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Research Article

Comparison of RIRS and Mini-PCNL for 2-3 cm Renal Lower Calyx Stones

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Abstract

Aim: To compare the reliability, efficacy, and Stone-Free Rate (SFR) for RIRS and mini-PCNL performed in a single clinic by a single surgeon for renal lower calyx stones of 2-3 cm and to identify the advantages and disadvantages of each method.

Method: From January 2014 to December 2018, 96 mini-PCNL and 111 RIRS patients with 2-3 cm renal lower calyx stones were retrospectively included in the study. The characteristics of the patient and surgery, surgery and fluoroscopy durations, complication rates, hemoglobin values, VAS scores, analgesic use and duration of hospital stay were evaluated. Non-Contrast Computed Tomography (NCCT) taken 3 months after surgery found all patients were stone-free or had fragments less than 3 mm, accepted as success.

Results: After RIRS and 1st session of mini-PCNL, stone-free rates were 79.28% and 82.3%, while these rates rose to 89.19% and 93.75% after assisting and repeated treatments. There was no statistical difference between success rates (p=0.748). RIRS was more advantageous in terms of fluoroscopy time, fall in hemoglobin, VAS, analgesic use and hospital stay, while PCNL was better in terms of surgery duration (P=0.036). There was no difference in complication rates (p=0.384).

Conclusion: RIRS remains a good alternative treatment choice for lower calyx kidney stones from 2-3 cm with low complication rates, short hospital stay, less analgesic requirements, and stone-free rate close to mini-PCNL.

Keywords: Kidney; Percutaneous nephrolithotomy; Retrograde intrarenal surgery; Stone

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Abbrevations

RIRS:	Retrograde İntrarenal Surgery
Mini(M)-PCNL:	Mini-Percutaneous Nephrolithotomy
Standart(St)-PCNL:	Standart Percutaneous Nephrolithotomy
F-URS:	Flexible Ureterorenoscop
ESWL:	Extrashock Wave Lithotripsy
VAS:	Visual Analog Scala
NCCT:	Non Contrast Computerize Tomography
USG:	Ultrasonography
IVP:	Intravenous Pyelography

Introduction

Invasive Percutaneous Nephrolithotomy (PCNL) methods are recommended in EAU guidelines for kidney stones larger than 2 cm, while Extracorporeal Shock Wave Lithotripsy (ESWL) is recommended for resistant kidney stones smaller than 2 cm in the lower pole calyx [1]. PCNL methods have a moderate learning curve for kidney stones and are applied with high success rate in the world in general [2]. Mini-PCNL continues the Stone-Free Rate (SFR) success of PCNL for large stones and has begun to be used due to lower incidence of major complications specific to standard PCNL like hemorrhage, especially. In fact, literature studies have proven the benefit of mini-PCNL for the fall in hemoglobin [3].

Among special patient groups like those with vertebral anatomic abnormalities, hemorrhage diathesis, obesity, multiple calyx stones requiring access to multiple calyces, solitary kidney and accompanying ureter stones, there are patient groups where the application of invasive mini-PCNL is risky and infeasible. Additionally, there are major complications like neighboring organ injury and abundant hemorrhage with invasive PCNL.

Due to these reasons, even with the excess of patient groups where mPCNL is the gold standard in the literature, there are surgical reports of F-URS and Retrograde Intrarenal Surgery (RIRS) and currently we see urologists perform RIRS independent of stone size [4-9]. RIRS differs from PCNL mainly in terms of low major complication rates. For kidney stones larger than 2 cm, success rates have reached satisfactory levels with repeated sessions and the aid of auxiliary methods.

Material-Method

From January 2014 to December 2017, RIRS and mini-PCNL surgeries performed for 2-3 cm renal lower calyx stones by a single surgeon in a single clinic were included in the study. Patients with treatment apart from ESWL for the same stone and pediatric patients were not included in the study. Preoperatively, all patients had serum biochemistry, renal function tests, urine testing and culture, radiography, Urinary System Ultrasonography (USG), Noncontrast Computed Tomography (NCCT) and some patients had Intravenous Pyelography (IVP) taken. Patients with proliferation in urine cultures were not operated until culture tests were negative; these patients were treated with antibiotics in accordance with their antibiogram. For PCNL,

general anesthesia was chosen as anesthesia, while some RIRS were performed with spinal anesthesia.

