stays. Considering cost implications, mPCNL could be a viable option, particularly in a peripheral setup. Both techniques offer viable options for treating renal stones of 1–2 cm, aiding clinicians in informed treatment decisions.

KEYWORDS

comparative analysis, nephrolithiasis, miniaturized percutaneous nephrolithotomy, retrograde intrarenal surgery

INTRODUCTION

The incidence of nephrolithiasis in India mirrors global trends, with a prevalence of around 12%, notably higher in the northern regions of the country, reaching 15%.[1,2] Recent technological advancements have significantly influenced the management of kidney stones, particularly with the development of minimally invasive techniques like extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS).[3]

The utilization of ESWL for renal calculi measuring 1–2 cm has consistently decreased over time, while there has been a simultaneous rise in the adoption of PCNL and RIRS due to their superior clearance rates.[4-6] The Central European Journal of Urology (2016) advocates for RIRS as the primary treatment choice for lower pole stones measuring < 20 mm and a secondary treatment for stones exceeding 20 mm, while PCNL is recommended for stones > 15 mm.[7] The PCNL is a well-established and safe method for treating renal calculi, providing shorter operation durations and superior rates of achieving a stone-free status compared to alternative therapies. However, concerns about higher perceived relative morbidity, particularly with regard to potential bleeding and damage to surrounding organs, limit the widespread adoption of PCNL.[8] In addition to this, the morbidities related to PCNL are linked to the size of the access tract. The introduction of mini PCNL became feasible with technological advancements, enabling the use of instruments for a tract size < 20 Fr to remove renal stones. This approach provides a comparable stone-free rate to traditional PCNL while potentially reducing associated morbidities.[9,10] The diminished success rate of ESWL and the elevated morbidity associated with PCNL for lower calyx stones prompted researchers to explore alternative approaches. The RIRS emerges as a viable alternative to both PCNL and ESWL for lower volume lower calyx stones, as it demonstrates a lower complication rate compared to PCNL while maintaining a stone-free rate similar to that of ESWL.[11]

The management of renal calculi measuring 1–2 cm shows comparable safety and efficacy between two techniques: RIRS and mPCNL, with similar durations of hospital stay. Both RIRS and mPCNL are considered viable choices for treating renal calculi in this size range. While each method has its advantages and disadvantages, it's important to note that they also differ in terms of associated costs.[12] The question of whether RIRS is superior to PCNL for managing renal stones is a matter of controversy. Given this uncertainty, the current study was undertaken to assess and compare the efficacy and safety of mini-PCNL and RIRS in the treatment of nephrolithiasis.

MATERIAL AND METHODS

This was a single-center, prospective, and observational study conducted at GMCH, over a 12-month period, from 15th October 2022 to 31st October 2023, involving patients with 1–2 cm renal calculi. The patients were divided into two groups; Group one included 100 patients scheduled to undergo RIRS, and the other group of 100 patients for mPCNL. The study design and methodology received approval from the institutional ethics committee and review board. Written informed consent was obtained from all patients prior to their participation in the study.

The patient in age group of > 18 years, either sex, with renal stones between 1-2cm were included in this study. Patient with abnormal renal anatomy, pregnant women, and pediatric patients (< 18 years) were excluded from study.

The demographic details of the patients including age, sex, and stone parameters were recorded. The stone parameters included stone size (mm), number, and location. The stone size was defined as the maximum diameter of the single stone.

All the patients underwent routine pre-surgical procedures like

complete blood count, urine analysis, and urine culture. Pre-surgical imaging included ultrasound kidney-ureter-bladder (US KUB) and non-contrast CT scan to assess the exact size and location of the renal stone. A prophylactic antibiotic was prescribed before the initiation of the procedure.

