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Comparison of ureteroscopy and percutaneous nephrolithotomy for renal pelvic stones over 2 cm

Semirigid ureteroscopy for renal pelvic stones

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Abstract

Aim: Advances in the technology of ureteroscopes and lithotriptors have led to the implementation of retrograde intrarenal surgery (RIRS) in the treatment of renal Stones. This study aimed to compare the outcomes and complications of semirigid ureterorenoscopy (s-URS) and percutaneous nephrolithotomy (PCNL) for the treatment of renal pelvic stones larger than 2 cm, retrospectively. Material and Method: Between January 2014 and July 2016, 90 patients with single renal pelvic stones of more than 2 cm were treated by PCNL (group 1) or s-URS (group 2). Group 1 had 44; group 2 had 46 patients. Demographic features of patients such as age, gender, body mass index (BMI) as well as stone size were compared. Perioperative course and postoperative outcomes such as stone-free and complication rates were also evaluated. Patients assessed by plain abdominal radiography 24 hours after surgery and non-contrast computed tomography at 3rd months, postoperatively. Clinical success was defined as stone-free status. Results: Mean ages of patients in group 1 and 2 were 40.29±19.78 and 38.41±23.26 year, respectively (p=0.681). Two groups were comparable in terms of gender, BMI, grade of hydronephrosis. Mean stone sizes were also similar. The mean operation, fluoroscopy and hospitalization times were shorter in group 2. After first sessions, mean stone-free rates for PCNL and s-URS were 81.8% and 60.8%, respectively (p=0.037). In the s-URS group,11 patients underwent f-URS due to stone migration into lower calix, and 7 of them became stone-free after those procedures. At 3rd months follow-up, those rates were determined as 84.1% and 76%, respectively. Discussion: Although s-URS is not superior to PCNL in the treatment of large renal pelvic stones, it can be used to reach renal pelvis and fragment those stones in selected cases.

Keywords

Semirigid Ureteroscopy; Percutaneous Nephrolithotomy; Renal Pelvic Stone

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Introduction

Treatment of renal stones has changed considerably from open surgery to minimally invasive procedures in the last decades. However, treatment alternatives may vary concerning stone size and localization. According to European Association of Urology (EAU) Guidelines, first-line treatment option for renal pelvic stones that are larger than 2 cm was accepted as percutaneous nephrolithotomy (PCNL) [1].

Although studies with PCNL reported high stone-free rates (SFR), it is still an invasive procedure with serious complications ranging from mild fever and pain to even death [2,3].

In the recent years, with the aid of technical improvements in ureteroscopes (e.g. small calibers, incorporation of working channels) and advances in intracorporeal lithotripsy, retrograde intrarenal surgery (RIRS) became more popular in the treatment of larger renal stones [4,5].

However, it must be remembered that RIRS procedures were mostly performed with flexible ureteroscopes (f-URS) and those procedures are associated with additional sessions and high rates of fiber breakage which may increase the complication rates and costs of those procedures [6-8].

Although semirigid URS (s-URS) is not accepted as the standard treatment for renal pelvic stones owing to its limited maneuver ability, it can be used to reach renal pelvis without any difficulty in some cases. To date, some studies are reporting the use of rigid or s-URS in the treatment of renal pelvic stones in the literature [9,10]. However, studies comparing the outcomes of s-URS with PCNL and f-URS were limited.

Since data about the use of s-URS in the management of large renal stones were scarce, the present study aimed to evaluate and compare the outcomes of s-URS and PCNL procedures in the management of renal pelvic stones between 2-4 cm, retrospectively.

Material and Method

A retrospective analysis of 90 patients who were treated at our clinic for renal pelvic stones between January 2014 and June 2016 was performed. Non-contrast computerized tomography (CT) and/or intravenous pyelography (IVP) were performed for each patient. Inclusion criteria consisted of the presence of a single renal stone located in the pelvis, stones larger than 2 cm in diameter and for group 2, stones which were accessed safely without any severe resistance to s-URS. Exclusion criteria consisted of the presence of any previous stone treatment, the presence of multiple and/or more complex stones including staghorn ones and any anatomic renal anomaly.

