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Outcome of retrograde intrarenal surgery and percutaneous nephrolithotomy in a tertiary care teaching hospital

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Abstract

Introduction: The PCNL and RIRS are widely used procedures for the treatment of upper urinary tract stones.

Method: This retrospective study was carried out in the Department of Urology, Rapti Academy of Health Sciences, Dang, Nepal. Ethical approval was obtained. Patient charts were reviewed for from 01 Aug 2023 to 30 Jul 2024 Microsoft Excel and IBM SPSS were utilized for the parameters such as age sex, stone, and tract size, duration of surgery, and postoperative outcomes (stone clearance rate, length of hospital stay, haemoglobin loss, blood transfusion rate, fever and any additional endoscopic, radiological, or surgical procedures), using descriptive statistics (numbers and frequencies), and their relationships were assessed using the Chi-squire / Fisher's extract test. A p-value of ≤0.05 was considered statistically significant.

Result: In the present study, the renal stones were most common in the 30–39-year age. There was a predominance of female sex, and right-sided location of stone. The majority of patients in both groups had stones smaller than 20 mm. RIRS with TFL had a shorter hospital stay (p=0.00001), lower haemoglobin loss (p=0.000016). The stone-free rate (SFR) was 28/31 (90.32%) in the RIRS with TFL group and 35/41 (85.36%) in the PCNL with PL group (p=0.07).

Conclusion: The PCNL with PL and RIRS with TFL had similar operative times and were equally effective in achieving stone clearance for upper urinary tract stones up to 3 cm in size. However, PCNL with PL was associated with greater haemoglobin loss and longer hospital stays.

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Introduction

Urolithiasis prevalence is increasing globally due to dietary factors, climate change, and advanced diagnostic modalities such as computer tomography (CT) and ultrasonography (USG).[1] Endoscopic advancements, and energy sources like Holmium: Yttrium-Aluminium-Garnet (Ho:YAG) and Thulium Fibre Laser (TFL)s, have revolutionized urinary tract lithotripsy.[2] While these lasers are common in developed countries, the traditional energy source, pneumatic lithotripsy (PL), remains prevalent in resource-limited settings due to factors like cost and availability.[3, 4] TFL is safe and offers several advantages, including higher efficiency, faster ablation speed, less retropulsion, and shorter operating time.[5] Percutaneous nephrolithotomy (PCNL) generally has a higher stone-free rate but also carries a greater risk of complications compared to retrograde intrarenal surgery (RIRS).[6]

RIRS and PCNL are primary treatment options for upper tract stones. The 2024 EAU Guidelines on Urolithiasis advocate RIRS for kidney stones smaller than 2 cm and PCNL for larger ones.[7] However, other factors related to the patient and the doctor often influence the chosen treatment.[8] With the advent of newer-generation flexible ureterorenoscopes, newer laser lithotriptors, this trend is also being exploited in stones larger than 2 cm and competing with PCNL.[9,10] The success and complications of both procedures can vary based on stone size, location and the energy source used.

Limited data comparing RIRS and PCNL are available in literature. This study aims to evaluate stone-free rate, operative time, blood loss, transfusion needs, and hospital stay in Nepalese patients undergoing PCNL with PL and RIRS with TFL in Rapti Academy of Health Sciences, Dang, Nepal.

Method

After receiving ethical approval from the RAHS, Internal Review Board (Ref. No. 376: September 8, 2024; Research ID: 013-2024), this retrospective study was carried out in the Department of Urology, Rapti Academy of Health Sciences, Dang, Nepal. Patient file records who had undergone mini PCNL (M-PCNL) and RIRS during 01 Aug 2023 to 30 Jul 2024 were collected from hospital record section were reviewed. The hospital started M-PCNL with PL on 22 Aug 2023 (Bhadra 5, 2080 BS) and RIRS using TFL (thulium fibre laser lithotripsy) in March of the same year.

Data of patients with upper urinary tract calculi up to 3 cm who underwent M-PCNL or RIRS were analysed, except those with 1) >30 mm and multiple stones; 2) Single kidney, abnormal kidney, or prior renal procedures; 3) Chronic renal failure, pregnancy, and urinary tract cancer.

The mini percutaneous nephrolithotomy (M-PCNL) group had a tract size of 16 to 20 Fr, and retrograde intra-renal surgery (RIRS-TFL) group had a flexible digital uretero-renoscope using an energy source as Thulium Fibre Laser 200 micro mm with variable frequency 10-30 Hz and energy from 400 -1200 Joules to manage stones. Stone clearance was defined as no identifiable stone or residual fragments of <4mm on plain abdominal X-ray of kidney, ureter and bladder (KUB) after 2-4 weeks after DJ removal. Operation time for PCNL was defined as time taken from the puncture of PCNL to the placement of DJ stent. Operation time for RIRS was defined as time taken from the ureteral access sheath (UAS) placement to completion of the placement of DJ stent. The post-operative fever was defined as axillary temperature >100.4°F recorded twice or more using a digital thermometer.

