

# Mini percutaneous nephrolithotomy versus retrograde flexible ureterorenoscopy in the treatment of renal calculi in anomalous kidneys

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## Summary

**Objectives:** To report our single center experience in comparing mini-percutaneous nephrolithotomy versus flexible ureterorenoscopy for management of renal stones up to 2 cm in anomalous kidneys.

**Materials and methods:** Records of the last 30 patients with stones less than 2 cm in anomalous kidney treated by mini-percutaneous nephrolithotomy were reviewed and compared to last 30 patients treated by flexible ureterorenoscopy.

**Results:** Mean stone size was significantly higher in the mini-percutaneous nephrolithotomy group (17.90 mm) than in flexible ureterorenoscopy group (14.97mm) ( $p < 0.001$ ). Mean operative time (80.33 min vs 56.43 min) and fluoroscopy exposure time (4.49 min vs 0.84 min) were significantly higher in the mini-percutaneous nephrolithotomy group than in the flexible ureterorenoscopy group ( $p < 0.001$ ). The mean post-operative drop in hemoglobin concentration was significantly higher in the mini-percutaneous nephrolithotomy group (0.47 gm versus 0.2 gm) ( $p < 0.001$ ). Stone free rate after 12 weeks follow up was not statistically significant between the 2 groups (90% in mini-percutaneous nephrolithotomy vs 80% in flexible ureterorenoscopy) ( $FEp = 0.472$ ).

**Conclusions:** Both modalities were found to be safe and effective for treatment of stones less than 2 cm in anomalous kidneys.

**KEY WORDS:** Mini percutaneous nephrolithotomy; Flexible ureterorenoscopy; Anomalous kidneys.

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## INTRODUCTION

Congenital anomalies of the kidney including anomalies of lie, rotation and fusion are caused by impaired migration of the ureteric bud and metanephric blastema upwards from pelvis to upper abdomen. The renal calyces are normally rotated 30-50 degrees behind the coronal axis so that the calyces point laterally, and the pelvis points antero-medially, when this axis is disturbed, the condition is known as renal malrotation (1).

The incidence of urolithiasis in anomalous kidneys is higher than in normal kidney, as these conditions lead to impaired urine drainage and urinary stasis as well as an increased incidence of upper urinary tract infection.

The anatomy and location of these kidneys makes the management of urolithiasis challenging (2). The majority of those patients have been historically treated with open surgery. However nowadays various minimally

invasive modalities for stone treatment are used in those patients, such as, *percutaneous nephrolithotomy* (PNL), mini-perc, ultramini-perc, micro-perc, extracorporeal shockwave lithotripsy (SWL) and *flexible ureterorenoscopy* (F-URS) with reported variable stone free rates. Other possible available treatment options are laparoscopic-assisted PNL and *laparoscopic pyelolithotomy* (LP) (3).

In the present study, we report our single center experience in comparing mini-perc versus F-URS for management of renal stones up to 2 cm in patients with anomalous kidneys.

## MATERIALS AND METHODS

We retrospectively reviewed the records of patients with stones in anomalous kidneys treated by miniperc between January 2016 to June 2020 and we compared them to the records of patients with same stone criteria treated by flexible ureterorenoscopy. We excluded patients below 18 years, stones more than 2 cm in maximum diameter or patients with multiple stones and patients with ectopic pelvic kidneys. Preoperative radiological investigations included plain X-ray of abdomen and pelvis and non-contrast CT. Stone size was calculated by measuring the maximum stone diameter.

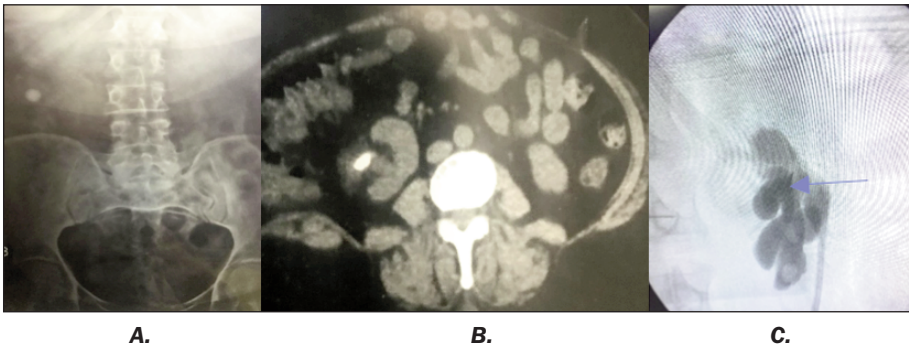
All procedures were performed by the same surgeon at our institute.

