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The evaluations of ESWL, RIRS and m-PCNL treatments in kidney stones smaller than two centimeters

Hüseyin Saygın[1]*, Gökhan Gökce[1], Esat Korgalı[1]

Abstract

Objective: The aim of the current study was to compare the outcome of minimal invasive treatment (RIRS, m-PCNL) with the ESWL, Micro-Percutaneous Nephrolithotomy (m-PCNL), and Retrograde intrarenal surgery (RIRS) in patients with renal calculi less than two centimeters in size.

Methods: Preoperative renal ureter-bladder (KUB) film and computed tomography (CT) used to imaging stone size and localization in all patients. Ninety consecutive patients were randomized equally to three groups. We evaluated age, gender, stone size, length of hospitalization, stone-free rates, X-ray duration that patients were exposed during the processes, general anesthesia time, Visual Analogue Scale values, Modified Clavien Complication Scale scores after RIRS, mPCNL, and ESWL on renal stones smaller than 2 cm.

Results: At the end of the first month, stone-free rate for the lower calyx stones was 33.3% (3 patients out of 10) in ESWL, 83.3% (10 patients out of 12) in RIRS, and 90.9% (10 patients out of 11) in m-PCNL. ESWL's success in the lower-calyx stones was found to be low. Our rates for the stones in renal pelvis, middle, and upper calyx were % 85.7 (18 patients out of 21) in ESWL, % 94.4 (17 patients out of 18) in RIRS and % 94.7 (18 patients out of 19) in m-PCNL. No difference was observed in the duration of hospitalization among patients who underwent RIRS and m-PCNL. The VAS scores in ESWL group were higher than other groups. There were no significant differences for fluoroscopy time between the groups. Decrease in hemoglobin values before and after the procedure were found to be significant in m-PCNL group ($p<0.05$).

Conclusions: We compared three minimal invasive treatments for less than 2 cm renal stones; m-PCNL and RIRS methods were found to be more effective than ESWL, especially aspects of the stone free rates.

Keywords: ESWL, RIRS, m-PCNL

Introduction

In European Association of Urology (EAU) guidelines; first choice of treatment for kidney stones smaller than two centimeters (cm) reported as Extracorporeal shock wave lithotripsy (ESWL) or other endourologic approaches. If there is no suitability for ESWL for 10-20mm, lower calyx stones endourologic initiatives are recommended as the first choice (1). If the standard of care for renal calculi is larger than 2 cm in size, it is called as percutaneous nephrolithotomy (1). However, nowadays, there is no consensus on the best treatment modality for renal calculi less than 2 cm in size. There are many treatment options including ESWL, standard /mini / micro PCNL, and RIRS (1). The success of ESWL, which is a minimally invasive method, is relatively low due to the rate of stone clearance in lower calyceal stones and the need for repetition in hard stones (2). The disadvantage of RIRS treatment is ureteral injury, necessity of anesthesia, and high instrument cost (3-4). Modified PCNL technique m-PCNL is a minimally invasive method for the treatment of renal stones smaller than 2 cm (3). The target of minimal invasive procedures of stone treatments is to decrease the complication rates, the length of hospitalization, morbidity, and mortality with high the success rates (5-6).

Based on our literature research, there is no any study which comparing the clinical outcome of RIRS, m-PCNL, and ESWL for renal calculi less than 2 cm in size. Especially, in lower pole stone clearance rates are lower than stones in other location with ESWL and there is no study comparing these treatment modalities for lower calix stones. The aim of the current study was to compare the outcome of minimal invasive treatment with the ESWL, m-PCNL, and RIRS in patients with renal calculi less than 2 cm in size. The hypothesis is that the stone clearance rates with the microperc and RIRS will be higher than the ESWL.

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1 Cumhuriyet University, Faculty of Medicine, Department of Urology, Sivas, Turkey
*** Corresponding Author:** Hüseyin Saygın **E-mail:** dr.saygin@hotmail.com

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Materials and Methods

This study was prospectively designed in adult patients with renal stones smaller than 2 cm in a tertiary center. The local ethics committee approved this study and written consent was obtained from all the participants. Ninety consecutive patients with renal stones smaller than 2 cm were randomized into m-PCNL, RIRS, and ESWL groups.