Patients were divided into two categories as PCNL (group 1) and s-URS (group 2). Group 1 included 44; group 2 had 46 patients, respectively. All operations were performed by two surgeons (TS and FK) who were expertised both in PCNL and s-URS. Demographic parameters of patients including age, sex, body mass index (BMI) and stone size were evaluated. Preoperative laboratory tests included serum creatinine and hemoglobin levels, platelet counts, coagulation tests and urine cultures. All patients had a sterile urine culture before the procedures.

Informed consent was obtained from each patient before surgery. Stone size was measured according to EAU guidelines [1].

PCNL technique

Briefly, following the preparation of patients in the lithotomy position, a 6f ureteral catheter was inserted cystoscopically. The patient was taken to the prone position, and access to the kidney was performed under C-arm fluoroscopy using an 18 gauge needle. After that, a guide wire was introduced, and dilatation up to 30F was performed with an Amplatz dilator [11]. Then, the sheath was placed, and by entering with a Storz nephroscope, stones were fragmented with a pneumatic lithotriptor (Vibrolith, Elmed, Ankara, Turkey). Stone fragments were removed with forceps. A 16F nephrostomy tube was placed into renal pelvis in all cases. The operative time was calculated from the insertion of the 6F catheter in the lithotomy position to the final placement of nephrostomy tube.

Semirigid URS technique

First, the patients were placed in the dorsal lithotomy position. An 8.5/11.5F, 42.5-cm-long, semirigid ureteroscope (s-URS) with a 6F working channel (Wolf, Knittlingen, Germany) was used for the procedure.

After visualization of the ureteral orifice, a polytetrafluoroethylene guide was put through the orifice up to renal pelvis, and s-URS was inserted with the guidance of that guide. Ureteral balloon dilation was performed if necessary. We did not try any forceful maneuvers to facilitate access to the renal pelvis in those patients, and when the stones were accessed in the pelvis, they were fragmented by holmium-yttrium-aluminum-garnet (Ho: YAG) laser under direct vision. For laser lithotripsy, Ho: YAG 273 μm laser fiber was used in all cases.

Energy and frequency settings were of 0.8 to 1.2 J and 8 to 10 Hz, respectively. After lithotripsy, stone fragments smaller than 2 mm were left for spontaneous passage. Basket or forceps were used for the removal of larger fragments. A 4.8F Double-J stent was routinely inserted in all patients and removed 21 days after the surgery. Operative time was measured from the insertion of s-URS to the completion of stent placement.

The patients in both groups were compared concerning operation, fluoroscopy and hospitalization times, stone-free, and complication rates. Initial stone-free rates were determined 24 hours after the surgical procedures with a kidney-ureter-bladder (KUB) radiogram. Patients were re-evaluated with KUB or non-contrast computed tomography (CT) if auxiliary procedures necessary at 3 months after the surgery or shock wave lithotripsy. The procedures were considered successful if the patient was stone-free with no residual fragments on radiologic interventions on 3-month follow-up. Complications were recorded according to the modified Clavien classification system [12].

Statistical analysis

Statistical analyses were performed using SPSS 21.0 (SPSS, Chicago, IL, USA). The normality of the distribution of the data for each variable was explored using Kolmogorov-Smirnov test. Data were presented as the mean± standard deviation (SD). Continous variables were compared by using Student's t and Mann-Whitney U tests as appropriate. Proportions of categorical variables were analyzed by chi-square or Fisher's exact test. A p value of less than 0.05 was accepted as statistical significance.

Results

Baseline demographic variables were comparable regarding age, gender, BMI, grade of hydronephrosis, laterality and mean stone sizes (Table 1). A sterile urine culture before surgery was asked for each patient.

