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Comparison of retrograde intrarenal surgery, mini percutaneous and super mini percutaneous in the treatment of <2cm renal lower pole stones

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Abstract

Renal lower pole stones are a common disorder in the community. In this study, we aimed to compare Retrograde intrarenal surgery (RIRS), Mini PCNL(percutaneous nephrolithotomy) and Super Mini PCNL treatments in the treatment of lower pole stones. Patients who had lower pol renal stones with <20 mm stone sizes were enrolled in the study. Preoperatively, renal stone and kidney characteristics were evaluated renal ultrasonography, intravenous pyelography and/or non-contrast abdominal computed tomography (CT). RIRS, Mini PCNL and Super Mini PCNL surgery methods were performed. Holmium laser and pneumatic lithotriptor were used for stone lithotripsy. The mean age of the patients in the RIRS group was 35 ± 5.23 years, the mean age in the Mini PCNL group was 38.3 ± 6.47 years and the mean age in the Super Mini PCNL group was 34.12 ± 3.56 years. RIRS were performed in 43 patients, Mini PCNL 37 patients and Supper Mini PCNL 35 patients.Stone free in RIRS was 74.3% Mini PCNL was 93.3% Super Mini PCNL was 94.6 %. According to clavien dindo classification postop grade2-3 complication , in RIRS was 4,6% Mini PCNL was 8,1% .But no grade2-3 complication was seen in Super Mini PCNL group. Hospital stay of RIRS was 1.59± 2.03 mini pnl was 3.73±1.76 and Super Mini PCNL was 2.3±1.55.Cost analysis respectively ,RIRS group, $801.52 ± 25.32; Mini PCNL group, $698.33 ± 22.37; Super Mini PCNL group,$703.13±62. In lower pole stones, RIRS is minimally invasive and have less hospital stay.Stone free rates were higher in Mini PCNL and Super Mini PCNL than RIRS. Super Mini PCNL has short hospital stay and less postoperative complication rate than Mini PCNL. RIRS is more expensive than Mini PCNL and SMP.

Keywords: Lower pol stone,treatment,RIRS,mini PCNL,supper mini PCNL

Introduction

Urolithiasis is the most common urological benign disease and its prevalence rate has increased worldwide in the past decades. At present, the prevalence rate of urolithiasis varies from 1 to 20% [1].

Recently, the incidence of urolithiasis has increased due to various factors. These factors are geographic, climatic, genetic and nutritional. Urolitiasis is one of the leading urological diseases that need to be treated [2].

The prevalence of kidney stone is increasing and the optimal treatment of symptomatic lower-pole renal calculi (LPC) remains quite challenging. Hence, current treatment modalities for 1–2 cm LPC continue to be contested the European Association of Urology (EAU) guidelines shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS) are recommended treatment options for 1–2 cm LPC [3].

SWL is the least invasive treatment modality to treat renal stones; however, it is the least efective in the management of lower pole renal stones. Endoscopic procedures such as PCNL and RIRS are preferred in methods of renal stone therapy [2].

PCNL and RIRS have taken the place of SWL for treatment of kidney stones as a result of development of minimally invasive techniques and instruments in the last years. Each procedure has its own advantages and disadvantage. Mini-PCNL and RIRS are procedures that are preferred for minimally invasive treatment due to their negligible stone-free and complication rates [4].

The current EAU guidelines for urolithiasis recommend SWL as the initial treatment for renal stones smaller than 2 cm, except for the lower pole stones with unfavorable risk factors [5].

Over recent years, the introduction of miniaturized PCNL

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techniques such as Miniperc, super mini percutaneous (SMP), and Ultra-miniperc has further expanded the indications for management of renal stones by percutaneous techniques [6].

Miniaturized PCNL (mini-PCNL), defined as a PCNL involving the use of smaller nephroscopes [7]. can be performed effectively to manage kidney stones with high stone free rates and low complications [8].

The new tecnic for kidney stones, SMP is safe, feasible, and effective for managing renal calculi of <3 cm, with the advantages of a small percutaneous tract, less blood loss, high efficacy in stone clearance, improved visual field, short operation duration, and ease of operation [9].

In this study, we aimed to compare RIRS, mini PCNL and SMP in terms of postoperative complications, preoperative and postoperative hemoglobin levels, residual stone, inserted catheter, operation time and hospital stay in the treatment of renal lower pole stones smaller than 2 cm.

