Percutaneous Nephrolithotomy Versus Non-Stented Extracorporeal Shock Wave Lithotripsy for Medium Sized Kidney Stones

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ABSTRACT

Background*:* nephrolithiasis is a common complex disease. It is the third most common disaster of the urinary tract, exceeded only by urinary tract infections and pathologic conditions of the prostate. About 50 % of recurrent stone formers have just one life time recurrence. At present, the great expansion in minimally invasive techniques has led to the decrease in open stone surgery (OSS). Extracorporeal shock wave lithotripsy (ESWL) has been introduced as an alternative approach which disintegrates stones in the kidney and upper urinary tract through the use of shock waves (SWs). Nevertheless, as there are limitations with the success rate in ESWL, other minimally invasive modalities for kidney stones such as percutaneous nephrolithotomy (PNL) are considered.

Aim of the work*:* this study aimed to evaluate the effectiveness of ESWL VS PNL in management of non-lower polar medium sized stone (1-2 cm) as regards to stone size, location and number.

Patients and Methods*:* this is a prospective randomized comparative clinical study that was conducted in Ain Shams Urology Department and Agouza Hospital Urology Department from December 2016 till September 2017.Sixty patients were enrolled; of which 30 patients underwent PNL and other 30 patients underwent Non-stented ESWL complaining of non-lower polar medium sized calyceal stones (1-2 cm). All patients were categorized into two subgroups; **group A** for ESWL and **group B** for PNL. Patients with lower calyceal stones, stone burden more than 2 cm, recurrent kidney stones, renal impairment, pregnant women and children were excluded from this study. Our study included 45 males (75%) and 15 females (25%) with a mean ± SD age 43.78±12.68 years (range 25 to 65). The patients' criteria (age, sex, body mass index) and the stone characteristics (side, stone size, attenuation value and skin- to-stone distance) were compared between both groups. The SFR rate, the need for secondary procedures were calculated and compared.

Results*:* 30 patients underwent PNL and the other 30 patients underwent Non-Stented ESWL. Twenty nine patients (96.6%) who underwent PNL rendered SFR detected by Non-enhanced Helical CT (Less than 4 mm) after one month; two cases 2 mm and 3 mm CIRF and only one case with 4 mm residual whereas only 5 patients (16.7%) in the ESWL group with high significance ($P < 0.001$) and all patients in PNL group were completed stone clearance without auxiliary procedure ($p< 0.001$).

Conclusion*:* PNL is the modality of choice in medium sized (1-2cm) lower calyceal renal stone. PNL was more effective than ESWL for treating medium sized (1-2 cm) non lower polar renal stone, it has advantages of higher initial SFR with short time of treatment and lower auxiliary procedures (lower retreatment rate).However, ESWL was associated with fewer complications.

Keywords: extracorporeal shockwave lithotripsy (ESWL), percutaneous nephrolithotomy (PNL), stone-free rate (SFR).

INTRODUCTION

Nephrolithiasis is a common complex disease.it is the third most common disaster of the urinary tract, exceeded only by urinary tract infections and pathologic conditions of the prostate. About 50 % of recurrent stone formers have just one life time recurrence [1].

Currently, ESWL is indicated for most uncomplicated upper urinary tract calculi, that is, an aggregate stone burden of <2 cm in kidneys with normal renal anatomy. Shock wave lithotripsy is also considered as an appropriate alternative for the management of ureteral stones anywhere in the ureter with a few caveats (pregnancy, mid and lower ureteral stones in women of child bearing age) [2, 3, 4].

AUA and EUA 2015 guidelines committees for the management of renal calculi considered ESWL and endourological procedures as equivalent first-line therapy for the treatment of most urinary stones independent of location or type and for size equal or less than two centimeters though as stone burden increases SFR for ESWL decreases [5].

ESWL with PNL indicated as a sandwich therapy for staghorn stones and start with ESWL with total SFR about 66 % [6].

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The European Association of Urology Guidelines recommended PNL for treatment of renal stones ≥2 cm and lower pole stones ≥1.5 cm [7]. The American Urological Association (AUA) Guidelines recommended PNL as the first line treatment for staghorn calculi [8].