Perioperative and postoperative data of groups were given in table 2. Mean operative times for PCNL and s-URS groups were 113.41±27.92 (range 70-180) and 90.54±24.13 (range 50-130) min, respectively (p<0.001). Mean fluoroscopy time was significantly longer in PCNL group when compared to s-URS (p<0.001). Mean hospitalization time was significantly longer in PCNL group than s-URS group (2.89±1.11vs. 1.21±1.19 days) (p<0.001).

The stone-free rate was 60.8% for s-URS and 81.8% for PCNL groups after first sessions (p=0.037). Eight and 18 patients had residual stones in PCNL and s-URS groups, respectively. One patient underwent shock wave lithotripsy for the proximal ureteral stone in the PCNL group and became stone-free after that. A second f-URS procedure due to lower pole stones was needed in 11 patients in group 2. Seven of them became stone-free after those procedures, resulting in an overall success rate of 76%. Finally, at 3rd months of follow-up, stone-free rates were found as 84.1% for PCNL and 76% for the s-URS group.

Complication rates among groups were similar. There were no perioperative complications in either group. In the postoperative period, mild complications such as colic pain and fever were observed in both groups. However, one patient in the s-URS group had a minimal subcapsular hematoma which was found to be resolved in the follow-up.

One patient in group 1 needed a blood transfusion, and double-j stenting due to the prolonged extravasation was performed in 3 PCNL cases. The creatinine level was not found to be increased in any patient.

Table 1. Demographic and clinical characteristics of patients

Variables	PCNL group	s-URS group	p value
Mean age (y)	40.29±19.78	38.41±23.26	0.681
Gender			0.679
Male	24	23	
Female	20	23	
Mean BMI (kg/m^2)	25.21±3.35	24.72±2.88	0.754
Hydronephrosis			0.468
Grade 1	12	20	
Grade 2	13	9	
Grade 3	7	4	
Grade 4	4	1	
Laterality			0.398
Right	23	19	
Left	21	27	
Mean stone size(mm^2)	286.7±45.2	243.4±51.6	0.136

PCNL:Percutaneous nephrolithotomy; s-URS: Semirigid ureteroscopy; body mass index: BMI

Table 2. Perioperative and postoperative outcomes of study groups

Variables	PCNL	s-URS	P
Mean operation time (min)	113.41±27.92	90.54±24.13	<0.001
Mean fluoroscopy time (sec)	120.9±25.43	16.65±7.78	<0.001
Mean hospitalization time (days)	2.89±1.11	1.21±1.19	<0.001
Complication rate n,%	8(15.9)	6(13.0)	0.867
Grade 1	3	5	
Grade 2	1	1	
Grade 3a	0	0	
Grade 3b	3	0	
Stone free status n,%			
Stone free status after first procedure	36(81.8)	28(60.8)	0.037
Final stone free status at 3rd months	37 (84.1)	35(76.0)	0.125

PCNL:Percutaneous nephrolithotomy; s-URS: Semirigid ureteroscopy; body mass index: BMI

Table 3. Review of the literature on s-URS treatment of renal pelvic stones

Studies	n	Stone size (cm)	Operation time (min)	Overall stone free rates (%)	Complications
Atis et al.	25	1-2 cm	71.9	76	Fever
Byniarski et al.	32	>2 cm	82.3	75	Haemoglobin drop, pain
Suer et al.	48	1-2 cm	NA	83	
Present study	46	2-4 cm	90.5	76	Fever, pain, subcapsular haematoma

NA:Not available

Discussion

EAU guidelines recommended PCNL as the gold standard treatment of renal pelvic stones larger than 2 cm in diameter [1]. Since PCNL has high success rates, it also carries a significant risk of complications. The complication rates of PCNL procedures range between 0.04% to 10 % in the literature [2]. Those complications may range from mild fever or pain to even death [13].