Materials and Methods

Study population

After obtaining ethical approval from the faculty ethics committee the patients who underwent RIRS, mini-PCNL and SMP for lower pol kidney Stones <2cm, between January 2017 and April 2019 were retrospectively analyzed in our tertiary academic center. All patients were treated with 3 sessions of ESWL before surgery. However, the renal lower pole stones were not broken. After that, patients underwent surgical treatment. Since all the stones we intervened were lower calix stones, intravenous pyelography (IVP) was requested before surgery. Mini or super Mini PCNL was performed in patients with narrow pole angle in IVP. RIRS was performed in patients with comorbidity and not narrow lower pole angle. Routine DJ stents were not placed in patients before RIRS procedure. Only 6 patients underwent DJ stents prior to RIRS. DJ stent was inserted to these patients because the ureteral access sheath could not be sent to ureter. Patients who had lower pol renal stones with <20 mm stone sizes were incluted in the study. Stone sizes were calculated as the sum of maximal diameters of all stones. Patients below 18 years age and with multiple renal stones were excluded. This study was performed by two surgeon. Patients were evaluated renal ultrasonography, intravenous pyelography and/or non-contrast abdominal computed tomography (CT) in preoperatively. Demographic characteristics of the patients were age, sex, body mass index(BMI) and stone size. Laboratory tests were hemoglobin measurements, serum creatinine level, platelet counts, and coagulation screening tests in preoperative. Urine was sterilized before surgery and consent form was obtained from all patients.

Study design

This study is a comparative and retrospective study, our study was performed in a tertiary hospital. RIRS was performed in 43 patients, mini PCNL was performed in 37 patients and super mini PCNL was performed in 35 patients. These three surgical techniques were compared in terms of the treatment of renal lower pole stones <20mm, operation times, postoperative complications, catheter insertion, preoperative and post hemoglobin levels and blood transfusion.

SURGICAL TECHNIQUES

RIRS Technique

RIRS surgery were performed under general anesthesia and after that were located at the lithotomy position. Passive dilatation was performed primarily with 8-9,8 french Ureterorenoscopy (URS). 6-7,5 french URS were performed in cases that could not be passed with 8-9,8french URS. Then, two hydrophilicy guide wire (0.035-inch) were plased to the renal pelvis with ureteroscope. Under fluoroscopy, the 11F ureteral access sheath was placed on the ureter. We used a flexible ureterorenoscope (Flex Hawk, Germany). Kidney stones were fragmented using a Ho YAG laser (272 μm,wolf, Germany).

Mini-PCNL Technique

Mini PCNL was performed under general anesthesia. In the lithotomy position, the 5f open end ureter catheter was inserted into the ureter with rigid ureteroscope. Then, the patient was placed in prone position and access was obtained from the lower pole of the kidney with 18 needles under fluoroscopy. A 0.035mm hydrophilic guidewire was inserted into the renal pelvis. Primarily, 10F-14F-16F dilators were used ,respectively.Next, we inserted a 16-F sheath and introduced a rigid 14-F nephroscope. The stone fragmentation was performed using a Ho:YAG laser (365-μm fibre; energy 1.5 Jd; frequency 10 Hz). A 12-F nephrostomy tube was inserted into the calyceal system at the end of the procedure. Two days after the surgery, the nephrostomy tube was removed. After 3 week, double j stent (DJ) was removed with local anesthesia.

Super Mini PCNL Tecnique

Super-mini-percutaneous nephrolithotomy was performed under general anesthesia in lithotomy position. A 5- F open- end ureteric catheter was placed under ureteroscopic guidance into the renal pelvis in all patients. Then the patient was turned to prone position. Percutaneous access was performed under fluoroscopy. Tract dilatation was performed with facial dilators up to 14 F. Next a 14-F sheath was introduced into the pelvicalyceal system and 12-F rigid nephroscope was used for remove the renal stones. 272 μm holmium laser was used for stone fragmantation.The level of lazer energy 1.5 jd and frequency 10 hz. In case of pelvic perforation or residual stone, 26 / 4.8 dj was inserted. In the routine prosedure, 5f ureter catheter was inserted and this catheter was removed on postoperative first day. 10-f nephrostomy was performed in bleeding cases and in the presence of clinically significant residual stones. Nephrostomy tube was removed postoperative first day.

Cost analysis

The cost of each procedure was calculated and noted according to the invoices that were obtained from the hospital. Cost analysis was carried out both in TL and US$.

Statistical Analysis

Descriptive statistics for continuous variables in our study; Mean, Standard Deviation, expressed as Minimum and Maximum values; For categorical variables, they are expressed as Number and Percentage. Independent T-test was used to compare group means in terms of continuous variables Chi-Square test was used to determine the relationship between groups and categorical variables. Statistical significance level was taken as $p < 0.05$ in the calculations and SPSS (ver.23) statistical package program was used for the calculations.