RIRS

The surgical site was sterilized by applying 10% povidone iodine solution and then covered with sterile drapes. A standardized RIRS procedure was performed in patients. All stages of the procedure were performed in the lithotomy position, with fluoroscopic guidance. The process included initial rigid ureteroscopy followed by flexible ureterorenoscopy. In our approach, a URF P7R, 7.95 Fr flexible ureteroscope with a 200um or 272um laser fiber was utilized. At the end of the procedure, the entire pelvicalyceal system was visualized for any residual stone fragments. After lithotripsy, a 6 Fr/26 cm DJ stent was placed in all the patients. The Foley catheter was removed on postoperative day 1 or 2.

mPCNL

Patients were positioned in lithotomy posture. A 30° cystoscope was used for cystoscopy. A 0.032" guidewire was passed through the ureter into the desired location within the urinary system. Following this, a 6 Fr/70 cm ureteric catheter was guided into the renal pelvis, and Foley catheterization was carried out. In the prone position, a puncture, in a suitable calyx, was performed using an 18-gauge PCN needle. Subsequently, a flexible 0.035-inch glidewire was directed into the renal collecting system, preferably through the ureter. After removing the access needle, an incision was made through the skin and fascia. Nephroscopy was conducted utilizing a miniature nephroscope. Sheaths of 15 Fr, 16.5 Fr, and 20 Fr, respectively reusable in their sizes, were employed. The renal stone underwent fragmentation using a holmium: YAG laser with either a 550 um laser fiber, (Quanta 35 W Litho Holmium laser). Grasping forceps were used to remove stone fragments. In all cases, a 5 Fr/26 cm DJ stent was inserted. Removal of the Foley catheter and PCN typically occurred on postoperative day 1 or 2.

The endpoint of the present study was to compare the intra and post-operative outcomes between mPCNL and RIRS.

Statistical Analysis

SPSS version 22 was used for statistical analysis. Descriptive analysis was used to present the study outcomes. Continuous variables were described as mean and standard deviation (SD), whereas categorical variables were described as numbers and percentages. P< 0.05 was considered statistically significant.

RESULTS:

A total of 200 patients were included in this study. The proportion of male population was higher than the female population in both the groups; mPCNL (61.0 % vs. 39.0 %) and RIRS (57.0 % vs. 43.0 %). The mean age of the patients undergoing mPCNL (51.2 years) was higher than RIRS (48.3 years). The mean stone size was comparable between both the groups; RIRS (14.1 mm), and mPCNL (14.5 mm). The mean stone density was higher in RIRS group (1026 HU) compared to mPCNL group (1007 IU). In mPCNL group, 63.0% of patients had single stone whereas, 37.0% had multiple stones. In RIRS group, 60.0% of patients had single stone whereas, 40.0% of patients had multiple stones. Hydronephrosis was present in 56.0% of patients undergoing mPCNL while in 52.0 % of patients undergoing RIRS. Upon considering the location of the renal stones, the majority of renal stones were located in lower calyx (31.0 %) in mPCNL group, whereas in RIRS group, the majority of the stones were located within multiple calyces (22.0 %). These observations are summarized in Table 1.

Table -1 Baseline Characteristics

Parameter	mPCNL (n=100)	RIRS (n=100)
Age (years), mean (SD)	51.2	48.3
Sex		
Male	61 (61.0)	57 (57.0)
Female	39 (39.0)	43 (43.0)
Mean stone size (mm), mean (SD)	14.5 (2.8)	14.1 (2.7)
Stone density (HU), mean (SD)	1007 (204.0)	1026 (204.0)
Number of stones		
Single	63 (63.0)	60 (60.0)
Multiple stones	37 (37.0)	40 (40.0)
Location of stones		
Upper calyx	8 (8.0)	10 (10.0)
Mid calyx	23 (23.0)	18 (18.0)
Lower calyx	31 (31.0)	20 (20.0)
Multiple calyces	11 (11.0)	22 (22.0)
Pelvis	27 (27.0)	30 (30.0)
Hydronephrosis		
Mild	30 (30.0)	26 (26.0)
Moderate	21 (21.0)	24 (24.0)
Severe	5 (5.0)	2 (2.0)

Data given as n (%), unless otherwise specified.
mPCNL, miniaturized percutaneous nephrolithotomy; RIRS, retrograde intrarenal surgery.