According to hospital protocol, patients with a negative pre-operative urine culture received a single prophylactic dose of 1-gram intravenous ceftriaxone. The RIRS was performed under either general or spinal anaesthesia. A 7.5 Fr semi-rigid ureteroscope (Olympus) was initially used to examine the ureter and stone. A ureteral access sheath was used selectively. The procedure was carried out using a 7.0–8.5 Fr flexible ureteroscope (Seesheen, China). Stone fragmentation was done using a dusting technique (0.4–1.2 J / 15–30 Hz) with a 60-watt thulium fibre laser (Quanta, Italy). At the end of the procedure, the entire pelvicalyceal system was inspected to confirm that no residual fragments larger than the laser fibre remained.

A 6 Fr, 26 cm double-J stent was placed in all cases. Patients were discharged on the first postoperative day if they were afebrile, had no significant haematuria, and had a normal leukocyte count (<11,000/mm^3).

The PCNL was performed with the patient in either the supine or prone position. A pneumatic lithotripter and a Niddhi (India) irrigation pump were used. Under fluoroscopic guidance, the tract was created using an Amplatz sheath with a dilator size of 16–20 Fr. A 10.5 Fr nephroscope (Olympus, Germany) was used in all cases. At the end of the procedure, the entire collecting system was examined via direct endoscopy and fluoroscopy to ensure complete stone clearance. A 6 Fr, 26 cm double-J stent and a 14 or 16 Fr urinary bladder catheter were placed in all cases. The catheter was removed on the first postoperative day if there was no haematuria.

As per hospital protocol, patients who underwent RIRS with TFL were discharged on the first postoperative day. Patients who underwent PCNL with PL were typically discharged on the second postoperative day, provided no complications occurred. Follow-up included an X-ray KUB 2–4 weeks postoperatively. During follow-up visit, the double-J stent was removed if no significant residual fragments were present. Residual fragments smaller than 4 mm or the absence of a radio-opaque shadow on follow-up imaging was defined as stone-free status. Patient with >4 mm stone on 4 weeks were considered stone not cleared, and were scheduled for an additional procedure.

The parameters analysed were demographics (age and sex); stone characteristics (size, number, and density); operative details (size of Amplatz sheath or UAS, and duration of surgery); and postoperative outcomes (stone clearance rate, length of hospital stay, haemoglobin, blood transfusion rate, and any additional endoscopic, radiological, or surgical procedures). Normality distribution of data was checked, descriptive statistics (numbers and frequencies), and association of categorical variables (X^2 /Fisher's exact test), analysed using the IBM SPSS 16. A p≤05 was considered statistically significant.

Result

Data of 72 patients of M-PCNL with PL (*n*=41) and RIRS with TFL (*n*=31) were available for analysis (after excluding 25 of total 97 patients who had stone surgery during the study period as per the inclusion and exclusion criteria mentioned in methodology). The clinicodemographic parameters in two groups (M-PCNL and RIRS) were comparable. Most of patients were in the age group of 30-39 years, females more in number, stone location was more on right side, 10-15 mm stone size was common and a density of >1000 HU, Table 1.

Haemoglobin loss greater than 2 mg/dL was observed in 24 and 2 patients in PCNL and RIRS, respectively (p<0.0000016). Stone-free status, operative time, hospital stay and postoperative fever were statistically not significantly different in two groups. The fall in haemoglobin of >2 g, and hospital stay were significantly more in PCNL, Table 2.

Table 1. Clinic-demographic profile of patients with M-PCNL (41) and RIRS (31), n=72

Variables	M-PCNL with PL n=41	RIRS with TFL n=31	p-value
Age (years)			
20-29	10	7	0.24
30-39	15	12	
40-49	9	3	
50-59	3	6	
>60	4	3	
Sex			
M	17	14	0.94
F	24	17	
Site of stone			
Right	22	21	0.23
Left	19	10	

Table 2. Outcome of patients with M-PCNL (41) and RIRS (31), n=72

Variables	PCNL with PL n=41	RIRS with TFL n=31	p-value
Haemoglobin loss (mg/dl)			
≤2	17	29	0.001
>2	24	2	
Stone free			
Yes	35	28	0.07
No	6	3	
Operative time			
<30 min	5	1	0.1
30-60 min	23	28	
>60 min	13	2	
Duration of hospitalization (d)			
2	0	28	0.001
3 or more	41	3	
Fever			
Yes	5	1	0.35
No	36	30	

*Fischer's exact

Discussion

This comparative study of M-PCNL with PL and RIRS with TFL for upper urinary tract calculi up to 3 cm in size showed that the RIRS had a shorter hospital stay (p=0.00001), and lower haemoglobin loss (p=0.00001). The stone-free rate was slightly higher at 90.32% (28/31) in the RIRS than 85.36% (35/41) in the PCNL. However, the difference was statistically not significant (p=0.07). Blood transfusion was not required in either group. These findings favour RIRS with TFL for short-term surgical outcomes, although the effectiveness of both methods was similar in terms of stone clearance and duration of surgery. The renal stones were most common in the 30–39-year's age. There was a female predominance in both groups, and right-side location was more common.