Preoperative renal ureter-bladder (KUB) film and computed tomography (CT) used to imaging stone size and localization in all patients. Adult patients with single stone smaller than 2 cm in kidney were included in the study. Patients with multiple kidney stones, coagulopathy, patients with active urinary tract infection and non-adult patients were excluded from the study.

Shock Wave Lithotripsy

The therapy was usually started at a lower power of 12 kV and then increased gradually to 20 kV. A maximum of 2000 shocks were delivered for each session (ELMED multimed classic Ankara, Turkey). One week after the ESWL session, patients were evaluated with renal-ureter-bladder (KUB) film for residual stone fragmentation. Repeated ESWL sessions were performed if inadequate fragmentation of the stone encountered, a maximum of 3 sessions.

Micro-PCNL

After general anesthesia, 6-F ureter catheter was inserted into the renal pelvis in the lithotomy position under cystoscopy. After moving to the prone position, contrast material was administered through the ureteral catheter to define the calyceal anatomy. After selection of a suitable calyx, with visualization of fluoroscopy 4.85 all-seeing needle (PolyDiagnost, Pfaffenhofen, Germany), it was advanced to the desired calyx. The clearness of the vision and wash out of stone fragments were obtained by the irrigation pump system that was controlled with a foot pedal. The stones were fragmented using (5-10 Hz, 0.5-1.2 joule) holmium:YAG laser (StoneLight Laser , AMS, Minnesota, USA) fiber under direct visualization. A 6-F ureteric catheter was removed approximately about 1 day postoperatively.

Retrograde Intrarenal Surgery

All procedures were performed with 7.5 F FLEX-XC flexible ureteroscopes (Karl Storz, Tuttlingen, Germany) and a 272-mm laser fiber was used for laser lithotripsy. The use of the ureteral access sheath was determined by the surgeons preference. At the end of the operation, a 4.8F JJ stent was routinely inserted.

Treatment success rate was defined as completely stone free rate (SFR) or presence of clinically insignificant residual fragment (<3 mm) on x-ray KUB and USG after 1 month of last procedure in both groups. Complications were classified according to the modified Clavien Clasification System. Mean procedure time, mean fluoroscopy time, hospitalization time, pain score on day 1 using visual analog scale, and complications using modified Clavien Clasification Scale were collected in the study groups.

Statistical analysis

Datas were presented as the mean ± SD and percentage. Datas were processed using SPSS-14 for Windows (SPSS Inc., Chicago, IL, USA). Statistical analysis was performed with chi-square, t, and ANOVA tests. After ANOVA, Tukey test was used as a post hoc test if a significance found. A p value of less than 0.05 was considered as significant.

Results

The selected demographics and stone characteristics of the ESWL, RIRS, and m-PCNL groups were found similar ($p>0.05$) (Table 1). The Table 2 presents operative and postoperative data of the study groups. There was no significant difference with regard to the operation times between the RIRS and the m-PCNL groups (42.3 ± 0.4 vs. 48 ± 18.6 min; $p>0.05$). Although the operating time of ESWL group was significantly longer compared to other study groups (66.0 27.7 min vs. 42.3 ± 0.4 vs. 48 ± 18.6 min, respectively; $P= 0.001$); however, the ESWL patients did not receive general anesthesia as related to the nature of procedure.

Considering 3 groups by detected on X-ray KUB 1 months after surgery, nine patients in the ESWL group, three patients in RIRS group, and two patients in m-PCNL group were detected with residual fragment. The stone clearance rates at 1 month follow-up were 70 %, 90%, and 93,3% for the ESWL, RIRS and m-PCNL groups in the order of writing. The lower pole stone clearance rates were lower than other groups for the ESWL group (Table 3). The stone clearance rates of RIRS and m-PCNL techniques were found similar ($p>0.05$).

In the m-PCNL group, one patient with solitary kidney who underwent nephrectomy for stony atrophic kidney, on the first postoperative day, urinary system ultrasonography was performed because of pain and decreased urine output. Pelvicaliectasis was detected and a jj stent was placed on the first postoperative day. In addition, one patient in the m-PCNL group underwent (CT) due to postoperative decrease in hemoglobin and 18x10x9 cm hematoma was detected in the retroperitoneum.