### Mini-perc group

All procedures were performed under general anesthesia. Insertion of a 6 Fr open tip ureteric catheter was performed in the lithotomy position, then the patient was turned prone. All pressure points were padded.

The optimal calyx of entry was determined by using both biplanar C-arm fluoroscopy after retrograde injection of the half-diluted contrast and ultrasonography (Figure 1). If bowel and/or viscera were found across the chosen access, then it was displaced away by pressure of US probe as was described by *Desai et al.* (4). A tract was gradually dilated with fascial dilators (*Cook Urological, USA*) and 16.5/17.5 operating sheath was inserted.

A 34-cm long semirigid ureteroscope (9.5 Fr) (*Karl Storz; Tuttlingen, Germany*) was used with *Auriga XL 50W Holmium Laser machine (Boston scientific; USA)* and 600  $\mu$  laser fiber. After inspection of the pelvicalyceal system, the



**Figure 1.** (A). Plain KUB showing right hypochondrial radiopaque shadow (B). Axial CT cut showing 1.2 cm stone in right laterally malrotated kidney (C). Fluoroscopic image after retrograde pyelogram showing complete lateral renal pelvis malrotation with stone inside (blue arrow).

stone was dusted using holmium-Yag laser with energy of 0.5-0.8 J and frequency of 12-16 Hz. Most of the small fragments were cleared spontaneously with irrigation fluid coming out around the ureteroscope. Larger fragments were retrieved by a 5 Fr forceps (Karl Storz, Tuttingen, Germany). If the pelvicalyceal system, under fluoroscopic and nephroscopic inspection, was found to be clear, a 6 Fr double-J stent (DJ) was placed if needed with or without insertion of 14 Fr nephrostomy tube (PCN).

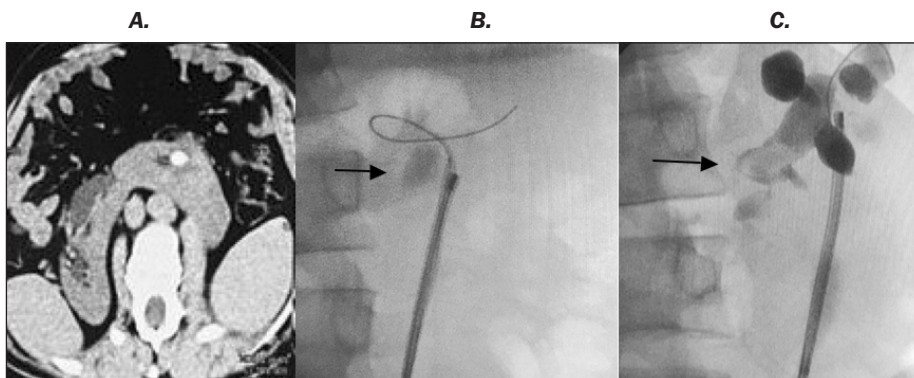
**F-URS group**

All procedures were performed under general anesthesia with the patient in the lithotomy position, using a 9.5-Fr semi-rigid ureteroscope (Karl Storz; Germany); the ureter was cannulated with a 0.038-inch hydrophilic tip guidewire. The lower ureter was dilated by the semi-rigid ureteroscope (Karl Storz, Germany) over the guidewire. Retrograde pyelogram through the ureteroscope was done for better understanding of the pelvi-calyceal anatomy. After dilating the ureteral orifice and lower ureter a second hydrophilic tip guidewire was inserted into the pelvicalyceal system. Under fluoroscopic guidance a 7.5 Fr F-URS (Flex-X2; STORZ, Tuttingen, Germany) was back loaded on one of the guidewires into the kidney (Figure 2). A pressurized manual irrigation pump was used to have clear vision. After inspection of the pelvis and calyces and identification of the stone, Auriga XL 50W Holmium YAG Laser machine (Boston scientific; USA) and 200/312 μ laser fiber, with settings of 0.5-0.8 J/12-16 Hz was used for dusting the stone. In some patient when in situ stone dusting was difficult, the stones were relocated into the upper calyx using a zero tipped nitinol basket (Boston scientific, USA) basket. A JJ stent was placed in all patients after the completion of the procedure under fluoroscopy. Intraoperative variables

