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ORIGINAL ARTICLE

Comparison of stone-free rate between percutaneous nephrolithotomy and retrograde intrarenal surgery

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Abstract

Background: The management of urolithiasis in the kidney has been drastically changed in the era of endourology, mainly consisting of three surgical procedures: extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS). Since ESWL is usually less invasive via ambulatory clinic routes, this study aimed to examine the stone-free rate (SFR) between PCNL and RIRS.

Methods: We retrospectively reviewed patients who had renal stones and were treated with either PCNL or RIRS from June 2016 to June 2018. Staghorn stones, stones with diameters <1 cm, and stones with diameters >2 cm were excluded. Patients who underwent multiple surgeries for bilateral renal stones and those with graft kidney stones were excluded from the study. X-ray, sonography, and/or computed tomography (CT) were used to calculate the size of the stones. Follow-up was evaluated by the same image examination within three months after surgery. Stone-free was defined as no residual stone or the presence of asymptomatic calculi <4 mm. The operation time was defined as a skin-to-skin interval.

Results: Following exclusion criteria, there were 39 patients in each arm, with no difference in age, sex, or any other demographic data. The average stone size in the PCNL and RIRS groups was 16.3 and 14.0 mm, respectively ($p = 0.009$). There was no significant difference in SFR (71.8% vs 61.5%, $p = 0.337$); the operation time was significant longer ($p < 0.001$), and the hospital stay was significantly shorter ($p < 0.001$) in the RIRS group.

Conclusion: PCNL and RIRS are both feasible options for managing kidney stones. However, the initial stone size might affect the selection of operation. The SFR in the PCNL group was numerically but not statistically higher. The RIRS group, on the other hand, had a longer operation time but a shorter hospital stays.

Keywords: Percutaneous nephrolithotomy; Retrograde intrarenal surgery; Stone-free; Urolithiasis

1. INTRODUCTION

The optimal management of renal calculi has always been an issue, despite advances in endourological equipment and techniques that have made minimally invasive surgeries more feasible with less complication. According to the European Association of Urology guidelines, percutaneous nephrolithotomy (PCNL) is preferable over retrograde intrarenal surgery (RIRS) or extracorporeal shock wave lithotripsy (ESWL) for renal calculi larger than 20 mm. On the other hand, RIRS or ESWL may be preferred for stone sizes less than 10 mm. However, for those with diameters between 10 and 20 mm, the term "endourology," including PCNL and RIRS, may be an option without definite preference.[1]

According to the American Urological Association guidelines, clinicians should offer PCNL as first-line therapy for total renal stone burdens >20 mm; otherwise, RIRS should be considered. However, patients receiving PCNL should also be well-informed about the nature of the procedure, as well as its morbidity and potential complications. Besides, ESWL should not be offered as the first-line therapy for patients with lower pole stones >10 mm; endoscopic approaches to large lower pole stones offer substantial benefits over ESWL, with only moderate increases in risk.[2] Nevertheless, there is still no clear-cut indication for renal calculi ranging from 10 to 20 mm in size.

The Taiwan Urological Association guidelines suggested that the range of stone size suitable for RIRS should be extended to 10–25 mm, according to the National Health Insurance's classification of renal calculi. However, because treatment options varied widely among surgeons, facilities, and even different countries or continents, our study aimed to search for some comparison data between PCNL and RIRS from a single tertiary institution in Taiwan and to provide some evidence for considerations, especially for renal calculi between 10 and 20 mm.

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2. METHODS

Patients diagnosed with renal stones and scheduled for surgery between June 2016 and June 2018 were retrospectively analyzed. This study enrolled 264 patients undergoing PCNL or RIRS procedures, and the study protocol was reviewed and approved by the institutional review board (IRB No. 2022-02-004CC). Only patients with a stone size between 10 mm and 20 mm were included. In addition, patients with staghorn stones, a history of kidney transplantation, bilateral renal stones, and previously diagnosed metabolic disorders related to stone formation[3,4] were excluded, as illustrated in Fig. 1. Finally, 39 patients were assigned to each group of PCNL and RIRS.

