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Which One is More Effective for 15-25 Mm Renal Pelvis Stones? ESWL, F-URS, Miniperc or PNL

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Abstract

To compare the success of ESWL, F-URS, Miniperc and PNL for 15-25 mm renal pelvis stones in terms of Stone Free Status (SFR), Fluoroscopy Time (FT), Procedure Time (PT), Complication Rates (CR), and Cost Effectiveness (CE). Between January 2010 and January 2017, patients having 15-25mm renal pelvis stone were directed to the four different procedures: ESWL, F-URS, Miniperc or PNL. Patients having ESWL, F-URS, Miniperc or PNL were defined as group 1,2,3,4, respectively. The SFR, FT, PT, CR according to the Clavien Classification, and costs were noted. There were 196 patients with 49(25%), 49(25%), 25(12%), 73(37%) in group 1,2,3,4, respectively. Best SFR was achieved in group 4 on short and long term follow-up with 67% and 86% success rates. Hgb drop was not significant in groups except in group 4 (p=0.54,0.8,0.63,0.001 for group1,2,3,4). Creatinine change was not different in groups except in group 4 (p=0.82,0.863,0.746,0.042 for group1,2,3,4). FT and PT were shortest in group 1, FT was longest in group 4, and PT was longest in group 3. The CR was statistically different among groups, except miniperc and PNL. Group 1 was significantly cheaper from group 2,3,4 (p=0.001,0.009,0.01). Group 4 was cheaper than group 2 and 3 (p=0.002,0.005), and group 2 was cheaper than group 3 (p=0.03). For 15-25 mm renal pelvis stones, PNL is superior to ESWL, F-URS, and miniperc with best SFR, moderate CE and CR.

Introduction

Managing the stone disease with the highest possible success rate in a single setting using the less costly technique is the aim of all endourologists in worldwide. Before 1950s, open stone removal was the treatment of choice for all kind of stones [1]. However, since 1950s, technological advances have changed the management algorithm for stone surgery by using of new instruments. In 1976, Fernstrom et al defined Percutaneous Nephrolithotomy (PNL) technique through a nephrostomy tract [2]. In 1983, first use of Extracorporeal Shock Wave Lithotripsy (ESWL) for adults was reported, and caused a complete change in the management [3]. In 1990, Fuchs et al. published the first report of flexible ureterorenoscopy (F-URS) procedure [4]. In 1998, Jackman et al. described the technique of minipercutaneus nephrolithtotomy (miniperc) using a 11 Fr vascular sheath for infants and preschool children [5].

Current EAU guideline for urolithiasis recommends ESWL and other endourology techniques for renal stones between 10 mm to 20 mm and for larger stones than 20 mm, PNL, F-URS or ESWL are recommended to manage the best success rate [6]. However, every technique has its' own advantages or disadvantages: ESWL seems to be the non-invasive method, but has lower Stone Free Rate (SFR), or PNL seems to have best SFR, but more complications. F-URS and miniperc (<20Fr) have been gaining attention for smaller stones in the area of ESWL and PNL with lower risk of complications and sufficient SFR [7]. Generally, SFR was reported to be >80% for F-URS, miniperc and PNL, but 25% to 65% for ESWL.

In this research, our hypothesis was whether or not one of the techniques "ESWL, F-URS, Miniperc or PNL" is superior to the other in terms of SFR, Fluoroscopy Time (FT) Procedure Time (PT), Complication Rates (CR), and Cost Effectiveness (CE) for 15-25mm renal pelvis stones.

Materials and Methods

This study was approved by the Ethical Committee of our Institute and followed the Institution's Review Board of Human Subject Guidelines. We retrospectively analyzed outcomes of 15 mm to 25 mm renal pelvis stones between January 2010 and January 2017 in a different center. The data

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Table 1: Patient Demographics.