The operative time was higher in patients with RIRS (47.2 min) than mPCNL (44.8 min). The stone-free rate was comparable in all locations, except in the lower calyx, where mPCNL demonstrated a higher efficacy compared to RIRS (97.0 % vs. 80.0 %, p=0.02). The drop in mean hemoglobin (Hb) levels was more pronounced in mPCNL group compared to RIRS group (0.7 g/dl vs. 0.1 g/dl, p= 0.001). The mean duration of the hospital stays was significantly higher in patients who underwent mPCNL (1.70 days) than RIRS (1.1 days) group, p= 0.029. these observations are summarized in Table 2.

Table – 2 Baseline Characteristics

Parameter	mPCNL (n=100)	RIRS (n=100)	
Time taken (in minutes)	44.8	47.2	>0.05
Stone free rate (%)			
Upper calyx	88	90	0.600
Middle calyx	92	90	0.070
Lower calyx	97	80	0.020
Pelvis	92	96	0.120
Multiple calyces	87	94	0.280
Hb drop (g/dl)	0.7	0.1	0.001
Hospital stays duration (days)	1.7	1.1	0.029

Data given as mean (SD), unless otherwise specified.
Hb, hemoglobin; mPCNL, miniaturized percutaneous nephrolithotomy; RIRS, retrograde intrarenal surgery.

Incidences of fever (12.0 % vs. 14.0 %), urinary tract infections (3.0 % vs. 5.0 %), and sepsis (0 vs. 1.0 %) were more common in RIRS group than mPCNL group; however, these differences were statistically insignificant. Similarly, occurrences of urine leak (2.0 % vs. 0) and steinstrasse (0 vs. 2.0 %) were more prevalent in the mPCNL group than RIRS group, but these differences were statistically insignificant. These observations are summarized in Figure 1.

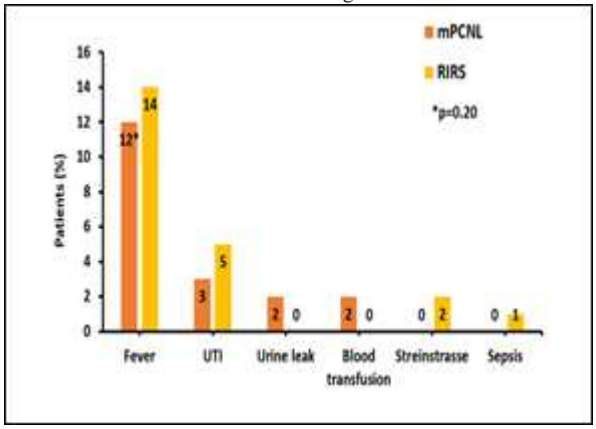

Figure 1: Comparative Analysis Of Complications Between Both The Groups

mPCNL, miniaturized percutaneous nephrolithotomy; RIRS, retrograde intrarenal surgery; UTI, urinary tract infections.

DISCUSSION

Multiple studies have indicated that both RIRS and mPCNL can serve as effective alternative options for the treatment of nephrolithiasis ranging from 2-3 cm, particularly in patients with concurrent comorbidities.[11,13] The adoption of mPCNL has emerged as a recognized method to decrease perioperative morbidity associated with standard PCNL.[8,14,15] However, advancements in flexible

Ureterorenoscopy (URS) technology have broadened the scope of indications for RIRS, demonstrating a favorable risk profile in comparison to PCNL. Therefore, mPCNL and RIRS are now competing for the same mid-sized stones.[16-18]

In this study, it was observed that both RIRS and mPCNL exhibited substantial similarities across all assessed parameters. mPCNL proved to be a preferable choice for lower calyceal stones, while RIRS demonstrated advantages such as a lower drop in hemoglobin levels (mPCNL: 0.7 vs. RIRS: 0.1) and a shorter hospital stay (mPCNL: 1.7 vs. RIRS: 1.17). Additionally, considering its cost-effectiveness, mPCNL could be a viable option, particularly in a peripheral healthcare setting.