Results

The mean age of the patients in the RIRS group was 35 ± 5.23 year,in the Mini PCNL group was 38.3 ± 6.47 year and in the Super Mini PCNL group was 34.12 ± 3.56 year. The mean stone size was 13.44 ± 3.97 mm in the RIRS group, 16.7 ± 5.1mm in the Mini PCNL group and 15.3 ± 4.32 mm in the SMP group. Average operation time in RIRS 80 ± 25.15 minute, in Mini PCNL67.93 ± 20.05 minute and in SMP 65.32 ± 21.53 minute. Stone free rate was 56.4% in the RIRS group, 80.0% in the Mini PCNL group and 81.3% in the SMP group. Length of hospital stay was 1.59 ± 2.03 day in the RIRS group, 3.73 ± 1.76 day in the Mini PCNL group and 2.3 ± 1.55 day in the SMP group. According to clavien dindo classification, complications of grade2 and above were seen in 2 cases in RIRS and 3 cases in Mini PCNL. Postoperative grade2 and above complications were not observed in the SMP group. Preoperative and demographic findings of the patients are shown in table 1, operative and postoperative findings of RIRS and Mini PCNL are shown in table 2, operative and postoperative findings of RIRS and Super Mini PCNL are shown in table 3 and operative and postoperative findings Mini PCNL and Super Mini PCNL are shown in table 4. The operative and postoperative findings of all three groups are shown in table 5.

Table 1. Preoperative and demographic parameters in study groups

Variable	RIRS group	Mini-PCNL group	Super Mini PCNL
Number of patients	43	37	35
Gender male/female	26/17	21/16	20/15
Side left/right	24/19	18/19	22/14
Stone size (mm)	13.44±3.97	16.7 ± 5.1	15.3±4.32
Stone localization	Lower pole	lower pole	lower pole
BMI (kg/m2)	25.7±3.21	26.11±2.64	24.83±3.41
Stone opacity (opaque / nonopaque)	40/3	36/1	35/0

Table 2. Intraoperative and postoperative parameters and surgical complications in study groups of RIRS and Mini PCNL.

Variable	RIRS	Mini-PCNL	P value
Operative time (min)	80±25.15	67.93 ± 20.05	P=0.033
Stone free	56.4%	80.0%	P=0.027
<4mm residue	17.9%	13.3%	P=0.043
>4mm residue	22.6%	6.7%	P=0.013
Catheter status (%)			
DJ catheter	74.4%	33.3%	P=0.032
Ureter catheter	25.6%	66.7%	P=0.034
Hospital stay (day)	1.59± 2.03	3.73±1.76	P=0.023
No. of Clavien complications			
Grade 0	39	34	p>0.05
GradeI	2	0	P=0.031
Grade II	1	2	P=0.045
Grade III	1	1	p>0.05
Grade IV/V	0	0	
Preoperative Hb (g/dL)	14.76± 1.75	12.94± 1.68	p>0.05
Postoperative Hb (g/dL)	14.57± 1.74	11.91± 1.46	P=0.037
Blood transfusion	0%	5.4%	P=0.039
Cost	$801.52 ± 25.32	$698.33 ± 22.37	P=0.011

Table 3. Intraoperative and postoperative parameters and surgical complications in study groups RIRS and Super PCNL.

Variable	RIRS	Super Mini-PCNL	P value
Operative time (min)	80±25.15	65.32±21.53	P=0.038
Stone free	56.4%	81.3%	P=0.023
<4mm residue	17.9%	14.33%	P>0.05
>4mm residue	22.6%	4.27%	P=0.017
Catheter status (%)			
DJ catheter	74.4%	35.2%	P=0.015
Ureter catheter	25.6%	64.8%	P=0.022
Hospital stay (day)	1.59± 2.03	2.3±1.55	P>0.05
No. of Clavien complications			
Grade 0	39	33	P>0.05
GradeI	2	2	P>0.05
Grade II	1	0	P=0.042
Grade III	1	0	P=0.042
Grade IV/V	0	0	
Preoperative Hb (g/dL)	14.76± 1.75	13.57±1.23	p>0.05
Postoperative Hb (g/dL)	14.57± 1.74	13.25±1.11	p>0.05
Blood transfusion	0%	0%	
Cost	$801.52 ± 25.32	$703.13±62	P=0.011

Table 4. Intraoperative and postoperative parameters and surgical complications in study groups of Mini PCNL and SMP

