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Outcomes of retrograde intrarenal surgery compared with ultra-mini percutaneous nephrolithotomy in the management of renal calculi

Aakash Pai, Htut Aung Wai, Miriam Ali, Michael Theaker, Graham Watson, Simon Mackie

East Sussex Health Care National Health Service Trust, United Kingdom

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Corresponding author
Aakash Pai
East Sussex Healthcare NHS trust
Kings drive
Eastbourne
BN21 2UD, UK
phone: +44 1323 417 400
aakashpai77@gmail.com

Introduction To evaluate the outcomes of retrograde intrarenal surgery (RIRS) and ultra-mini percutaneous nephrolithotomy (umPCNL) in the management of renal calculi.

Material and methods Between March 2015 and January 2018, a total of 44 patients were treated with umPCNL. The outcomes of these patients were compared with 75 patients who underwent RIRS for renal calculi during the same time period.

Results Median stone size was 9 mm in the umPCNL group and 7 mm in the RIRS group. Stone-free rates after a single procedure were achieved in 85% of patients for the RIRS group and 98% for the umPCNL group. 16% of RIRS patients were left with a ureteric stent, whilst 7% of patients (n = 5) needed a second RIRS. One patient in the umPCNL group was left with a percutaneous nephrostomy; all other patients were left totally tubeless. The mean operative time was 66 minutes in the RIRS group and 55 minutes in the umPCNL group (p = 0.04). The minor complication rates for the RIRS and umPCNL groups were 17% and 15%, respectively. One patient in the RIRS group required postoperative nephrostomy insertion; there were no major complications in the umPCNL group. The median length of stay was 0 days in the RIRS group and 1 day in the umPCNL group.

Conclusions The overall study showed that umPCNL has low complication rates and good stone-free rates, with a lower requirement for ancilliary procedures. UmPCNL is an acceptable alternative in selected patients with small- to moderate-sized renal calculi.

Key Words: flexible ureteroscopy ‹› renal calculi ‹› ultra-mini percutaneous nephrolithotomy

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is an established and safe technique for the management of renal calculi; delivering shorter operative times and higher stone-free rates than other treatment options. However, PCNL is limited by a perceived higher relative morbidity, with bleeding and damage to the surrounding organs being of particular concern. On the other hand, there is evidence emerging that a reduced tract size leads to a reduction in morbidity [1, 2] and pain scores from PCNL [3]. With this in mind, ultra-mini-PCNL (umPCNL) has developed, employing an 11–13Fr sized sheath [4–7]. An 11Fr tract corresponds to an almost eight-fold reduction in cross-sectional area compared to a conventional 30Fr tract, with a resultant theoretical reduction in renal trauma and bleeding.

Miniaturization in PCNL has been mimicked in retrograde intrarenal surgery (RIRS), with smaller caliber ureterorenoscopes with larger, more durable working channels [8]. Ureterorenoscopic miniaturization, superior vision, improved deflective capability and the use of ureteric access sheaths [9] means

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that a greater range of renal calculi are now being tackled ureteroscopically [10, 11].
With more complex stones being managed ureteroscopically and smaller stones being treated via miniaturized PCNL tracts, there is an imperative requirement to provide evidence as to the relative outcomes and indications of these two procedures. The aim of our study was to compare the outcomes of umPCNL with RIRS at our institution.

MATERIAL AND METHODS

Between March 2015 and January 2018, 44 patients were treated with umPCNL. All procedures were undertaken by two primary surgeons (GW and SM). Computerized tomography (CT) scans were performed preoperatively in all patients. Patient demographics including age, sex, body mass index and stone characteristics were recorded. Stone size was calculated as the maximum diameter on the preoperative CT scan.
Within the same time period, 221 patients underwent RIRS. From this cohort, 75 patients had RIRS for renal calculi and were included in the ureteroscopy cohort. The other 146 patients had ureteroscopy for ureteric calculi and thus were excluded from this study. The baseline demographic and clinical data are shown in Table 1.

Ultra-Mini percutaneous nephrolithotom technique

We initially placed a 6Fr open ended ureteric catheter retrogradely. Access was subsequently performed under fluoroscopic or ultrasound guidance using an 18-gauge needle. A hydrophilic nitinol guidewire of 0.035 inches diameter was passed through the needle and the tract was dilated with Alken dilators under fluoroscopic control. The ultra-mini PCNL system was used, which consists of a 1 mm (3Fr) telescope, 7.5Fr nephroscope inner sheath and a 13Fr metallic outer sheath, which serves as the outer sheath. Stones were fragmented using a Holmium: YAG laser. Stone fragments were either washed out or removed with a basket. At the end of the procedure, we instilled 20 ml of 0.5% bupivacaine into the PCNL tract.