Mini-PCNL technique: After anesthesia, patients were placed in the dorsal lithotomy position, the external urethra was entered with a 20 F rigid cystoscope and a hydrophilic guide wire was sent into the relevant ureter. Then a 6 F open-ended ureter catheter was advanced and a 16 F urethral probe was inserted. Then the patient was turned to prone position and 50% diluted nonionic contrast material was sent through the ureter catheter under fluoroscopy and all calices were allowed to fill with opaque material. If possible, access was through the posterior lower calyx below the 12th level; for patients were access could not be provided through this calyx access to the middle and upper calices was provided through intracostal routes. After the insertion of an 18 G needle, a guide wire was sent to the intrarenal system and if possible, directed toward the upper calyx or ureter and then alkane metal dilatators were inserted in the kidney over the guide wire. Then a 16.5/17.5 F operating sheath was inserted above the dilators, and the lower calyx was entered with a 12 F nephroscope and the surgical field and stone were imaged. Stones were fragmented with a pneumatic lithotripter and ho: YAG laser (365 nm fiber; energy 0.8 J, frequency 12 Hz). If possible, fracture into large parts was ensured and these were removed through the access with foreign object forceps. At the end of surgery, fluoroscopy and endoscope were used to confirm there was no stone in the field that could be removed from inside the kidney. Then a 14 F nelaton probe was left in all patients as nephrostomy tube. Patients with gross hemorrhage through the probe had the tube clamped for 2 hours. Additionally, patients with many small fragments escaping through the ureter had JJ stent inserted. Patients with hemorrhage stopped through the nephrostomy tube (mean 3rd day) had tubes removed. Patients were called for check-up 3 times 1 week, 1 month and 3 months later. Check-up investigations included hemogram, creatinine, radiography, urinary USG and NCCT. Patients with JJ stent inserted had the stent removed in the 4th week. Patients with stones remaining in the ureter had ESWL and R-URS or F-URS performed.

Rırs technigue: Patients had both spinal and general anesthesia administered. After anesthesia, patients were turned to the dorsal lithotomy position. First the external urethral meatus was entered with R-URS, then a hydrophilic guidewire was sent through the relevant ureter orifice followed by the R-URS into the ureter. Some patients whose ureter could not be entered had balloon dilatation, while some had 2 to 4 week present (DJ stent) inserted. Over the hydrophilic guidewire, a 9.5/10.5 f, 11/13 F or 13/15 F access sheath was inserted (Cook medical) or for some patients F-URS (Karl Storz, Tuttlingen, Germany) was sent over the guidewire directly to the kidney. All processes where the guidewire progressed from the ureter to the kidney, the access sheath was inserted, DJ stent inserted or direct removal over the guidewire were performed under fluoroscopy. Intraoperatively fluoroscopy was used with dilute contrast material to find the entry to the lower calyx, and to identify the pelvicalyceal angle, infundibular length and width. Stones were fragmented with holmium-YAG laser. Large stones were fragmented with the dusting mode, while small stones were fragmented with fragmentation mode. Dusting mode used high frequency (8-12 fr) low Joule (5-8) energy, while fragmentation mode used low frequency (5 fr) and high Joule (8-10) energy. Stone fragments above 2 mm were removed with a nitinol-tipped basket forceps. During surgery to increase image clarity, the pump from a fluid set was used to apply pressure while the surgery continued, even if an irrigation pump was not used. At the end of surgery to determine stone-free status and confirm lack of residual fragments, all calices and renal pelvis were examined in detail with URS, and fluoroscopy was used for opaque stones. All patients had ureter catheter or JJ stent inserted. Patients with ureter catheter had the catheter removed after 12 hours. Patients who could cope with DJ stent had it removed after 4 weeks. Patients were called for check-up 1 week, 1 month and 3 months later.