PNL is also preferred for the management of multiple renal stones or stones in dependent areas of the kidney such as lower pole [9]. Other factors, including stone composition, patient factors and renal anatomy can influence the success of specific treatment modalities [10]. Other indications are calyceal diverticulae [11], renal anomalies [12] and urinary diversion [13].

In the present study we compared the effectiveness of PNL vs ESWL in management of non-lower polar medium sized renal stones as regards to stone size, stone location and stone number.

PATIENTS AND METHODS

A total of 169 patients were assessed for eligibility of which 85 patients did not match the inclusion criteria and hence were excluded and 24 declined to participate in this study. The study included 60 patients who were randomized to 2 equal groups of 30 each using the sealed envelope method. Full history has been taken with routine laboratory tests i.e. urinalysis, urine culture, creatinine, liver function tests, a complete blood count and coagulation profile was done.

Radiological investigations included a plain X-ray of the abdomen and pelvis and Non-enhanced Helical CTUT were done.

The study was approved by the Ethics Board of Ain Shams University.

RESULTS

Basic patients and stones characteristics of all involved cases in this study were tabulated, compared and discussed.

Two visits were done for all patients who had KUB at one and three months post operatively to assess stone clearance (SFR).

'Success' included patients who became stone-free or had residual [CIRF] (<4 mm) fragments. Our study included 45 males (75%) and 15 females (25%) with a mean ± SD age 43.78±12.68 years (range 25 to 65). Stones were in the right kidney in 32(46.70%) patients and in the left kidney in 28 (53.30%). Mean stone size was 1.70 cm ± 0.28 cm (range 1 to 2.2 cm). On non-enhanced Helical CT mean stone density was 1275.74 ± 153.89 HU. Concerning stone site, there was upper calyceal in 16 patients (26.7%), middle calyceal in 15 patients (25.0%), pelvis in 22 patients (36.7%) and pelviureteric in 7 patients (11.7%).

30 patients underwent PNL and other 30 patients underwent Non-Stented ESWL. Twenty nine patients (96.6%) who underwent PNL rendered SFR detected by Non-enhanced Helical CT (Less than 4 mm) after one month; two cases 2 mm and 3 mm CIRF and only one case with 4 mm residual whereas only 5 patients (16.7%) in the ESWL group with high significance (P < 0.001) and all patients in PNL group were completed stone clearance without auxiliary procedure (p<0.001).

Overall SFR: no statistically significance difference in outcome at 3 months follow-up between ESWL and PNL groups regarding SFR.

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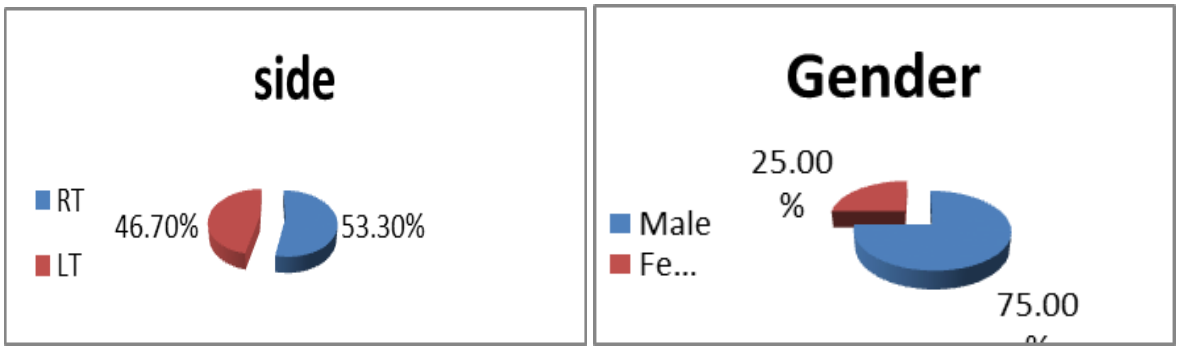