The wider use of lasers has been reported in recent years, but whether laser energy will replace traditional energy sources remains unanswered.[11,12] Comparative results are insufficient to demonstrate a significant benefit of laser PCNL over non-laser PCNL regarding postoperative fever, blood transfusion rate, length of hospital stay, and the need for postoperative ancillary procedures.[13] There are limited studies comparing Moses technology and TFL, particularly in miniaturised PCNL. PCNL with Ho:YAG laser lithotripsy was reported with longer operative times and lower SFR compared with PCNL with TFL lithotripsy.[13] The operative time is an important parameter and correlates with complications.[14] The operative time is influenced by several factors such as surgical modality, operator experience, and the type of instrumentation.[14] Our study showed that the operative time was not statistically significant in the PCNL with PL group compared with RIRS with TFL group (p=0.07), which may be due to our initial experience or small sample size. Studies have reported significantly higher efficiency, faster ablation speed, smaller fragments, and shorter operating times with TFL compared with other energy sources.[15,16] Studies have shown that TFL can dust all types of stones regardless of their composition.[17]

The PL is a traditional energy source commonly used in urolithiasis management due to its lower purchase and maintenance costs.[18] It has proven effective in fragmenting all types of urinary stones. The resulting fragments are approximately 4 mm and larger; forceps are often required to remove the larger fragments.[19] In our study, both methods demonstrated equivalent and high stone clearance rates, 28/31 (90.32%) in the RIRS with TFL and 35/41 (85.36%) in the PCNL with PL group. Reported stone-free rates in PCNL with PL range from 85% to 96% for stones up to 3 cm in size, and stone-free rates after RIRS with TFL are greater than 90%, ranging from 86.6% to 98.21%.[16,18] These findings are consistent with our study.

Various studies have reported PCNL as a superior treatment modality due to its higher single-step stone-free rate, shorter operative time, and fewer postoperative complications.[20] A slightly lower SFR was reported in RIRS, which may still be accepted for less radiation exposure and significantly less postoperative pain.[20,21] The studies have shown no significant difference in quality of life between the two groups.[22] In the present study, the hospital stay was longer in the PCNL with PL group than RIRS with TFL group (p<0.0001). Prolonged hospital stays are associated with economic and psychological stress for patients and an increased rate of hospital-acquired infections.[23,24]

There is increased understanding and improvement of PCNL techniques. Miniaturisation of scopes, smaller tract sizes, and the use of newer energy sources have led to decreased intraoperative and postoperative bleeding, haemoglobin loss, and length of hospital stay.[25] Studies have shown higher haemoglobin loss and a greater need for blood transfusions in PCNL with PL compared with laser lithotripsy for complex renal stones.[26,27] In the present study, haemoglobin loss was higher in the PCNL with PL group (p=0.000016), although blood transfusions were not required in either group. In our study, no additional endoscopic, radiological, or surgical procedures were required during the postoperative period. This may be attributed to the small number of cases, the smaller stone size of less than 20 mm in three-fourths of cases in both groups or use of small tract size 20 Fr or less in PCNL group.

Post-operative fever or infection related complications are another important parameter, which depends on the stone size, renal anatomy and patient's patient-related factors.[28] A recent meta-analysis concluded that there was no significant difference in incidence of post-operative fever in M-PCNL and RIRS.[28] Our study reported the post-operative fever in one case in RIRS with TFL and 5 cases of PCNL with PL (p=0.35). The fever responded to antibiotic and antipyretic therapy in all cases.

Our study has some limitations, like a retrospective data from a single institution. We used two different energy sources—TFL and pneumatic lithotripsy—for two different procedures to treat upper urinary tract stones. Stone clearance was defined by X-ray KUB only as per hospital protocol, possibly to reduce the cost. Follow-up CT scans were not performed due high cost and radiation concerns. Although this study evaluated the effectiveness and safety of newer TFL and traditional pneumatic lithotripsy in two different techniques, it may be useful in resource-limited regions, where the cost of purchasing and maintaining a Pneumatic Lithotripter (PL) is considerably lower than that of the newer Thulium Fibre Laser (TFL).

Conclusion

The mini-Percutaneous Nephrolithotomy (M-PCNL) with Pneumatic Lithotripter and Retrograde Intrarenal Surgery (RIRS) with Thulium Fibre Laser showed similar operative time and equal effectiveness in achieving stone clearance for upper urinary tract stones up to 3 cm in size. Longer hospital stay was observed in the M-PCNL. There was a higher haemoglobin fall in PCNL than RIRS, but it did not require transfusion.

Author contribution

Concept and design: PR, JNS; Data acquisition: PR; Data analysis, interpretation: PR, JNS; Drafting: PR; Revision: PR, NY, JNS; Final approval of the version to be published: PR, NY, JNS; Agreement to be accountable for all aspects of the work: PR, NY, JNS.

Conflict of Interest

None

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None

Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

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