Statistical analyses

SPSS 22.0 (SPSS, Chicago, IL, USA) was used for data analysis. Results are presented as mean or percentage (%). Continuous variables were compared with the Student t or Mann-Whitney U tests as appropriate. Categoric variables were analyzed with the chi-square or Fisher's exact test. Statistical significance was determined as P<0.05.

Results

This study included 96 PCNL and 111 RIRS patients. The demographic characteristics of age, sex and BMI were similar in both groups (p>0.05). In terms of comorbid diseases, there were differences present (P<0.007). Stone size was 23.03±6.31 and 26.05±3.30 (p<0.001) in Group 1 and Group 2 (Table 1).

	Group 1	Group 2	*P*
Age (years+- sd)	47.08+-14.71	48,42+-13.46	
Gender(no,%)			
Male	69	67	0,496
Female	42	29	0,251
BMİ (kg/m²)	26,08+-4.52	27.05+-3.30	0,085
Comorbid disorders (no,%)			0,007
ht	17	17	
dm	15	11	
cold	3	-	
antiagregan	5	-	
Lateralite(no,%)			0,291
right	55	51	
left	51	45	
bilateral	5	-	
Stone size(mm+-sd)	23.03+-6.31	26.05+-3.30	0,001

Table 1: Demographic features and stone characteristics.

Cold (chronic obstructive lung disease), **BMI** (Body Mass İndex), **Sd**; standart deviation, *P*<0,005,Significant.

Surgery durations were 61.30±13.58 and 57.54±11.99 minutes for RIRS and mini-PCNL and this difference was accepted as statistically significant in favor of mini-PCNL (P=0.036). The fluoroscopy duration was more advantageous for RIRS (RIRS and mini-PCNL; 1.03±0.45s, 4.79±1.57s; P<0.001). RIRS was more advantageous for hemoglobin fall (0.57±0.39mg/dl, 2.07±1.14 mg/dl; p<0.001). RIRS was statistically better in terms of postoperative 1st day VAS values (4.0±1.52 and 4.57±1.12, P=0.003); as a result, RIRS was more advantageous for mean tramadol use (P<0.001). Duration of stay in hospital was 24.64±64 hours versus 71.51±26.88 (P<0.001), with RIRS again more advantageous compared to PCNL. There were differences

in terms of type of anesthesia (P<0.001). The stone-free rate or success rate after the 1st session of RIRS and PCNL was 79.28% versus 82.3%, while 3 months later stone-free rates were 89.2% and 93.75% with the aid of auxiliary methods in the RIRS and mPCNL groups (Table 2).

	Group 1	Group 2	P
Operation Time	61.30+-13.5	57.54+-11.99	0,036
Floroscopy Time	1,03+-0.45	4.79+1.57	< 0,001
Hb	0.57+-0.39	2.07+-1.14	
SFR **First** **3th months**	 %79.3 %89.2	 %82.3 %93.8	0,748
VAS	4.0+-1.52	4.57+-1.12	0,003
Tramadol (Mean,mg)	90	400	< 0,001
Hospital Stay	24.64+-64	71.51+-26.88	< 0,001
Anesthesia **General** **Spinal**	 62 39	 99 -	< 0,001
Auxiliary Procedures (No, %) **ESWL** **Re-URS-L** **Re-RIRS** **St-PCNL**	 8 3 7 2	 7 3 2 1	< 0,001

Table 2: Surgical features.

VAS: Visual Analog Scala; **HB:** Hemoglobin; **SFR;** Stone Free Rate; **ESWL:** Extra Shock Wave Lithotripsy, **URS-L:** Ureterorenoscopic Lithotripsy; **RIRS:** Retrograde intrarenal surgery; **St-PCNL:** Standart/Conventional Percutaneous nephrolithotomy; *P*<0,005, significant.

Complication rates in the RIRS and mPCNL groups were 10.8% and 10.4%, respectively (p=0.384) (Table 3).