2.1. Percutaneous nephrolithotomy

Percutaneous nephrostomy (PCN) with a balloon dilator as an appropriate calyx access was performed a day before the surgery. Under anesthesia, the Amplatz renal dilator set was used for dilation up to 28Fr, and a 24Fr Storz nephroscope was used to view inside the kidney. Stones were fragmented using Swiss Lithoclast Master (EMS Urology) until suitable for removal or spontaneous passage. The stone-free status of the kidney was controlled using nephroscopic visualization and fluoroscopy. PCN was allowed to drain adequately for several days.

2.2. Retrograde intrarenal surgery

The procedure was performed using a 12/14Fr (Boston Scientific) ureteral access sheath, a 9.5Fr flexible ureterorenoscopy (fURS) (Olympus), and a holmium YAG laser lithotripter (200 μm, Quanta system). Following the completion of fragmentation, the ureter was observed all along its length to observe any ureteral injury. A double-J stent was routinely placed after the procedure and removed two to four weeks after surgery.

2.3. Main outcome: stone-free rate

Kidney-Ureter-Bladder X-ray (KUB) or low-dose noncontrast computed tomography (CT) was used to determine the stone size. The duration of surgery was counted as skin-to-skin time. KUB, ultrasound, or CT determined stone-free status within 3 months after surgery. No residual stones or asymptomatic calculi <4 mm were defined as stone-free status.[5,6]

Characteristics, including age, gender, body mass index (BMI), stone size, and laterality, were recorded. Besides the main outcome of stone-free rate (SFR), the duration of surgery, hospitalization, postoperative urosepsis, and the length of intravenous (IV) antibiotics usage was also compared between the PCNL and RIRS groups.

2.4. Statistics

The software of Statistical Package for the Social Sciences Version 25 was applied. Since the sample size is relatively small, The Mann–Whitney U test was used for comparing continuous variables, and the Fisher exact test was used to compare categorical variables. A p value of 0.05 was considered statistically significant.

3. RESULTS

The process of patient enrollment is shown in Fig. 1. Seventy-eight patients were included in this study, with 39 patients in each group. There were 43 (55.1%) male patients, with a mean age of 61.7 years old and a mean BMI of 25.6 kg/m^2. The average stone size was 15.1 mm. Demographic data and clinical characteristics are listed in Table 1, with comparable preoperative parameters between the PCNL and RIRS groups. Regarding stone laterality, there was no significant difference (p = 0.256), with most located on the single site of the collecting system (82.1% in the PCNL group, 74.4% in the RIRS group). However, a statistical difference was noted for the mean stone size, with 16.3 and 14.0 mm in the PCNL and RIRS groups, respectively (p = 0.009).

The perioperative outcomes and clinical manifestations are listed in Table 2. SFR was 71.8% and 61.5% in the PCNL and RIRS arms, respectively, with numerical but not statistical differences (p = 0.337). Alternatively, a significantly longer hospitalization duration was noted in the PCNL, compared with the RIRS group, regarding mean (7.6 vs 4.9, p < 0.001) or median (7 vs 3, p < 0.001) days. Nevertheless, the duration of surgery revealed an opposite result, with the RIRS taking longer operation time (74.3 vs 137.3 minutes, p < 0.001). However, the possibility of postoperative urosepsis and the length of IV antibiotics usage were comparable in the PCNL and RIRS groups.