were recorded including operative time, fluoroscopy time, need for blood transfusion, complications, etc. Postoperative assessment included hemoglobin level, serum creatinine level, need for auxiliary procedures, complications according to Clavian Dindo classification, and pain assessment using visual analogue scale (VAS) (5). Plain X-ray abdomen and pelvis was done on the first postoperative day and at 3 months. Non contrast CT was also performed. Stone free status (SFR) was defined as the absence of any residual fragments ≥ 3 mm at 3 months in CT. Statistical analysis was carried out using SPSS statistics software version 20. Categorical variables were described using frequencies and percentages. Chi-square test was used for testing associations between categorical variables. When the assumptions of chi-square test were not met, Fisher's exact p value was selected for 2:2 tables and Monte Carlo p value was reported for more than 2:2 tables. Continuous variables were described using mean and standard deviation. In such case, independent sample t-test was used for comparing two independent groups and paired sample t- test was used for comparing two dependent groups. Statistical significance was accepted as p < .05. All applied statistical tests of significance were two-tailed.

**RESULTS**

Both groups were comparable regarding age, sex, body mass index and mean stone density. Mean stone size was significantly higher in the mini-perc group than in F-URS group (p < 0.001). Patients' demographic data and stone criteria are listed in Table 1. Overall, the most common presenting symptom was pain (66.7% of patients in mini-perc group vs 40% in F-URS group) and the most common stone location was the renal pelvis in both groups.



**Figure 2.** (A). Axial CT cut showing 1.5 cm stone in the lower calyx of left kidney in patient having horseshoe kidney (B). Intraoperative fluoroscopic image showing the f-URS inside the left kidney and the stone (black arrow) (C). Fluoroscopic image after retrograde contrast injection into the pelvicalyceal system through the f-URS and showing the stone in the lower calyx (black arrow).

**Table 1.**  
Comparison between the two studied groups according to demographic data and stone criteria.

	Mini perc (n = 30)		RIRS (n = 30)		p
	No.	%	No.	%	
Sex					0.519
Male	25	83.3	23	76.7	
Female	5	16.7	7	23.3	
Age (years)					0.594
Mean ± SD	42.53 ± 10.47	41.07 ± 10.71			
BMI					0.553
Mean ± SD	29.30 ± 2.78	28.80 ± 3.64			
Nature of the renal anomaly					<sup>Mc</sup> p = 0.451
Medial malrotation	6	20.0	4	13.3	
Ventral malrotation	10	33.3	13	43.3	
Lateral malrotation	1	3.3	2	6.7	
Horseshoe kidney	10	33.3	10	33.3	
Renal duplication	3	10	0	0.0	
Crossed ectopic kidney	0	0.0	1	3.3	
Stone side					0.121
Right	12	40.0	18	60.0	
Left	18	60.0	12	40.0	
Stone site					<sup>Mc</sup> p = 0.136
Renal pelvis	25	83.3	17	56.7	
Lower calyx	4	13.3	9	30.0	
Upper calyx	0	0.0	1	3.3	
Middle calyx	1	3.3	3	10.0	
Stone size (mm)					< 0.001*
Mean ± SD	17.90 ± 2.43		14.97 ± 3.50		
Stone density (HU)					0.358
Mean ± SD	1148.7 ± 279.6		1087.9 ± 225.3		

From January 2016 till June 2020, 103 patients with stones in anomalous kidneys were treated in our institution; 25 patients were excluded from the current study as they were not meeting the inclusion criteria; 37 patients were treated with mini-perc and 35 patients were treated with f-URS. After excluding 7 patients in the mini-perc group who were lost to follow up and 5 patients in f-URS group, we evaluated 30 patients in the mini-perc group and 30 in the F-URS group (Figure 3). Operative time (80.33 min vs 56.43 min) and fluoroscopy exposure time (4.49 min vs 0.84 min) were significantly higher in the mini-perc group than in the F-URS group respectively. Also, the post-operative drop in hemoglobin concentration was significantly higher in the mini-perc group than f-URS group (0.47 gm versus 0.2 gm respectively) ( $p < 0.001$ ). No statistically significant difference between the 2 groups was found regarding hospital stay. Blood transfusion was required in only 1 patient in the mini-perc group (Clavien grade II). Clinical and operative outcomes are summarized in Table 2.

Middle calyceal puncture was done in 15 patients, upper calyceal puncture in 10 patients, lower calyceal puncture in 4 patients and non-papillary puncture in 1 patient.