	Group 1	Group 2	P
Subcapsular haematoma (no,%)	1	-	0.384
Ürosepsis (no,%)	6	-	
Fever (no,%)	3	-	
Gross hematüri (no,%)	2	2	
Steinstrasse (no,%))	-	2	
Hidrotorax (no,%)	-	1	
Leak of nephrostomy (no,%)	-	1	
Reversıbl rise in RFT (no,%)	-	2	
Blood transfusion (no,%)		2	
Total No (%)	12 (10.8%)	10 (10.4%)	
Clavien-Dindo Classifications (No,%)			
Grade 1	11	4	
Grade 2	0	2	
Grade 3	0	4	
Grade 4	1	0	

Table 3: Complications.

Renal Function Tests; P<0.005, significant.

Discussion

The lower calyx of the kidney carries the risk of forming more stones and stone treatment involving more difficulties due to anatomic disadvantages compared to other regions of the kidney. ESWL offers very good SFR rates for lower calyx stones up to 1 cm, but involves many unknowns for stones above 2 cm like formation of stone paths by stone fragments, no fragmentation of stones or fragments not leaving the calyx [1].

Standard and/or miniaturized PCNL methods are currently the best treatment methods known for kidney stones larger than 2 cm. Including the lower calyx, stone free rates of 85-100% can be obtained for all kidney stones. But the procedure may cause blood loss, neighboring organ injury and parenchyma injury in the kidney. Mini-PCNL has begun to be used to reduce the complications of standard PCNL [3].

RIRS can be easily used to access the most difficult calyx of the lower calyx due to 270-degree flexion capability and increased image quality for upper urinary tract stones with the current advances in flexible endoscopic technology. Guidelines recommend flexible URS as an alternative treatment choice for upper urinary system stones smaller than 2 cm and resistant to ESWL [1]. This provides better stone-free rates compared to ESWL for this group of stones.

Most authors in the literature appear to choose RIRS for some patients with large stones either to avoid the complication risks associated with PCNL methods or because PCNL is risky for the patient. For high risk patients for mini-PCNL surgery, including patients with hemorrhage diathesis, morbid obesity, and musculoskeletal system deformities, it appears to be more logical to consider RIRS instead of mini-PCNL for anterior calyx stones which are difficult to access with mini-PCNL, stones requiring multiple access, solitary kidney or ureter upper level stones. In parallel with this, it is a reality that it is beneficial to note body habitus, renal anatomy, cost and patient choice in making the decision about which method to use for treatment of patients [4,5].

Currently native tract surgery has increased urologist's enthusiasm. In terms of acting as a guide to urologist colleagues, we compared surgical results for mini-PCNL with the current fashion of RIRS for lower calyx stones from 2-3 cm, as we did not find many examples in the literature. Different to mini-PCNL, the success of the flexible endoscope for lower calyx stones requires some favorable anatomic criteria related to the kidney like IPA, IW, IL and PCH [6]. In patients with these favorable criteria, RIRS may provide stone-free rates of 60-93% for lower calyx stones [7,8]. Mini-PCNL may provide stone-free rates of 90-97% for lower calyx stones [8]. It is necessary to state that the most important element to increase the success of both surgeries is the experience of the surgeon. Additionally, it is known that mini-PCNL is superior to RIRS for patients with lower calyx diverticulum stones and closed infundibulum.

In terms of SFR and surgery durations in metaanalysis and original articles comparing standard PCNL and RIRS for lower calyx stones <2 cm and >2 cm [4,5,8-12], PCNL was found to be superior to RIRS in terms of hospital stay, complications, hemoglobin fall and fluoroscopy. RIRS was reported to be an alternative to invasive PCNL

in this group of stone patients. It should not be forgotten that to obtain acceptable success with RIRS for lower calyx stones, there may be a need for repeated sessions and support by auxiliary methods [7,13].

A retrospective study by Li, et al. compared mini-PCNL (16 F surgical sheath, 10 F nephroscope) with RIRS for 1.5-2.5 cm lower calyx stones and revealed the advantage of RIRS for duration of hospital stay and cost [14]. They reported the outcomes for mean surgical duration and total stone-free rates were similar for both methods. They emphasized that RIRS may be a good alternative treatment choice to mini-PCNL for lower pole stones.