Retrograde intrarenal surgery technique

A standardized RIRS procedure was performed in all cases. All stages of the procedure were performed in the lithotomy position, with fluoroscopic guidance. We performed an initial rigid ureteroscopy and subsequent flexible ureterorenoscopy. We did not use an ureteral access sheath in any of the cases. A 7.5 Fr fiberoptic flexible ureteroscope with a 200um laser fiber was used during the intervention. We did not routinely leave a ureteric stent post RIRS; however, indications for leaving a stent included residual stones, bleeding, ureteral trauma or if an infection was suspected.

Statistical analysis

Data was analyzed with GraphPad Prism software. Statistical analysis was performed using the student T-test for normally distributed continuous variables. We used the Mann-Whitney U test for continuous variables with a skewed distribution. Categorical variables were analyzed using a chi-square or the Fisher's exact test.

Follow- up

Routine follow-up evaluation was undertaken three months postoperatively with either plain radiography or renal ultrasonagraphy. If stone recurrence

Table 1. *Baseline demographic and clinical data for each group*

	Retrograde intrarenal surgery	Ultra-mini percutaneous nephrolithotomy	P Value
Number of patients	75	44	
Mean age	57	54	0.87
BMI (kg/m)	29.6	32.6	0.5
Female (%)	36	40	0.77
Stone localisation			
Upper calices	32%	48%	0.15
Middle calices	4%	5%	1.0
Lower calices	33%	28%	0.81
Pelvic	31%	19%	0.11
Median Stone burden (mm) (range)	7 (3 to 20)	9 (7 to 17)	0.21

BMI – body mass index

Table 2. *Comparison of outcomes of retrograde intrarenal surgery (RIRS) and ultra-mini percutaneous nephrolithotomy (umPCNL)*

	RIRS	umPCNL	P value
Mean (SD) total operative time per patient, minutes	66 (3.8)	55 (2.3)	0.04
Length of stay (Days)	0 (0–4)	1	0.03
Complications (overall)	17% (n = 13)	15% (n = 6)	0.41
Blood transfusion	0	0	
Fever	5	5	
Renal colic	4	3	
Urinary retention	3	0	
Hb change (g/dl)	–	1.2	
Need for stent/nephrostomy	11 stents	One nephrostomy	0.03
Readmissions (pain) infection	5 1	0	0.06
Additional procedures Nephrostomy insertion	1	0	
Stone-free	85% (n = 65)	98% (n = 43)	0.045

was diagnosed or suspected, non-contrast CT was performed.

RESULTS

All PCNL procedures were completed through a single percutaneous tract. Nine of the umPCNL were performed in the prone position with the remaining 35 in the supine position. One patient in the umPCNL group was left with a nephrostomy, all other patients were left completely tubeless. 16% of RIRS patients were left with a ureteric stent, whilst 7% of patients (n = 5) needed a second RIRS. Table 2 shows the comparison of perioperative and postoperative data.

Median stone size was comparable between the umPCNL (9 mm) and RIRS groups (7 mm). There was no significant difference in the stone location.

The average total operative time was significantly longer for the RIRS group (p = 0.04). Stone-free rates after a single procedure were achieved in 86% for the RIRS and 98% for the PCNL group (p = 0.045). 7% of the RIRS group (n = 5) needed a second RIRS after which they were stone-free. For lower pole calculi, the stone-free rate was 76% for RIRS and 100% for umPCNL. Calcium oxalate was the most prevalent stone composition in both groups (PCNL group, 78%, RIRS group, 73%).

The minor complication rate (Clavien grade I + II) was 17% in the RIRS group and 15% in the umPCNL group. The mean hemoglobin drop was 1.2 g/dl in the umPCNL group. No patients in either group needed a blood transfusion. One patient in the RIRS group developed postoperative obstruction and infection with no stone fragments remaining on non-contrast CT. A retrograde ureteric stent was attempted; however, a hydrophilic wire would not pass the level of obstruction and therefore a percutaneous nephrostomy was inserted. A subsequent nephrostogram one week later showed good drainage to the bladder with no obstruction and no further intervention was required. There were no complications above Clavien grade II in the umPCNL group. In the umPCNL group, the median length of stay was 1 day (an overnight stay), whilst in the RIRS group 68% of patients (N = 49) were discharged on the same day.