Stone free rate on day 1 postoperative was 76.7% (23/30) in mini-perc group and 40% (12/30) in F-URS group; the difference was statistically significant ( $p = 0.004$ ). After 3 months there was no statistically significant difference in the SFR between both groups. The clinical and operative outcomes are summarized in Table 2.

In the mini-perc group, two patients underwent SWL

for residual fragments and one patient was considered for follow up. In F-URS group, 2 patients required a second session of F-URS for residual fragments, 1 patient underwent SWL and 3 patients were considered for follow up. In terms of complications, 4 patients in mini-perc group suffered moderate postoperative pain (Clavien grade 1) despite receiving sodium diclofenac and 2 patients developed fever. In F-URS group, three patients suffered moderate colic pain postoperatively (Clavien grade 1) and fever developed in 6 patients (20%). Mild postoperative hematuria was observed in 15 patients (50%) in each group.

## DISCUSSION

Stones within the normal pelvicalyceal system are accessed and endoscopically treated based on specific and well-known stone factors such as size and location. Guidelines and indications of endoscopic management of stones are well known in orthotopic and orthomorph renal units. However, in the anomalous renal units, deviation from the standard anatomical structure makes stone access and manipulation more challenging.

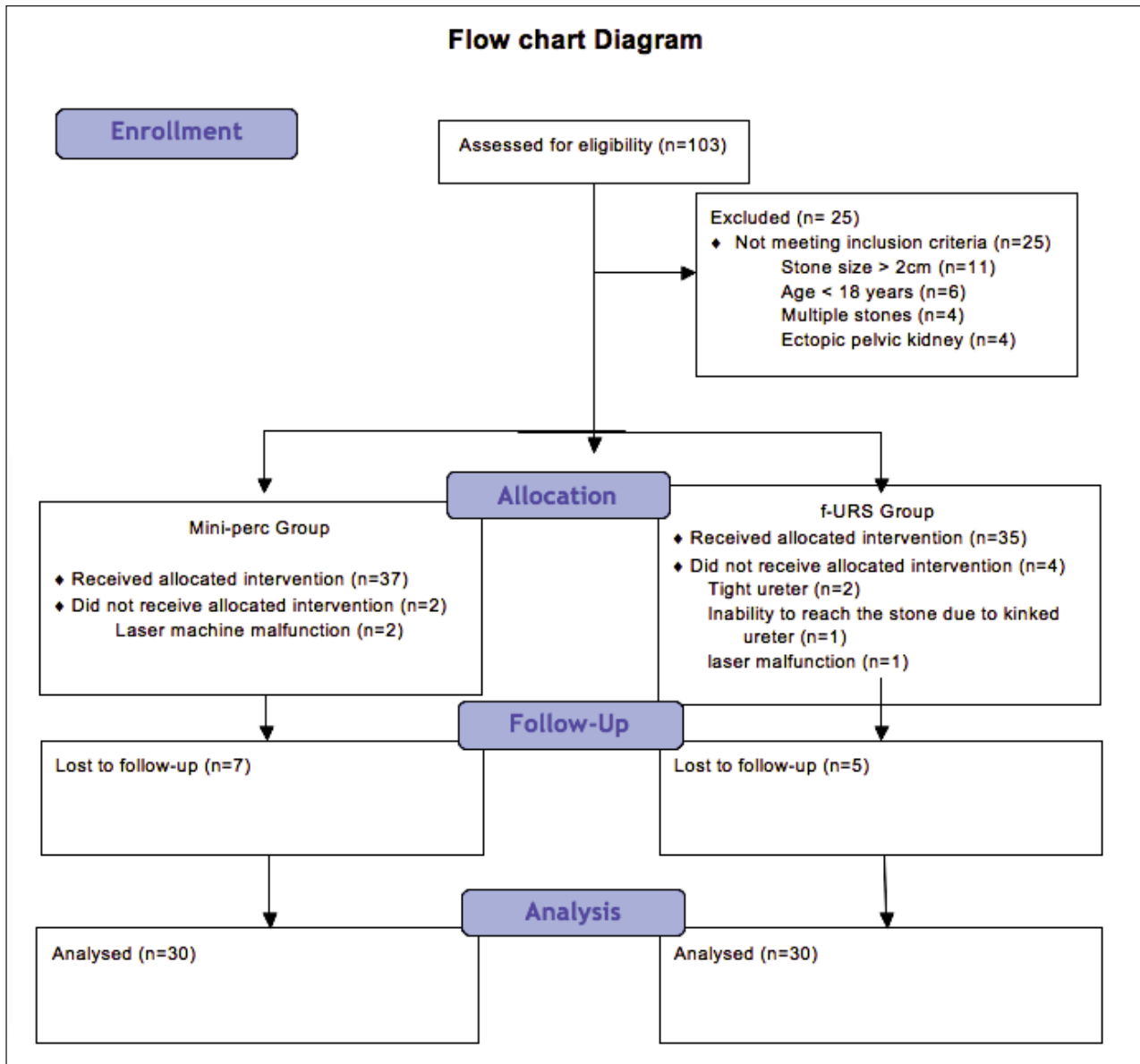
In this study, we observed our previously managed patients with stones in anomalous kidneys. The purpose of this research was to compare the outcome of mini-perc and flexible URS in treating stones less than 2 cm in diam-