The metaanalysis study by Gao, et al. reported that mini-PCNL was more successful that RIRS for lower calyx stones in terms of SFR [15]; however, RIRs involved shorter hospital stay and less hemoglobin fall. They found the SFR rates for small tract surgeries like ultramini- and micro-PCNL to be similar to RIRS.

Fayad, et al. compared tube-free mini-PCNL with RIRS for lower calyx stones smaller than 2 cm in a prospective randomized study [16]. They found mini-PCNL disadvantageous in terms of length of hospital stay, while it was more advantageous than RIRS in terms of surgical duration. In terms of SFR, mini-PCNL was more successful (92.72%, 84.31% for mini-PCNL and RIRS, respectively). They found the increased fever rate was higher after RIRS.

Jiao, et al. reported mini-PCNL was more effective for lower calyx stones from 1-2 cm compared with RIRS [17], while there was longer duration of stay and increased hematoma incidence. Both methods were the same for measurement of postop pain and surgery duration.

Lee, et al. in a prospective and randomized controlled study of RIRS and mini-PCNL for kidney stones larger than 1 cm found they were equivalent in terms of SFR [18], surgery duration, amount of hemoglobin fall and duration of hospital stay. However, postoperative VAS and analgesic requirements were worse in the RIRS group.

Wilheim, et al. compared ultramini-PCNL and RIRS for kidney stones from 10-35 mm in size [19]. For medium and large kidney stones, both methods had similar SFR and were successful (UM-PCNL vs. RIRS 92% vs. 96%) with RIRS more advantageous in terms of hospital stay.

Kandemir, et al. found SFR and complication rates were similar for RIRS and the microperc method for lower calyx stones up to 1.5 cm in size [20]. They reported microperc was disadvantageous in terms of stay in hospital and fluoroscopy time.

Gross, et al. reported the success of RIRS for lower pole stones in expert hands [21], that it may be performed with low complication rates and that it was superior to invasive percutaneous methods in terms of morbidity.

De, et al. in a metaanalysis study reported RIRS was ahead of minimally invasive PCNL for stones smaller than 2 cm in terms of SFR [22]. They stated that RIRS also had advantages in terms of short hospital stay, while complication rates and amount of hemoglobin fall were worse than PCNL methods.

Jiang, et al. compared RIRS and mini-PCNL in a metaanalysis researching 13 articles and stated the stone-free rate for kidney stones with mini-PCNL was statistically superior [23].

Pelit, et al. in a retrospective study evaluated RIRS and mini-PCNL for kidney stone patients with mean stone size of 2 cm [24]. Mean surgical duration, fluoroscopy duration, and hospital stay was worse for mini-PCNL, while with the aid of auxiliary methods final SFR were 90.6% and 91.1% for RIRS and mini-PCNL, respectively. With both methods, no major complication according to the Clavien Dindo classification was encountered.

Ramon, et al. compared miniperc with RIRS. Miniperc had disadvantages in terms of hemoglobin fall values [25], analgesic agent requirements and hospital stay, while RIRS had disadvantages of requiring more sessions for large volume stones, long surgical duration and higher costs of hospital stay.

In our study, after single session mini-PCNL our success rate of 82.3% at the end of the 1st month increased to 93.75% after 3 months with auxiliary treatments like ESWL and URS. With RIRS, repeated sessions and auxiliary methods increased our success rate to 89.19% in the postoperative 3rd month ($P>0.05$). In light of these values, in patients with favorable anatomic criteria and stones from 2-3 cm, we think RIRS may be a good alternative treatment choice to invasive PCNL methods.

In our study, we experienced 10.8% complication in RIRS patients and 10.4% complications with mini-PCNL patients. In the literature, most mini-PCNL complications are below grade 3, with most being grade 1 complications and rates reported from 11.9-37.9%. Like most similar studies in the literature there were no grade 4 and 5 complications in our mini-PCNL group [3,23].