	ESWL (Group1)	F-URS (Group2)	Miniperc (Group3)	PNL (Group4)
Patients (n)	49 (25%)	49 (25%)	25 (12%)	73 (37%)
M/F	36/13	35/14	17/8	60/13
Age (mean)	41.95(21-78)	40.83(22-79)	43.90(28-70)	41.04(21-83)
Side of surgery	20(40%) left, 29(60%) right	24(49%) left, 25(51%) right	5(46%) left, 6(54%) right	31(43%) left, 42(57%) right
Stone burden (mm)	17.88(15-23)	19.61(15-25)	17.16(15-23)	20.33(16-25)

regarding SFRs, FT, PT, CR according to the Clavien Classification [8], and costs were retrospectively noted. All patients who had undergone ESWL, F-URS, Miniperc or PNL were grouped as group 1,2,3 and 4, respectively. The short and long-term comparisons were made. Short term outcomes consisted of the comparisons between pre-operative and postoperative first day Hemoglobin (Hgb), serum urea and creatinine, SFRs evaluated with KUB. Long-term outcomes documented by the comparison of preoperative and postoperative third month SFRs evaluated with CT. Stone-free status was defined as no residual fragments on radiologic evaluation with KUB at postoperative 1. day, and CT at postoperative 3. month. Residual stones <4 mm with no pain were defined as non-significant residual stones (NSRS). Residual stones <4 mm with pain, and residual stones >4 mm were defined as Significant Residual Stone (SRS).

ESWL was applied using the Siemens Lithoscope (TAZK07892) ESWL machine. F-URS was applied using Storz Flex X2 and 9.5 F ureteral access sheath was used (UAS). The miniperc was applied using the 10F semirigid Karl Storz nephroscope and PNL was applied using 26F semirigid Olympos nephroscope.

Statistical analysis

Statistical analysis was done using Statistical Package for Social Sciences 20.0 software (SPSS 20.0 for MAC). Descriptive statistics were noted with mean (minimum-maximum), numbers, and percentiles. Shapiro-Wilk, Kurtosis, and Skewness Tests were used to assess the variables' normalization. The Mann-Whitney U Test was used to compare the pre and post procedure independent scale parameters. The Wilcoxon Test was used to compare the pre and post procedure dependent scale parameters. Chi-square test was used to compare the stone-free status. Probability of $p<0.05$ was accepted as statistically significant.

Results

There were 196 patients with 49(25%), 49(25%), 25(12%) and 73(37%) in group 1,2,3 and 4, respectively. There were 36(74%) males and 13(26%) females in group 1, 35(71%) males and 14(28%) females in group 2, 17(68%) males and 8(32%) females in group 3, and 60(82%) males and 13(18%) females in group 4. The mean patient age was 41.95(21-78), 40.83(22-79), 43.90(28-70) and 41.04(21-83) in group1,2,3 and 4, respectively. Demographic characteristics of patients were not statistically different among groups (p=0.982) (Table1). The stone size, Hgb and creatinine levels, FT, PT, urethral stenting status, and complication were summarized in Table 2. Stone- free status was summarized in Table 3. Most of the stones were located at right kidney among all groups (Table 2). Best SFR was achieved in group4 on short and long term follow-up with 67% and 86% success rates. Hgb drop was not significant in groups except in group 4. Creatinine change was not different in groups except in group 4. JJ stent insertion rate was lowest in group 1, and highest in group 3 and 4. FT and PT were shortest in group 1, FT was longest in group 4, and PT was longest in group 3. The CR was statistically different among groups, except miniperc and PNL.

The cost was calculated to be 103.4, 798.57, 822.79 and 416,76 Euro per patient for group1,2,3 and 4, respectively. Group 1 was significantly cheaper from group 2,3 and 4 (p=0.001,0.009,0.01). Group 4 was cheaper than group 2 and 3 (p=0.002,0.005), and group 2 was cheaper than group 3 (p=0.03).

Discussion

In order to express the success of a treatment modality for a stone disease, authors report their operational results emphasizing on different aspects like SFR, resolution of the pain, FT, PT, CR or CE. However, most reports compare only two treatment procedures. The main superiority of this article is that we compared four techniques for the treatment of a renal pelvis stone. A stone in renal pelvis location makes us think using different techniques for the treatment due to easy reach and probable spontaneous expulsion for a residue. To our knowledge, limited data was reported for the treatment renal pelvis stones.