**Table 2.**  
Comparison between the 2 groups regarding clinical and operative outcomes.

	Mini perc (n = 30)		RIRS (n = 30)		p
	No.	%	No.	%	
Intraoperative complications					<sup>ff</sup> p = 0.237
Yes (red out)	3	10	0	0	
No	27	90	30	100	
Blood transfusion					<sup>ff</sup> p = 1.000
Yes	1	3.3	0	0	
No	29	96.7	30	100.0	
Operative time (minutes)					< 0.001*
Mean ± SD	80.33 ± 15.42		56.43 ± 18.6		
Radiation exposure time (minutes)					< 0.001*
Mean ± SD	4.49 ± 0.80		0.84 ± 0.41		
SFR (3 months)					<sup>ff</sup> p = 0.472
Stone free	27	90	24	80	
Significant residual	3	10	6	20	
Hospital stay (day)					0.704
Mean ± SD	1.27 ± 0.64		1.33 ± 0.71		
Hb drop					< 0.001*
Mean ± SD	0.47 ± 0.34		0.20 ± 0.14		
Auxiliary procedure					<sup>ff</sup> p = 1.000
Yes	2	6.7	3	10	
No	28	93.3	27	90	
Fever					<sup>ff</sup> p = 0.254
Yes	2	6.7	6	20	
No	28	93.3	24	80	
Hematuria					<sup>ff</sup> p = 1.000
Yes (mild)	15	50	15	50	
No	15	50	15	50	
(VAS) Pain					<sup>Mc</sup> p = 0.214
No pain	1	3.3	3	10	
Mild	25	83.3	24	80	
Moderate	4	13.3	3	10	

**Figure 3.**

Flow chart like diagram of inclusion and exclusion criteria showing number of patients excluded, number of patients enrolled, and number of patients subjected to analysis in each group.



eter in patients with anomalous kidneys. Several variables were studied and correlated to stone free rate and incidence of complications. Patients of the two groups were matched in terms of preoperative factors except for stone size, which reflected the surgeon's preference for the mini-perc in large stones over f-URS. To our knowledge, there is not much data in the literature comparing mini-perc with f-URS for treatment of small and medium sized stone in anomalous kidneys. Although the SFR in the mini-perc group (90%) is higher than the f-URS group the difference is not statistically significant and it is associated with a lower complication rate in the f-URS group. Post-operative Hb drop was significantly higher in the mini-perc group than the f-URS group.

PNL is considered an acceptable intervention for stones in anomalous kidneys with reported high SFR (> 90%) (6, 7). Unfortunately, in anomalous kidneys, PNL is

challenging and potentially associated with risks of access failure and vascular injuries (7).

There are several studies that reported the SFR after PNL in patients having different renal anomalies (6-9). *Mosavi-Bahar et al.* (8), initially reported 81% success rate after a first session which increased to 100% after second-look PNL and/or SWL in 16 patients with anomalous kidneys. Similar data with comparable outcome were reported by *Gupta et al.* (6) and *Rana et al.* (9). In a larger series, *Osther et al.* (7), reported standard-PNL in 202 anomalous-kidneys with SFR of 76.6%.