Variable	Mini-PCNL	Super Mini PCNL	P Value
Operative time (min)	67.93 ± 20.05	65.32±21.53	
Stone free	80.0%	81.3%	
<4mm residue	13.3%	14.33%	
>4mm residue	6.7%	4.27%	P<0.05
Catheter status (%)			
DJ catheter	33.3%	35.2%	
Ureter catheter	66.7%	64.8%	
Hospital stay (day)	3.73±1.76	2.3±1.55	P<0.05
No. of Clavien complications			
Grade 0	34	33	
GradeI	0	2	P<0.05
Grade II	2	0	P<0.05
Grade III	1	0	P<0.05
Grade IV/V	0	0	
Preoperative Hb (g/dL)	12.94± 1.68	13.57±1.23	
Postoperative Hb (g/dL)	11.91± 1.46	13.25±1.11	P<0.05
Blood transfusion	5.4%	0%	P<0.05

Table 5. The operative and postoperative findings of all three groups

Variable	RIRS	Mini-PCNL	Super Mini PCNL	P value
Operative time (min)	80±25.15	67.93 ± 20.05	65.32±21.53	P=0.033
Stone free	56.4%	80.0%	81.3%	P=0.027
<4mm residue	17.9%	13.3%	14.33%	P=0.043
>4mm residue	22.6%	6.7%	4.27%	P=0.013
Catheter status (%)				
DJ catheter	74.4%	33.3%	35.2%	P=0.032
Ureter catheter	25.6%	66.7%	64.8%	P=0.034
Hospital stay (day)	1.59± 2.03	3.73±1.76	2.3±1.55	P=0.023
No. of Clavien complications				
Grade 0	39	34	33	p>0.05
GradeI	2	0	2	P=0.031
Grade II	1	2	0	P=0.045
Grade III	1	1	0	P=0.042
Grade IV/V	0	0	0	
Preoperative Hb (g/dL)	14.76± 1.75	12.94± 1.68	13.57±1.23	p>0.05
Postoperative Hb (g/dL)	14.57± 1.74	11.91± 1.46	13.25±1.11	P=0.037
Blood transfusion	0%	5.4%	0%	P=0.039
Cost	$801.52 ± 25.32	$698.33 ± 22.37	$703.13±62	P=0.011

The total cost for lower pol Stones <2cm in the RIRS group was comparable to that in the Mini and Super Mini PCNL under the Turkish healthcare system. However, in the RIRS group, it was higher than the mini and Super Mini PCNL(RIRS group, $801.52 ± 25,32; Mini PCNL group, $698.33 ± 22,37; Super Mini PCNL group,$703,13±62; US$1 = 5.8 TL).

Discussion

RIRS has increasingly been used for moderately sized kidney stones in recent years [10,11]. However, this technique has limitations such as low success rate in the lower calyx, necessity of using ureteral access sheath, necessity of placing DJ stent in case of failure due to inability to gain access in the first session and requirement of a second session, and longer duration of the surgical period as the stone size increases [12].

RIRS is considered an acceptable treatment for kidney lower pol calculi but not a first-line treatment for calculi of 1.0-2.0 cm in diameter [13].

Although flexible URS is a minimally invasive procedure, complications such as subcapsular hematoma may occur. After that RIRS subcapsular renal hematoma represents a rare but potentially serious complication. The elevated intrarenal pressures and long time of operation play an important role in subcapsular hematoma etiology [14].

In our study, RIRS was performed in 43 patients with renal lower pole stones. Stone free rate was 74.3% in patients who underwent RIRS. When we compared RIRS with Mini PCNL or Super Mini PCNL, it was observed that DJ stent placement, operation time and residual stone retention rates were high but preoperative and postoperative hemoglobin values, length of hospital stay and postoperative pain rates were lower in RIRS (p <0.05) In one patient who underwent RIRS, postoperative subcapsular hematoma developed and then this hematoma was evacuated with percutanous catheter.

SMP was more effective than RIRS for treating 1-2 cm LPC in terms of a better stone free rate(SFR) and lesser auxiliary procedure rate. The complications and hospital stay were comparable. RIRS has the advantage of less postoperative pain. The SFR after a single treatment was significantly higher in the SMP group than in the RIRS group (91.2% vs 71.2%) [15].

This was probably due to the favourable location and angulation of the lower calyx of the kidney for SMP puncture, meaning that percutaneous access could be achieved directly in line with the target stones in the lower pole [16].

In study of Atassi et al. A total of 160 patients were included and randomized to the two procedures RIRS and SMP. Although stone parameters were comparable among the two groups (15 vs. 14.3 mm), postoperatif 1-day and 3-month SFR were significantly higher in SMP (day1: SFR 91.2 vs. 71.2%,; 3 months: 93.8 vs.82.5%, There were no significant differences in operating time, hospital stay, and complication rates between the groups [17].