The efficacy of PCNL in the treatment of large renal stones was reported in some studies. In one of them, Haggag et al. performed PCNL to treat 40 patients with renal pelvic stones larger than 2.5 cm and reported an SFR of 80% [14]. A more recent study including 30 patients with renal pelvic stones over 2 cm reported an SFR of 89%. Zengin et al. also evaluated the outcomes of PCNL in patients having 2-3 cm renal pelvic stones and reported a success rate of 95.5% [15]. Akman et al. also investigated the success rates of PCNL in patients who had renal stones 2-4 cm in diameter and reported an SFR of 91.2%, respectively [16]. Our success rate with PCNL at 3rd months of follow-up was similar to other renal pelvic stone series as 84.1%. Also, complication rates of PCNL were reported to be between 9-22% in those series, and our complication rate (15.9%) was consistent with the literature.

Technological improvements in the new generation of ureteroscopes such as small caliber URSs and digital optics and advances in laser lithotripsy have made the use of RIRS for renal stones more popular [4,5]. It has been widely accepted that RIRS procedures significantly decreased morbidity rates in the management of renal stones [17,18].

RIRS has good efficacy and less morbidity in the treatment of large renal stones. In many series, the overall success rates were reported to be between 77-93% after additional procedures for the treatment of renal stones larger than 2 cm [5,7,19]. More recently, Al-Busaidy et al. reported an 81% SFR with a mean average procedure number of 2.1 in 71 patients who had 2-4 cm renal stones [20]. In a recent systematic review, 10 RIRS studies were evaluated, and a SFR of 89.3% with an average of 1.6 procedures in 441 patients who had a mean stone size of 2,9 cm was determined [21].

Although RIRS series reported favorable outcomes, it must be emphasized that all those series were performed by f-URS which has some disadvantages including requirement for a second session, less durability, and high fiber breakage rates [5,6,22]. The requirement for additional sessions is the major disadvantage of RIRS, and it may not only increase the procedural costs but also expose the patients to additional anesthetic risks. It has also been noted that durability of f-URS is lower than s-URS and affected by number and complexity of procedures, the experience of the surgeon and sterilization methods [23]. Sung et al. reported that repair costs increased more with decreasing ureteroscope diameter and increasing instrument length for f-URS when compared to s-URS [6].

The same study also revealed the reasons for high fiber breakage rates for f-URS as the working channel damage from laser burn or instrument passage and extreme scope deflection with an indwelling instrument. Another disadvantage of f-URS is related to the use of ureteral access sheath (UAS). This auxiliary instrument is commonly preferred in RIRS cases up to 86% and used to facilitate the reentry into the ureter, decrease operative time and improve SFRs, particularly, in the treatment of large renal stones [24]. However, UAS cannot be placed into the ureter and may fail in one-fifth of the patients [25]. A prospective study investigated the ureteral wall injuries resulting from the insertion of a 14F UAS in 359 patients and revealed an 86.6% rate of low-grade injuries [26]. The rate of high-grade injuries were noted as 13.4% in the same study.

S-URS is a routine part of RIRS to dilate upper urinary tract and place a hydrophilic guidewire to the renal pelvis in many studies [16,27]. However, research on the use of s-URS to treat renal stones were limited, and s-URS is not accepted as a primary treatment modality. Success rates of s-URS at reaching renal pelvis were reported to be between 53-91% in some studies [9,10,28]. SFR and complications that were encountered in those series were presented in table-3.

Our s-URS group only consisted of patients whose stones were accessible with semirigid instruments and who had sufficient follow-up data. We determined an SFR of 60.8% after first s-URS procedures. This rate improved to 76% after additional f-URS sessions. However, it should be mentioned that SFRs, after first s-URS sessions, were inferior to f-URS series and 11 out of 18 men needed an eventual f-URS procedure for residual stones. A relatively acceptable SFR was achieved with the help of f-URS in our study. Using s-URS in the management of renal pelvic stones may offer some advantages such as shorter operation and hospitalization times when compared to f-URS and PCNL [9,10]. In our study, mean operation times was shorter in the s-URS group. However, this may be due to the definition of operative times. When compared to other s-URS studies, our sessions lasted longer, but this difference may be due to the large stone size of our study population. Our mean fluoroscopy times was significantly shorter in the s-URS group. It is well known that PCNL generally requires longer fluoroscopy times than RIRS and series with f-URS reported an average fluoroscopy time of 18 to 108 seconds. Since data about fluoroscopy times in s-URS studies were scarce, we cannot compare our data with those studies. However, our mean scopy time was found as 16.6 seconds which was lower than RIRS studies.