In the terms of Stone Free Rates (SFR), El-Nasah et al. [9] reported 87% SFR at third month and also reported that there was no difference of disintegration between renal pelvis and non-pelvis stones. Deem et al. [10] reported 33% SFR at third month for renal stones by using ESWL. They also examined the stone locations, but there wasn't enough patient to refine the SFR for a renal pelvis stone. Resorlu et al. [11] reported 67% SFR for ESWL, but they did not analyze the difference among stone locations. Kruck et al. [12] reported 39.3% SFR for non-lower pole stones using ESWL. In our study, we detected 46% SFR at third month in ESWL group. Our results seem to be similar to the literature, but the difference was that we only examined the renal pelvis stone, excluding the other locations. While comparing ESWL with other techniques, Kruck et al. [12] encouraged the use of miniperc or F- URS rather than ESWL for stones >1cm. They reported miniperc, F-URS and ESWL had 77.3%, 72.7%, and 14.8% SFR for lower pole stones, and 80.4%, 69.2%, and 39.3% for non-lower pole stones, respectively. Another multicenter study reported 83.6%, 86.1%, and 77.2% SFR in miniperc, F-URS, and ESWL, respectively [13]. In our study, we detected 81%, 82% and 46% SFR in miniperc, F-URS, and ESWL, respectively. Although SFR between miniperc and F-URS was similar; SRS in two techniques made a statistically significant difference favoring the use of F-URS for a renal pelvis stone. Only, Hassan et al. [14] compared the ESWL and PNL for 20 mm to 30 mm renal pelvis stone and reported 75% and 95% success, respectively. Our results were compatible with the literature with 46% and 86% SFR in ESWL and PNL, respectively. Pan et al. [15] reported the use of F-URS and miniperc for 20 mm to 30 mm stones with 40% and 57% SFR, respectively. While comparing PNL and F-URS for renal pelvis stones >20 mm, Bryniarski et al. reported 81% and 50% SFR, respectively [16]. Ozturk et al. [17] reported the use of PNL and F-URS for 10 mm to 20 mm lower pole stones with 94% and 73% SFR. Mishra et al. [7] compared the miniperc and PNL

	ESWL (Group1)	F-URS (Group2)	Miniperc (Group3)	PNL (Group4)
PreoperativeHgb (g/dL)	13.9 (13.2-15.7)	14.7 (14.3-15.3)	13.2 (10.52-15.5)	12.89 (9.8-18.3)
PostoperativeHgb (g/dL)	13.7 (13.2-15.5)	14.5 (14-15.1)	12.8 (9.1-15.7)	11.16 (9.8-18.3)
PreoperativeCreatinine(mg/dL)	1.1 (0.72-1.58)	0.95 (0.67-1.15)	1.07 (0.79-1.78)	0.92 (0.82-1.63)
PostoperativeCreatinine(mg/dL)	1.2 (0.83-1.62)	0.98 (0.72-1.15)	1.05 (0.73-1.79)	1.12 (0.92-1.74)
Flouroscopy time(min)	5.2 (3-9)	6.2 (3-17)	9.5 (3-15)	13.1 (5-17)
Procedure time(min)	41.03 (26-51)	51.04 (17-142)	95.2 (28-151)	82 (44-150)
JJ stent insertion	7 (14%)	28 (57%)	11 (100%)	73 (100%)
Complication	0 (0%) Clavien 1 3 (6%) Clavien 2 1 (2%) Clavien 3a 0 Clavien 3b	18 (36%) Clavien 1 9 (18%) Clavien 2 0 Clavien 3a 0 Clavien 3b	6 (54%) Clavien 1 1 (1%) Clavien 2 0 Clavien 3a 0 Clavien 3b	23 (31%) Clavien 1 12 (16%) Clavien 2 0 Clavien 3a 0 Clavien 3b
Comparison of Complications: P values	(P=0.001) (P=0.001) (P=0.077) (P=0.005) (P=0.01) (P=0.002)			
	ESWL (Group1)	**F-URS (Group2)**	**Miniperc (Group3)**	**PNL (Group4)**
Stone free status on 1. day (Short Term)	7 (15%) **Stone free** 16 (32%) **NSRS** 26 (53%) **SRS**	27 (56%) **Stone free** 11 (22%) **NSRS** 11 (22%) **SRS**	7 (64%) **Stone free** 2 (18%) **NSRS** 2 (18%) **SRS**	49 (67%) **Stone free** 18 (25%) **NSRS** 6 (8%) **SRS**
Comparison of Stone free status on 1. day (Short Term): P values	(P=0.039) (P=0.01) (P=0.07) (P=0.006) (P=0.02) (P=0.009)			
Stone free status at 3. month (Long Term)	22 (46%)**Stone free** 16 (32%) **NSRS** 11 (22%) **SRS**	40 (82%)**Stone free** 8 (16%) **NSRS** 1 (2%) **SRS**	9 (81%)**Stone free** 1 (9%) **NSRS** 1 (9%) **SRS**	54 (86%)**Stone free** 15 (10%) **NSRS** 4 (4%) **SRS**
Comparison of Stone free status at 3. month (Long Term): P values	(P=0.001) (P=0.001) (P=0.09) (P=0.006) (P=0.039) (P=0.04)			