Furthermore, mini-perc in anomalous kidneys was prospectively evaluated by *Sanjay-Khadgi et al.* (10) who reported a SFR of 89.8% after a single session, which was improved to 93.2% after a 2<sup>nd</sup> mini-perc session and to 98.3% after auxiliary SWL. Similarly, in our cohort, despite the retrospective nature and the smaller size, we

reported 90% initial SFR. In the current study, significantly longer operative time was reported in the mini-perc group that can be a consequence of a selection bias as larger stones were more frequently treated by mini-perc while small stones by flexible URS. Operative time in the current study in mini-perc group (45.0-110 min) is comparable to what was previously reported with standard PNL (69-100 min) (6-9) and in other mini-perc studies (25-105 min). (10) Mean operative time in F-URS group in the current study was  $56.43 \pm 18.6$  min compared with other series, which showed an operative time of 106 min by Weizer *et al.* (2), 126 min by Molimard B *et al.* (11) and 74 min by Gajendra *et al.* (12). In the current series the targeted calyces were selected according to the site of the stone inside the kidney, although in horseshoe kidney upper calyceal puncture was selected in all patients to facilitate access to renal pelvis and lower calyx and avoid bowel injury. The lower calyceal stones which represented 30.0% of the total stone site in f-URS group were approached by the scope deflection in order to take them by tipless nitinol Dormia baskets and to reposition in a more favorable site (upper calyces or renal pelvis) for laser lithotripsy (5 patients) or to dust them in situ (4 patients) which took a longer operative time than stones in the other sites, so explaining the wide variation in operative time in f-URS group. The mean hospital stay in the present series is shorter (1.27 days) than reported in previously mentioned standard PNL studies (3-3.2 days) (6-9) and in a mini-perc study (2.75 days) (10).

Intraoperative blood loss and consequent blood transfusion was the most alarming adverse event in our mini-perc series. This group reported significantly greater hemoglobin drop 0.47 g/dl than in flexible URS group and required blood transfusion in one patient (3.3%). Blood loss was comparable to what reported by similar studies, due to the presence of abnormal vasculature (6, 13, 14). However, none of our patients in the mini-perc group required angio-embolization, that was reported in some studies using standard PNL (15).

In the current study, no pleura related complications occurred in either group.

Correspondingly, Shokeir *et al.* (15), and Viola *et al.* (16), did not report pleural injuries after upper pole puncture in patients with horseshoe-kidney. On the other hand, Mosavi-Bahar *et al.* reported mild pleural complication in two patients (8). Gupta *et al.* (6), and Ozden *et al.* (17), reported pleural injury which was managed by intercostal tube insertion in one patient. Raj *et al.* reported pneumothorax in 6 % of patients with horseshoe kidneys undergoing PNL (18).

Acute deflection capability (up to 270°) and clear vision of new generation flexible ureteroscope together with progressively thinning of laser fibers and introduction of nitinol stone baskets have facilitated management of calculi located in lower calyces or difficult accessed calyces, therefore f-URS has the potential ability to overcome the anatomical and technical challenges of stone treatment in renal anomalies, leading to SFR (70 to 88.2%) in up to 1.5 sessions for stones < 3 cm (2, 11). In the current series the SFR after 3 months was 80% after a single session of f-URS and 86.6% after the second session. Molimard *et al.* (11)

reported SFR of 53% after the first session, and 88.2 % after the second one. Gajendra *et al.* (12) reported 72% SFR after the first procedure and 88% after the second session. Haddad *et al.* reported stone-free rate of 75% for stones with average diameter of 12.22 mm (19).

In the current study we reported the SFR of miniperc and f-URS in patients with horseshoe kidneys; 80% (8 patients) who underwent miniperc were stone free after a single session, while in the f-URS group the SFR was 60% (6 patients) after a single session and 70% after the second session which is comparable to the SFR in study conducted by Eryildirim *et al.* (84.2% with conventional PNL and 82.0% with f-URS) (20). The higher SFR in the miniperc group can be attributed to better fragments drainage during the procedure. The retrospective nature of the study allowed us to witness surgeons' preference in these cases. It was clear the preference of mini-perc over the flexible URS for large stones.

The SFR in the current series might have been increased and the need for second look mini-perc or SWL might have been lowered if flexible nephroscope was used in combination with mini-perc. However, the outcome of mini-perc in the current series is comparable to other standard PNL and mini-perc studies, taking into consideration that the smaller size of mini-perc allows maneuverability and the access to more calices which might not be reached by standard PNL.

Being an observational and retrospective study, we acknowledge limitations such as mismatch between study groups, the non-blinding of the surgeons, small sample size, and the lack of cost analysis.

Consequently, larger prospective randomized studies are needed to accurately compare f-URS and mini-perc in the management of stone in anomalous kidneys and to acknowledge the specific indications of each modality.

## CONCLUSIONS

Mini-perc and f-URS are both feasible, with considerable safety, in the management of stones in anomalous kidneys. The choice between the available endourological procedures requires wisdom in the decision, good evaluation and planning.

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