A study conducted by Sebaey et al. indicated that both techniques have relatively similar stone-free rates.[13] However, in the present study, it was observed that mPCNL exhibited significantly higher stone free rate in lower calyx compared to RIRS (97.0% Vs. 80.0%, p=0.02). Similar observations were recorded in multiple studies which have showed that although PCNL has a high stone-free rate, it has significant complications despite technological advancements.[19-21]

A study by Karakoc et al. observed that when compared with the RIRS group, the hospital stay was longer in the PCNL group (4.5 days vs. 1.56 days) days in the PCNL group.11 This was similar to the multiple study results, where the hospital stay was significantly shorter in the RIRS group compared with the PCNL group ($p<0.001$).[11,18] This trend was also observed in this present study where the duration of the hospital stay was significantly higher in mPCNL group when compared to RIRS group (1.7 vs. 1.1, p=0.029).

The existing evidence suggests that mPCNL is as effective and safe as standard PCNL for the extraction of renal calculi, with a minimal risk of significant complications (Clavien grade ≥2).[22] One such significant complication of PCNL and RIRS is sepsis; a life-threatening postoperative complication.[23] A study by Michel et al. observed that complications occurring during or following PNL may manifest, with an overall complication rate reaching up to 83%. These complications include extravasation (7.2%), transfusion (11.2–17.5%), and fever (21.0–32.1%). Major complications, such as septicemia (0.3–4.7%) and injuries to the colon (0.2–0.8%) or pleura (0.0–3.1%), are rare occurrences.[24] A study by Gill et al. observed that the blood transfusion rate was 8.3% in the PCNL group compared to 1.6% in the RIRS group. Post-operative fever was higher in the RIRS group (13.1% vs. 5.0%). In comparison to PCNL, RIRS demonstrated acceptable efficacy with a lower risk of bleeding necessitating transfusion.[25] This was consistent with the observations recorded in this present study where the incidence of fever was higher in RIRS group when compared to mPCNL group (14 vs. 12), and blood transfusion was required only in mPCNL group.

It can be inferred that the decision between the two procedures depends on factors such as resource availability, infrastructure, and the preferences of both the surgeon and the patient. The surgeon's preference may be influenced by various factors, with expertise in a particular technique being a crucial consideration. Furthermore, patients should be informed and consented for all available treatment options. Consequently, factors such as the expenses associated with disposables play a significant role in decision-making.[12]

Limitations

The study involved 200 patients diagnosed with renal stones between 1-2 cm, all from a single institution (GMCH). The relatively small sample size and the exclusive focus on a specific healthcare facility may limit the generalizability of the findings to a broader population. Conducting the study at a single institution (GMCH) may introduce institutional biases, and the results might not be fully reflective of variations in surgical practices and patient demographics across different healthcare settings. In addition to this, the study had a duration of only one year. A longer follow-up period could provide a more comprehensive understanding of the outcomes over time, including potential long-term complications or recurrence rates associated with the different surgical methods.

Future Directions

Conducting larger-scale, multicentric prospective randomized trials with longer follow-up durations could help to provide insights into the durability of outcomes over time, including the recurrence rates and potential late complications associated with both RIRS and mPCNL. A more in-depth economic analysis comparing the costs associated with RIRS and mPCNL, including both direct and indirect costs, could contribute to a comprehensive understanding of the economic implications of choosing one procedure over the other. By addressing these future directions, researchers can further refine and expand the knowledge base in nephrolithiasis management, ultimately improving patient outcomes and guiding clinicians in making informed treatment decisions.

CONCLUSIONS

In this study, the comparative analysis between mPCNL and RIRS revealed that mPCNL proved more effective for lower calyceal stones, whereas RIRS exhibited advantages in terms of lesser hemoglobin drop and shorter hospital stays. Considering cost implications, the choice between these techniques becomes pivotal. mPCNL was more cost effective and could be considered in a peripheral setup. Both RIRS and mPCNL offer viable options for treating renal stones of 1–2 cm. Understanding their distinctions in efficacy, safety, and economic implications will assist clinicians in making informed decisions to optimize patient outcomes.

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