According to the available literature, RIRS and SMP were compared studies. Stone free rate in RIRS is from 65% to 92% RIRS known as that low-risk surgical procedure in treating small renal stones. However, The success of RIRS in renal lower pole stones is low. Especially if the lower calyx angle is narrow, the success of RIRS is further reduced. Other disadvantages, If the ureter is not large enough, dilatation is necessary then this extends the process, RIRS has high cost, In large stones, multiple sessions may be required, risk of ureteric damage, and DJ stent insertion rate is high. Recently, in the comparative randomized and prospective studies of RIRS and SMP, SMP had higher SFR than RIRS and was more effective in the treatment of renal pole stones smaller than 2 cm. Complications were comparable in both treatment modalities, however, there was less postoperative pain in the RIRS. This study showed that SMP is an effective and safe method that could be an alternative to RIRS, especially in the treatment of lower pole Stones [18].

In this study, stone free rates postoperatif one month were higher in patients who underwent SMP than patients with RIRS respectively (95,6% vs74,3%) and also the operation time is lower in SMP than RIRS ($p<0.05$). As the literature is given, it is difficult to return to the lower pole with RIRS. In SMP, it is easier to reach the lower pol stone because it is entered directly from the lower pol of kidney.

The complication of PCNL is related to large tract size. If we decrease PCNL size,morbidity rates is decrease too. It is a modified Mini- PCNL technique using a miniaturised scope through a smaller, 10–14 F nephrostomy tract. With the newly designed irrigation-suction sheath, the critical limitations of new miniaturised PCNL, poor irrigation and challenging stone extraction were completely addressed. Several studies have suggested that SMP is highly effective and safe for moderate- sized Stones [19].

In present study, when we compared the patients who underwent mini PCNL with Super Mini PCNL, postoperative hemoglobin drop, postoperative complication, dj stent placement and hospital stay were less in SMP group than Mini PCNL group ($p<0.05$). The operation time was similar in both groups. As it is understood from this, when the tract number decreases the complication rates decrease.

In patients who were treated 'tubeless' following PCNL, the hospital stay was reduced significantly. In study of Shah et al. 94.8% the patients did not require a nephrostomy tube after SMP, and 67.5% did not require a nephrostomy tube or double J stent following SMP. This may explain why the mean hospital stay was similar in the SMP and RIRS groups [20,21].

In this study, 91.3% of patients who underwent SMP had no nephrostomy. Also, DJ stent was not present in 64.8% of patients. Only the ureter catheter was inserted in these patients and the ureteral catheter was removed on the postoperative 1st day. In particular, the hospital stay of SMP patients without nephrostomy was similar to that of RIRS patients. The mean of hospital stay in RIRS and SMP was 1.59 ± 2.03 vs 2.3 ± 1.55 respectively.

Smaller renal access sheaths were initially introduced for pediatric patients, but increasingly gained popularity in adults, as well. Procedures were performed with small instruments tend to be associated with significantly lower bleeding rates, while the operation times tend to be significantly longer. Stone-free (SF) rates are comparable in Mini PCNL and standard PCNL procedures [22].

In our study, blood transfusion was decreased, as the number of channels decreased. No blood transfusion to any of our patients in SMP group but 5,4% patients of Mini PCNL were done blood transfüzyon. No significant difference was found in terms of operation time. Stone free rates in SMP and Mini PCNL groups were similar.

In the study of Bağcı et al., the cost was significantly higher in the RIRS group than in the mini PCNL group [23].

Chung et al. compared RIRS, SWL, PCNL and open surgery in terms of cost. As a result of comparison, it is shown that the RIRS is more expensive than the others [24].

In our study, RIRS, Mini PCNL and SMP were compared in terms of cost analysis and RIRS was found to be more costly than Mini PCNL and SMP. Therefore, it is appropriate to consider the cost when planning surgery for kidney stones.

Limitations

The low number of our patients may have resulted in lower complication rates. In addition, lack of pediatric patients is the shortcomings of our study.

Conclusion

As a result, when we compare SMP with Mini PCNL , SMP is a safer method than Mini PCNL. On the other hand, when we compare SMP with RIRS, we found that SMP is as safe and effective as RIRS. However RIRS is more costly than SMP in the treatment of lower pole of kidney stones smaller than 2 cm. Therefore SMP can be an alternative to RIRS.

Competing interests
The authors declare that they have no competing interest.

Financial Disclosure
The financial support for this study was provided by the investigators themselves.

Ethical approval
2019 / 02-05, date 01,02,2019 Approval was obtained from the ethics committee of the yuzuncu yil university.

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