In the RIRS and m-PCNL groups, hemoglobin decrease was significantly higher. When we consider the RIRS and m-PCNL groups, the decrease in hemoglobin was significantly lower in the RIRS group (Table 4). No statistically significant difference was found between the groups in terms of stone size and fluoroscopic time.

The mean Visual Analogue Scala (VAS) was significantly higher in the ESWL group than the other groups. No statistically significant difference was found between the groups in the Modified Clavien Classification Scale. However, grade 2 complications in 7 patients in the RIRS group and grade 3B complications in the m-PCNL group of 2 patients were observed. In the m-PNL group one patient, who had solitary kidney, required JJ stent on the following day after surgery due to anuria. In the RIRS group, antipyretic and antibiotic drugs were used due to high fever after the operation.

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Table 1. Demographic data and stone size (Mean ± SD).

	ESWL (n=30)	RIRS (n=30)	m-PCNL (n=30)	Significance
Age, y	42.2 ± 14,3	44.3 ± 11,8	36.1 ± 14.9	P=0.06
Gender				
Male	22 (73%)	19 (63%)	16 (53%)	
Female	8 (27%)	11 (37%)	14 (47%)	P=0.275
Stone size, cm	1.0 ± 0.3	1.2 ± 0.3	1.2 ± 0.3	P= 0.058

Table 2. Comparison of operative and postoperative data.

	ESWL	RIRS	m-PCNL	Significance
Operating time, min	66.0 ± 27.7[a]	48.0 ± 18.6	42.3 ± 10.4	P= 0.001
Fluoroscopy time, sec	61.7 ± 24.9	50.3 ± 32.3	55.4 ± 30.4	P= 0.118
Visual analogue score (VAS)	5.0 ± 1.2[b]	3.2 ± 0.6	3.2 ± 0.8	P= 0.001
Hospital stay, day	-	1.1 ± 0.4	1.6 ± 0.9	P=0.107

Visual analogue score (VAS): Post op 1 day, scale 1–10. [a,b]P<0.05, SWL vs. RIRS and m PNL. *p<0.05

Table 3. Stone clearance rates

	Patients	Lower pole stone patients, n (%)	Complete stone clearance, n (%)	Lower pole stone clearance, n (%)	Significance
ESWL	30	9 (%30)	21(%70)	3(%33.3)	p=0.004*
RIRS	30	12(%40)	27(%90)	10(%83.3)	p=0.320
m-PCNL	30	11(%36.6)	28(%93.3)	10(%90.9)	p=0.685

*p<0.05

Table 4 Preoperative and postoperative hemoglobin value

	Preoperative hemoglobin (g/dl)	Postoperative hemoglobin (g/dl)	Significance
ESWL	14.7 ± 1.5	14.4 ± 1.4	t= 2.52 P= 0.07
RIRS	14.7 ± 1.9	13.9 ± 1.8	t= 5.78 * P= 0.001 *
m-PCNL	14.4 ± 1.7	13.3 ± 1.9	t= 6.90 P= 0.001 *

Discussion

Minimal invasive endourologic procedures are recommended for lower calyx stones (10-20 mm) as the first choice in the presence of unsuitable conditions for ESWL or failure (1). RIRS provides a significantly higher stone-free rate and lower retreatment rate compared with ESWL (7). m-PCNL has been shown to have a good stone clearance rate and similar complication rates when compared with RIRS (8). In this study, we confirmed that RIRS, m-PCNL, and ESWL are safe and effective methods for the treatment of renal stones smaller than 2 cm. The stone clearance rates of RIRS and m-PCNL techniques were found similar. The lower pole stone clearance rates were lower than other groups for the ESWL group. We excluded patients with high body mass index and patients with recurrent renal stone disease history from the study.

ESWL is an outpatient treatment without hospitalization and can be applied without general anesthesia to patients with high tolerance. It does not require hospitalization and patients can turn back to their daily activities after couple of hours from the process. In this study, ESWL was performed to 30 patients (22 male, 8 female) who had kidney stones smaller than 2 cm in our clinic (9 patients with lower pole calculi, 21 patients with middle, upper pole or renal pelvis calculi). Yoon et al. found stone free rates as %74.7 for 79 patients with lower calyx stones in 142 renal stone patients who underwent ESWL (9). Compared with this study, although we found similar results with Yoon et al. for middle and upper calyx stones, the stone-free rates for lower calyx stones were lower in our study. Singh et al. compared ESWL and RIRS in 35 patients with the average stone size of 16.4 ± 2.3 mm in ESWL group and 15.0 ± 3.6 mm in RIRS group, they found stone-free rate as 48.6 % and the first day VAS score as 2.40 ± 0.64 in ESWL group. Also their stone-free rate was %82.8 and the first day VAS score was 4.3 ± 0.4 and the operation time was 78.7 ± 20.0 minutes in RIRS group (10). In our study, the average stone