DISCUSSION

Technological advancements and higher stone-free rates have led to a shift from shock wave lithotripsy towards endourology in the management of renal calculi. Within endourology, modern flexible ureteroscopes mean that RIRS has been increasingly used for small to moderate renal stone burden. Within this milieu umPCNL has developed, with some evidence that a smaller tract size results in a lower complication rate compared to a standard procedure. UmPCNL has therefore developed as an additional option for small to moderate stone burden. Our study suggests that umPCNL is a viable treatment option for small and moderate-sized renal calculi, with improved stone-free rate, equivalent complication rates and reduced need for ancillary procedures compared to RIRS.

We acknowledge that despite there being no major complication in our cohort, there is a risk of major complication in PCNL. Clinical research of the endourological society (CROES) PCNL data has shown major complications including a blood transfusion rate of 5.8% [12] and hydrothorax (1.8%). However, Kukreja et al. in their prospective study of 301 PCNLs, found that the tract size was an independent predictor of bleeding risk [2]. Similarly, in their literature review, Ferakis concluded that mini-PCNL is associated with a lower risk of bleeding compared to conventional procedure [1]. Agrawal et al. in their study of 120 umPCNL showed no significant postoperative complications [13]. Our study, although with smaller numbers, revealed no complications above Clavien grade 2 in the umPCNL cohort.

RIRS has advantages, particularly with respect to reduced risk of visceral injury and bleeding compared to conventional PCNL. In addition, the stone-free rate of 87% in this study is acceptable and compa-

rable to other studies, 67% to 86.5% [14, 15, 16]. In comparison to other groups [14], the requirement for post RIRS ureteral stenting was relatively low at 16%. There is an attendant morbidity associated with ureteral stenting, which is a limitation of RIRS. In our study, 27% of patients who were stented were readmitted with stent-related symptoms.

Gupta et al. showed stone free rates of 93% in their study of tubeless umPCNL in 15 patients [6]. Agrawal et al. had stone free rates of more than 99% in his study of 120 umPCNL (13). A systematic review of PCNL with a tract size less than 15Fr showed an overall stone-free rate of 88.3% and no complications above Clavien grade III [7]. Previous umPCNL studies have shown average operative times ranging from 40 to 59 minutes [5, 6, 13], which is comparable to our average of 54 minutes.

Previous studies have compared PCNL and RIRS in the management of moderate-sized renal calculi, showing stone-free rates at the expense of greater morbidity in the PCNL group [14, 17, 18]. However, none of these studies looked at umPCNL, and our study has not shown higher complication rates in the umPCNL group.

None of the patients in the umPCNL group needed a JJ stent, with only one patient needing a percutaneous nephrostomy. The advantage of umPCNL is that they can often be tubeless, avoiding stent-related symptoms and the need for further procedure for stent removal. There are also other advantages to umPCNL in cases where the stone may not be accessible ureteroscopically due to a tight ureter or unfavorable renal anatomy. This is particularly pronounced in the lower pole, which was confirmed by higher lower pole stone-free rates in our study. Disadvantages of umPCNL include that there is a need for the puncture to be onto the stone as the umPCNL sheath does not allow flexible instruments. Similarly, there is a risk of stone migration into an inaccessible area.

The umPCNL had a shorter mean duration of surgery compared to RIRS. This may reflect that stone fragmentation and removal is easier via a PCNL tract than with RIRS. Whilst being as effective as other options, there is some evidence suggesting that umPCNL is less expensive than ureterorenoscopy [19]. Additionally, although not part of our study, Sabnis et al. showed that surgeon discomfort scores were higher in RIRS than in PCNL [20].

Limitations of this study include its retrospective nature and that there was a risk of selection bias. Schoenthaler showed that umPCNL and RIRS have equivalent postoperative analgesic requirement and pain scores [21], and a limitation of our study is a lack of this data. Additionally, due to the retrospective nature of the study, we did not collect postoperative hemoglobin in the RIRS group.

CONCLUSIONS

Stone clearance rates in both retrograde intrarenal surgery (RIRS) and ultra-mini percutaneous nephrolithotomy (umPCNL) are high, with acceptably low complication rates. RIRS has a higher requirement for postoperative stenting and ancillary procedures. In the management of small- to moderate- sized renal calculi, umPCNL is an effective alternative to RIRS and extracorporeal shockwave lithotripsy. There are limitations to both approaches, and they are both viable treatment options depending on the specific situation.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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