For RIRS most complications are below Clavien 3 with rates reported from 12-35% [13,26]. In our series, only 1 patient had a grade 4 complication. The patient was given intensive care treatment due to subcapsular hematoma and urosepsis and after conservative intensive care treatment, the initially 11 x 7 x 5 cm hematoma completely resolved by the 3rd month on renal USG. Of RIRS complications, 50% were the grade 1 complication of urosepsis. Preoperative large stone size, postoperative residue and comorbidities (like DM and cardiovascular disease) increase the postoperative complication rates for both mini-PCNL and RIRS. In the literature complications like fever, UTI, and urosepsis after RIRS are reported to be observed at higher rates than after invasive PCNL surgeries. Tokas, et al. reported that in RIRS surgeries, especially if UAS is not used [27], intrarenal pressure was monitored above 40 mmHg during surgery, while pressure remained below 20 mmHg during the whole surgery in mini-PCNL. High progression of intrarenal pressure during surgery may cause urosepsis to be observed at higher rates after RIRS. After mini-PCNL, the amount of hemoglobin decrease and blood transfusion requirements were greater than after RIRS.

Mini-PCNL causes a greater fall in hemoglobin than RIRS (9). It is reported there are 0.85-3% rates of blood transfusion and embolization requirements with mini-PCNL [13,23]. In our patients, 2.1% required blood transfusion.

Mini-PCNL, RIRS'dan daha fazla hemoglobin değerlerinde düşüşe neden olmaktadır [23]. Mini-PCNL'de %0.85-3 oranında kan transfüzyonuna ve embolizasyona ihtiyaç duyulduğu bildirilmektedir [13,23]. Hastalarımızın %2.1'de kan transfüzyonu ihtiyacımız oldu.

The metaanalysis by Jiang, et al. reported the complication rate for RIRS was lower compared to mini-PCNL, with similar Clavien grade 1 and 3 complication rates, but fewer grade 2 complications

compared to RIRS. Hemorrhage rates were reported to be higher with mini-PCNL [23].

Jones in a metaanalysis found 15.2% complication rate after mini-PCNL. According to the Clavien classification, they reported 44%, 28% and 28% Grade 1, 2 and 3 complications, respectively. No patient was found to have Clavien grade 4 or 5 complications [3].

Fluoroscopy is used in every stage of PCNL to enter the kidney with the nephroscope and visualize the stone and comprises a health risk for the doctor, patient and health workers in the surgery. In the literature, as in our study, studies comparing mini-PCNl and RIRS showed m-PCNL was disadvantageous in this regard [23]. Currently there are authors achieving the same surgical success without any fluoroscopy with RIRS. Perhaps the use of ultrasonography for initial entry to the kidney with mPCNL may reduce the fluoroscopy exposure slightly.

We examined VAS in the first 12 hours postoperative and found RIRS was statistically advantageous compared to mPCNL, with similar results to most studies. Pain is a situation lengthening duration of hospital stay and requiring the use of more narcotic analgesics and anti inflammatories. The nephrostomy tube, urethral probe, invasive entry to the muscle group in the flank region and kidney capsule-parenchyma causes more sensation of pain in mPCNL compared to native ureter surgery (RIRS). In parallel to the pain score, the RIRS group remained statistically behind analgesic use by mPCNL patients both in terms of variety of painkillers and frequency. However, though RIRS appears advantageous in terms of pain in the perioperative period, it is necessary to consider lower urinary tract complaints linked to JJ stent after discharge. Most patients complain about lower urinary tract system problems and some have the stent removed in the early period. Bryniarski, et al. found the postoperative VAS and narcotic analgesic use in the PCNL group was higher than the RIRS group [28].

Our duration of hospital stay was significantly high for mPCNL. A metaanalysis Forrest plot study by Kang reported RIRS was more advantageous in terms of hospital stay (MD 2.21 %95 Cl 0.49-3.93, P:0.12) [12]. As RIRS access is through the natural route, each stage of the surgery is performed visually and there is low complication risk, the duration of hospital stay being superior to PCNL is an expected result.

The major limitation of our study is the relatively low sample numbers in both groups. The main drawback for RIRS is the high cost of flexible URS and equipment and laser lithotripsy, especially in developed countries.