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size in the ESWL group was 1.0 ± 0.3 mm. We found 70% of stone-free rate in ESWL group. However, stone-free rate in our ESWL and RIRS groups were higher. VAS scores of our ESWL group (5.00 ± 1.23) at the first day of procedure were higher. In another study; ESWL, RIRS, and m-PCNL in 251 patients with the average stone size of 14,9 ± 2.9 mm in ESWL group and 15.6 ± 3.4 mm in RIRS group, they found stone-free rate as 65 % in ESWL group. Also their stone-free rate was %87 and the operation time was 43.1±17 minutes in RIRS group (11). These results are similar with our studies.

In this study, RIRS was performed to 30 patients (19 male, 11 female) who had kidney stones smaller than 2 cm in our clinic. (12 patients with lower pole calculi, 18 patients with middle, upper pole or renal pelvis calculi). Stephan Kruck et al. compared ESWL and RIRS in 202 patients, stone-free rate was 58.4 % in ESWL group. Also their stone-free rate was %77.88 and the hospitalization time was 2.3 ± 2.6 days in RIRS group. (12). Stone-free rates in our ESWL and RIRS groups were higher than this study, and the hospitalization time (1.1 ± 0.4 day) of our RIRS group was lower than this study. The study of Sabnis et al. was comparing RIRS and m-PCNL in 70 patients with the average stone size of 1.04 ± 0.25 mm in RIRS group and 1.1 ± 0.2 mm in m-PCNL group, they found stone-free rate as 94.3% and the first day VAS score as 1.6 ± 0.8 and hospitalization time 49 ± 18 hours in RIRS group. Also their stone-free rate was 97.1% and the first day VAS score was 1.9 ± 1.2 and the operation time was 51.6 ± 18.5 minutes and hospitalization time 57 ± 22 hours in m-PCNL group. (13) In our study, the average stone size in the RIRS group was 1.2 ± 0.3 mm. We found stone-free rate as 90% in RIRS group. VAS scores of our RIRS group (3.2 ± 0.6) and m-PCNL (3.2 ± 0.8) procedure were higher than this study.

In our study, m-PCNL was performed to 30 patients (16 male, 14 female) who had kidney stones smaller than 2 cm in our clinic. (11 patients with lower pole calculi, 19 patients with middle, upper pole or renal pelvis calculi). In Kiraç et al. study; RIRS and m-PCNL in 73 patients, they found stone-free rate as 88.8 % and hospitalization time was 24.5 ± 4.6 hours and operating time was 66.4 ± 15.8 minutes and fluoroscopy time was 72.5 ± 23.7 seconds in RIRS group (14). Also their stone-free rate was 89.1% and hospitalization time was 42.6 ± 13.6 hours and operating time was 53.0 ± 14.5 minutes and fluoroscopy time was 130.5 ± 49.5 in seconds in m-PCNL group. In our study, operative time and fluoroscopy time was lower than this study. Hatipoğlu et al. found stone free rates as 82.1% for 62 patients with lower calyx stones in 140 renal stone patients who undergone m-PCNL (15). In this study, they reported that average stone size of 15.1 ± 5.1 mm, operation time 55.8 ± 30.8 minutes, fluoroscopy time 107.4 ± 79.1 seconds and hospitalization time 1.8 ± 0.6 day. In our study, stone-free rate was higher and operation and fluoroscopy times were lower than this study.

Conclusions

ESWL, RIRS, and m-PCNL are minimal invasive treatments for renal stones smaller than 2 cm. For these stone sizes, ESWL technique is usually more preferred. But in this study, we compared patients with renal stones less than 2cm; m-PCNL and RIRS methods were found to be more effective than ESWL. However studies with larger number of patients are needed to confirm our results.

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Conflict of Interest: The authors declare that they have no conflict of interest

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