4. DISCUSSION

Evolving from the traditional laparotomy surgery, treatments of renal calculi have advanced so much that sometimes a wound is

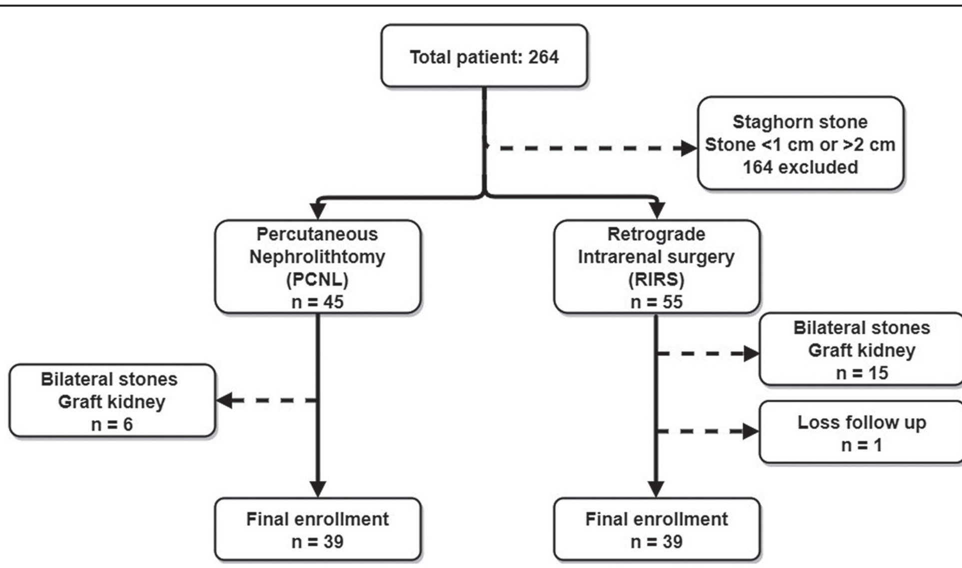

Fig. 1 Flowchart of patient enrollment.

Table 1

Demographic data and characteristics

	PCNL	RIRS	*p*
Number, n	39	39	
Age, mean (SD)	61.1 (9.9)	62.3 (12.4)	0.565
Male gender, n (%)	19 (48.7%)	24 (61.5%)	0.363
BMI, mean kg/m^2 (SD)	25.3 (5.4)	25.8 (4.4)	0.628
Mean stone size, mean mm (SD)	16.3 (3.6)	14.0 (3.4)	0.009
Laterality, n (%)			0.256
Right	21 (53.8%)	15 (38.5%)	
Left	18 (46.2%)	24 (61.5%)	
Stone location, n (%)			0.584
Single site	32 (82.1%)	29 (74.4%)	
Multiple site	7 (17.9%)	10 (25.6%)	

BMI = body mass index; PCNL = percutaneous nephrolithotomy; RIRS = retrograde intrarenal surgery.

Table 2

Perioperative outcomes and clinical manifestations

	PCNL	RIRS	*p*
Stone-free status, n (%)	28 (71.8%)	24 (61.5%)	0.472
Hospitalization, mean d (SD)	7.6 (5.5)	4.9 (5.1)	<0.001
Hospitalization, median d (IQR)	7 (6-8)	3 (2-6)	0.01
Duration of surgery, mean min (SD)	74.3 (34.2)	137.3 (53.8)	<0.001
Urosepsis, n (%)	8 (20.5%)	7 (17.9%)	0.999
IV antibiotics usage length, mean d (SD)	8.3 (8.2)	6.1 (2.3)	0.999

IQR = Interquartile Range; IV = Intravenous; PCNL = percutaneous nephrolithotomy; RIRS = retrograde intrarenal surgery.

not even required for adequate management. Still, PCNL is the surgery of choice for stones larger than 10 mm according to current guidelines,[1,2] but the improvement of RIRS makes the surgical decision more challenging. Although ESWL is still a viable choic of selected stone size, the treatment options still depends on shared decision making between urologists and patients.[7] In the realm of endourological surgery, as improvements in equipment have made a smaller caliber of PCNL safer and more feasible, for example, mini-PCNL or micro-PCNL,[6,8] it has also become more controversial regarding the choice between PCNL and RIRS, especially for stones between 10 and 20 mm. Therefore, we aimed to compare these two procedures based on perioperative outcomes concerning SFR and other clinical manifestations.