In conclusion, we consider that RIRS is close to mini-PCNL in terms of surgical duration, stone-free rate, and repeated session requirements and is an applicable alternative method due to advantages in terms of complications, duration of hospital stay, fewer pain complaints and less painkiller requirements, and blood loss for appropriate patients with lower calyx kidney stones from 2-3 cm.

References

1. Turk C, Knoll T, Petrik A, et al. Guidelines on Urolithiasis. EAU 2015: 1–71.

2. Lee JY, Jeh SU, Kim MD, Kang DH, Kwon JK, et al. (2017) Intraoperative and postoperative feasibility and safety of total tubeless, tubeless, smallbore tube, and standard percutaneous nephrolithotomy: A systematic review and network meta-analysis of 16 randomized controlled trials. BMC Urol 17: 48.

3. Jones P, Elmussareh M, Aboumarzouk OM, Mucksavage P, Somani BK (2018) Role of Minimally Invasive (Micro and Ultra-mini) PCNL for Adult Urinary Stone Disease in the Modern Era: Evidence from a Systematic Review. Curr Urol Rep 19: 27.

4. Donaldson JF, Lardas M, Scrimgeour D, Stewart F, MacLennan S, et al (2015) Systematic review and meta-analysis of the clinical effectiveness of shock wave lithotripsy, retrograde intrarenal surgery, and percutaneous nephrolithotomy for lower-pole renal stones. Eur Urol 67: 612-616.

5. Yuri P, Hariwibowo R, Soeroharjo I, Danarto R, Hendri AZ, et al. (2018) Meta-analysis of Optimal Management of Lower Pole Stone of 10 - 20 mm: Flexible Ureteroscopy (FURS) versus Extracorporeal Shock Wave Lithotripsy (ESWL) versus Percutaneus Nephrolithotomy (PCNL). Acta Med Indones 50:18-25.

6. Zheng C, Xiong B, Wang H, Luo J, Zhang C, et al (2014) Retrograde intrarenal surgery versus percutaneous nephrolithotomy for treatment of renal stones >2 cm: A meta-analysis. Urol Int. 93: 417-424.

7. Chung DY, Kang DH, Cho KS, Jeong WS, Jung HD, et al. (2019) Comparison of stone-free rates following shock wave lithotripsy, percutaneous nephrolithotomy, and retrograde intrarenal surgery for treatment of renal stones: A systematic review and network meta-analysis. PLoS One 14: 0211316.

8. Gao XS, Liao BH, Chen YT, Feng SJ, Gao R, et al (2017) Different Tract Sizes of Miniaturized Percutaneous Nephrolithotomy Versus Retrograde Intrarenal Surgery: A Systematic Review and Meta-Analysis. J Endourol 31: 1101-1110.

9. Jiang HY, Yu Z, Chen L, Wang T, Liu Z, et al. (2017). Article Minimally Invasive Percutaneous Nephrolithotomy versus Retrograde Intrarenal Surgery for Upper Urinary Stones: A Systematic Review and Meta-Analysis. BioMed Research International Pg no: 14.

10. Kilicarslan H, Kaynak Y, Kordan Y, Kaygisiz O, Coskun B, et al. (2015) Unfavorable anatomical factors influencing the success of retrograde intrarenal surgery for lower pole renal calculi. Urol J. 12: 2065-2068.

11. Parikh KP, Jain RJ, Kandarp AP (2018) Is retrograde intrarenal surgery the game changer in the management of upper tract calculi? A single-center single surgeon experience of 131 cases. Urol Ann 10: 29-34.

12. Bozkurt OF, Resorlu B, Yildiz Y, Can CE, Unsal A (2011) Retrograde intrarenal surgery versus percutaneous nephrolithotomy in the management of lower pole renal stones with a diameter of 15 to 20 mm. J Endourol 25: 1131-1135.

13. Bozzini G, Verze P, Arcaniolo D, Dal Piaz O, Buffi NM, et al. (2017) A prospective randomized comparison among SWL, PCNL and RIRS for lower calyceal stones less than 2 cm: a multicenter experience : A better understanding on the treatment options for lower pole stones.World J Urol 35: 1967-1975.