Table 2: Stone characteristics and complication rates of procedures.

for 10 mm to 20 mm renal stones, and reported 96% and 100% SFR, respectively. In our study, SFR was not statistically different between miniperc and PNL, but there was a statistically difference between F-URS and PNL. This difference was mainly caused by the distinct percent of SRSs between F-URS and PNL.

Hgb drop, creatinine change, FT, PT, and CR were the other important parameters to decide a treatment modality for a stone disease. Many reports compared the Hgb drop for operational techniques, but it was not reported for ESWL. In this research, we also reported Hbg drop for ESWL, and preop. and postop. creatinine levels was all groups. Pearle et al. [18] reported 65.5 min PT for ESWL. In a study, Hgb drop, and FT were reported to be less in F-URS, but the PT was less in miniperc group. The CR was not different in both groups [19]. Another study supported the same results [20]. Pan et al. [15] reported the mean PT to be 73.07 ± 13.5 and 62.39 ± 10.6 min in F-URS and miniperc groups, respectively, and Hbg drop was significantly higher in miniperc group. Contrary to studies above, Akbulut et al. [20] reported shorter PT, but similar Hgb drop and FT for F-URS compared to miniperc. Looking from the aspect of PNL, PNL was reported to have larger Hgb drop and CR compared to F-URS [21]. Resorlu et al. [11] reported significantly higher blood transfusion rates, FT and PT in PNL compared to F-URS. In the same study, they also reported higher CR for PNL compared to ESWL and F-URS. Mishra reported more Hgb drop for PNL, but more PT for miniperc. However, they did not report the FT. Giusti et al. [22] also reported the similar results [22]. In our research, Hgb drop was significant in PNL group, but not in the others. When calculating the creatinine change, there was a significant decrease in PNL group. Despite the significant Hgb drop in PNL group, there was no need for blood transfusion, and it did not make any chance on CR according to the Clavien Classification. The CR was statistically different among groups, except miniperc and PNL. FT and PT were detected to be least in ESWL group. The longest FT was in PNL group, and the longest PT was in miniperc group. The lengthy PT in miniperc group was due to diminished visibility and need for prolonged lithotripsy.

In our research, a JJ stent insertion rate was detected to be least in ESWL group. For renal stones, Mohayuddin et al. [123] reported no benefit of SFR using JJ stents for ESWL, and Ozyuvali et al reported no benefit for F-URS [24]. Due to reports similar to the ones mentioned, we applied JJ stents if there was a symptom of renal colic after ESWL and F-URS procedure. For miniperc and PNL, we routinely applied a JJ stent insertion antegradely due to the lack of the literature.

CE is an economic evaluation of different procedures for the same health problem. It is mostly important when a less expensive and similar or more successful procedure was detected. Limited data was reported for CE examining the treatment modalities for renal stones. Pan reported no CE difference between F-URS and miniperc, but more SFR in miniperc [15]. Bagcioglu reported better SFR and CE for miniperc than F-URS [25]. In our research, ESWL was the least costly method, but has the lowest SFR. PNL was the less costly method among operational procedures and had the highest SFT among all procedures.

Patient size is the main limitation of our study. More patients, especially in miniperc group, will reveal better results about this subject. We didn't add the laboratory tests for CE due to minimally effect on procedures and comparison. We didn't compare the complications about general and local anesthesia for ESWL and other operational procedures.

Conclusion

For 15 mm to 25 mm renal pelvis stones, PNL is superior than ESWL, F-URS, and miniperc with best SFR, moderate CE and CR.

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