Due to the high recurrence of renal calculi, SFR has been widely adopted as the main assessment for surgical efficacy.[5,6,9] Comparing SFR between PCNL and RIRS, a systematic review and meta-analysis by De et al indicated that the standard PCNL was associated with higher SFR and more complications, blood loss, and admission times. Furthermore, RIRS may provide higher SFR than mini-PCNL or micro-PCNL and could be considered a standard therapy for stones <2 cm.[10] In contrast, Cabrera et al. reported that mini-PCNL was significantly superior in effectiveness with a higher success rate than RIRS of 10–20 mm lower pole renal stones.[8] A prospective study by Jiang et al concluded that no significant SFR was observed between micro-PCNL and RIRS.[6] Obviously, the result remains controversial.[5,9,11–14]

While most systemic reviews and meta-analyses included studies calculating radiographic stone diameter as the preoperative parameter, more contemporary research adopted the aggregate stone burden as an alternative. According to studies using the Registry for Stones of the Kidney and Ureter (ReSKU) as a database, the stone multiplicity would affect surgical decisions in patients undergoing PCNL.[15] Merigot et al compared three different methods of stone burden estimation and suggested that three-dimensional should be considered when dealing with stones larger than 20 mm.[16] Ito et al reported that both the stone size in plain film and the volume calculated using CT were statistically related to the SFR of RIRS,[17] and the stone volume should be used for preoperative stone burden calculation if its size ≥20 mm or number ≥4.[18] To sum up, for stones ranging from 10 to 20 mm in size, the stone size could still be a surrogate for total stone burden, and that is why we still use it as the main outcome parameter.

Both PCNL and RIRS may lead to postoperative urosepsis. Fever is a relatively common postoperative manifestation of PCNL, with an incidence of 10.8%–16%.[19–22] Studies focused on sepsis or systemic inflammatory response syndrome after PCNL. Preoperative urine culture, intraoperative stone culture, and the number of access points were significant predictors, and stone culture is more commonly the causative organism of a postoperative urosepsis.[20,23] In RIRS, the postoperative infection rate was 7.7%–17.5%.[24–27] Higher stone burden and long surgical time were recognized as risk factors. Both PCNL and RIRS are performed under high hydrostatic pressure compared with open surgery. Therefore, surgeons must be aware that it could lead to adverse events, such as sepsis, and irreversible kidney injury has also been observed in animal models.[28,29] In our study, the rate of postoperative urosepsis and the length of IV antibiotics usage were similar to those in previous literature, and there were no significant differences between PCNL and RIRS groups.

Our results were supported by the detailed surveillance of preoperative parameters, the description of surgical methods, perioperative manifestations, and long-term follow-up of postoperative images. Moreover, the most common postoperative sequelae, urosepsis, was also recorded. Nonetheless, our study was limited by its retrospective design, the adoption of stone size as a surrogate for total stone burden, and the lack of tract establishment time for PCNL. The pain score comparison could not be properly compared as well due to retrospective data collection via electronic medical records in our facility. Last but not least, the mean stone size in group

RIRS was statistically smaller than that of group PCNL, even though only with a difference of 2 mm. Further prospective randomized trials are necessary for confirmatory conclusions; still, we provided some evidence for consideration between PCNL and RIRS.

In conclusion, PCNL and RIRS are both effective procedures for renal calculi, but there are still some controversies. The initial stone size or burden might also affect the selection of operation, although one could be considered a surrogate for the other, especially for stones between 10 and 20 mm. In our cohort, the SFR was numerically but not statistically higher in the PCNL group. The duration of surgery was significantly longer in the RIRS group, but the hospitalization was shorter. Nevertheless, there were no differences in postoperative urosepsis and the length of IV antibiotics usage between the PCNL and RIRS groups. Both PCNL and RIRS were safe and feasible for renal calculi ranging from 10 to 20 mm in size.

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