14. Kang SK, Cho KS, Kang DH, Jung HD, Kwon JK, et al. (2017) Systematic review and meta-analysis to compare success rates of retrograde intrarenal surgery versus percutaneous nephrolithotomy for renal stones >2 cm An update. Medicine (Baltimore) 96:49.

15. Zhao Z, Sun H, Zeng T, Deng T, Liu Y, et al. (2019) An easy risk stratification to recommend the optimal patients with 2-3 cm kidney stones to receive retrograde intrarenal surgery or mini-percutaneous nephrolithotomy. Urolithiasis.

16. Li MM, Yang HM, Liu XM, Qi HG, et al (2018) Retrograde intrarenal surgery vs miniaturized percutaneous nephrolithotomy to treat lower pole renal stones 1.5-2.5 cm in diameter.World J Clin Cases 6: 931-935.

17. Fayad AS, Elsheikh MG, Ghoneima W (2016) Tubeless mini-percutaneous nephrolithotomy versus retrograde intrarenal surgery for lower calyceal stones of ≤ 2 cm: A prospective randomised controlled study. Arab J Urol 15: 36-41.

18. Jiao B, Luo Z, Xu X, Zhang M, Zhang G (2019) Minimally İnvasive percutaneous nephrolithotomy versus retrograde intrarenal surgery in surgical management of upper urinary stones - A systematic review with meta-analysis. Int J Surg 1:1-11.

19. Lee JW, Park J, Lee SB, Son H, Cho SY, et al. (2015) Mini-percutaneous Nephrolithotomy vs Retrograde Intrarenal Surgery for Renal Stones Larger Than 10 mm: A Prospective Randomized Controlled Trial.Urology 86: 873-877.

20. Wilhelm K, Hein S, Adams F, Schlager D, Miernik A, et al. (2015) Ultramini PCNL versus flexible ureteroscopy: a matched analysis of analgesic consumption and treatment-related patient satisfaction in patients with renal stones 10-35 mm.World J Urol. 33: 2131-2136.

21. Kandemir A, Guven S, Balasar M, Sonmez MG, Taskapu H, et al. (2017) A prospective randomized comparison of micropercutaneous nephrolithotomy (Microperc) and retrograde intrarenal surgery (RIRS) for the management of lower pole kidney stones.World J Urol 35: 1771-1776.

22. Gross AJ, Bach T (2008) Lower pole calculi larger than one centimeter: Retrograde intrarenal surgery. Indian J Urol 24: 551-554.

23. De S, Autorino R, Kim FJ, Zargar H, Laydner H, et al. (2015) Percutaneous nephrolithotomy versus retrograde intrarenal surgery: a systematic review and meta-analysis. Eur Urol 67: 125-137.

24. Pelit ES, Atis G, Kati B, Akin Y, Çiftçi H, et al. (2017) Comparison of Mini-percutaneous Nephrolithotomy and Retrograde Intrarenal Surgery in Preschool-aged Children.Urology. 101: 21-25.

25. Ramón de Fata F, Hauner K, Andrés G, Angulo JC, et al. (2015) Miniperc and retrograde intrarenal surgery: When and how? Actas Urol Esp 39: 442-450.

26. Lavan L, Herrmann T, Netsch C, Becker B, Somani BK (2019) Outcomes of ureteroscopy for stone disease in anomalous kidneys: a systematic review.World J Urol.

27. Tokas T, Skolarikos A, Herrmann TRW, Nagele U; Training and Research in Urological Surgery and Technology (T.R.U.S.T.)-Group (2019) Pressure matters 2: intrarenal pressure ranges during upper-tract endourological procedures.World J Urol 37: 133-142.

28. Bryniarski P, Paradysz A, Zyczkowski M, Kupilas A, Nowakowski K, et al. (2012) A randomized controlled study to analyze the safety and efficacy of percutaneous nephrolithotripsy and retrograde intrarenal surgery in the management of renal stones more than 2 cm in diameter. J Endourol 26: 52-57.

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