Mean hospital stay was also found to be lower in the s-URS group. Previous studies showed that the most important reason for this delay is the placement of a nephrostomy tube. Our mean hospital stays in our s-URS group is similar to other studies performed either with s-URS or f-URS.

Another advantage of s-URS is its cost-effectivity compared with f-URS and PCNL. It has been suggested that use of s-URS for the extraction of main stone mass may lead to lower procedural costs by decreasing the need for f-URS and protecting relatively fragile flexible instruments [7]. In addition, it is reported that s-URS is obviously more cost-effective than RIRS and PCNL, especially when the amount of painkillers used, hospital stay and operative times were taken into consideration [10]. It is also noted that cost of repair was two times higher for flexible ureteroscopes when compared with s-URS and using s-URS will minimize the repair costs of instruments [6]. The present study determined that f-URS is needed only in 11 of the 46 s-URS patients which means that s-URS decreased the need for f-URS. It can be concluded that therapeutic costs may be lowered by this way. However, we did not perform a cost analysis in this study.

The major disadvantage of s-URS was reported as its limited maneuvering ability during stone fragmentation and residual stones which mostly fall into lower calyces. Those stones cannot be reached s-URS and may lower the success rates. In addition to filling the lower calyces with autologous blood clots before RIRS, some maneuvers such as changing the position of the patient and filling/emptying the kidney pelvis can prevent the migration of stones and may facilitate the disintegration. However, if residual fragments migrate into lower calyces, it may be a better option to switch from s-URS to f-URS. Since we performed repositioning of the patient and filling/emptying the renal pelvis in our sURS group, 11 patients needed an additional f-URS procedure due to the migration of stones into lower calyces. Seven of those patients became stone-free and our final SFR improved to 76% with the aid of eventual f-URS sessions.

Our complication rates were comparable among groups. However, all those complications were mild (<clavien 2) in group 2. There were 7 patients with postoperative fever and colic pain. They were successfully treated with appropriate antibiotics and analgesics. The rate and type of the complications in our study were also consistent with other s-URS studies (9,10,28). We did not observe any septic complication in patients after those procedures.

This study determined that although s-URS is not superior to PCNL in the treatment of large pelvic stones, success rates became comparable with the aid of additional f-URS procedures in selected patients. Besides, s- URS provided shorter operation, fluoroscopy times and hospital stays when compared to PCNL. s-URS also decreased the primary need for f-URS use and by this means, may help to decrease the procedure and repair costs. It can be suggested that when renal pelvic access is easily achieved with s-URS, starting the procedure with that instrument seems reasonable for patients who have renal pelvic stones larger than 2 cm in diameter. If s-URS fails in the stone fragmentation due to its restricted maneuver ability, a combination with f-URS will be a more favorable option to provide stone-free status. In spite of those results, further prospective studies should be conducted to offer s-URS as an alternative to PCNL and f-URS.

Our study has several limitations. First, this is a retrospective study performed in a single tertiary care center. Second, we did not perform a cost analysis of groups. Relatively small patient cohort, lack of randomization and short follow-up period may be counted as the other limitations. An adequately powered and qualitatively designed randomized controlled trial with a comprehensive cost-analysis would be necessary to identify whether or not s-URS can hold up against the superior stone-free rates of PCNL and s-URS can be a valid alternative for PCNL or f-URS for this indication.

Conclusion

PCNL is the primary treatment modality for renal stones larger than 2 cm in size. Technological improvements made RIRS procedures more popular with comparable success and less morbid complication rates. Although s- URS cannot be offered as an alternative to PCNL and f-URS, it can be used for the fragmentation of renal pelvic stones with acceptable success and complication rates in selected cases. However, further prospective and randomized trials are needed to confirm these findings.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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