Figure 1: demographic data

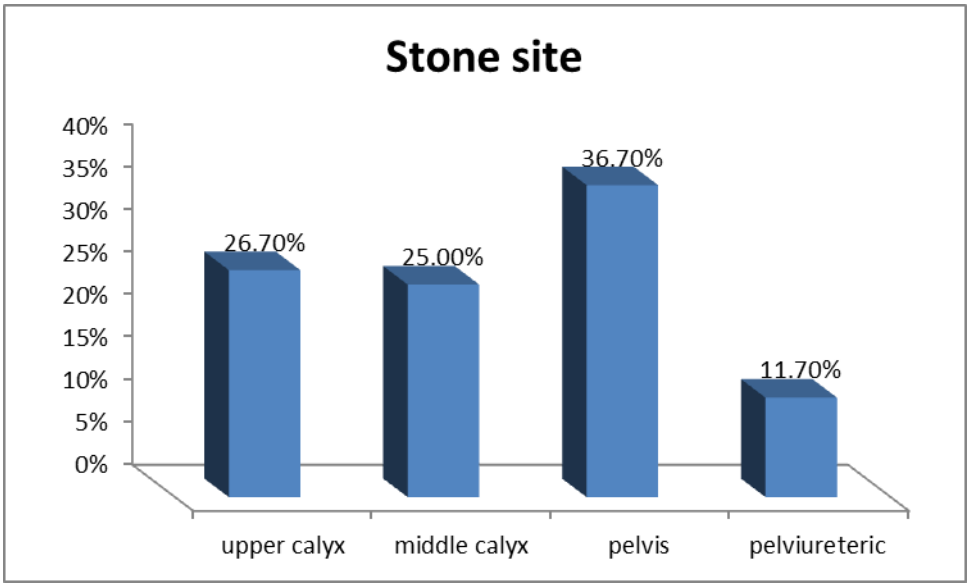

Figure 2: comparison between ESWL and PNL groups regarding stone site.

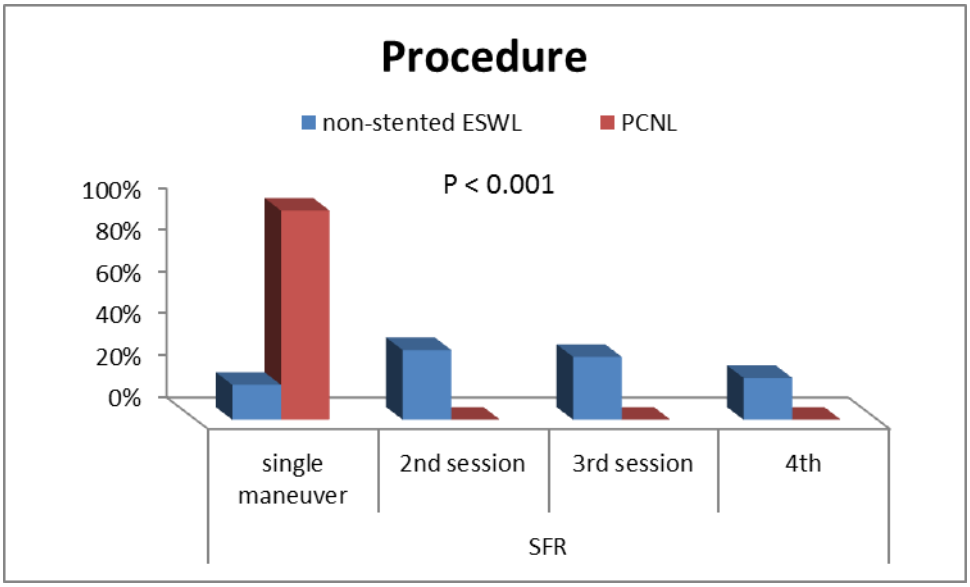

Figure 3: auxiliary procedures between ESWL and PNL.

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Table 1: basic patients and stones characteristics of all involved cases in this study

	Mean	Standard Deviation	Median	Minimum	Maximum
Age (years)	43.78	12.68	42.50	25.00	65.00
SSD (cm)	9.71	1.59	9.50	7.00	12.60
HU	1275.74	153.89	1300.00	1010.00	1500.00
Stone size	1.70	.28	1.70	1.00	2.20
BMI	26.06	2.77	25.95	21.80	33.50

Table 2: comparisons between patients' demography and stone's characteristics in both groups of patients

	Procedure										
	non-stented ESWL					PNL					P value
	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	
Age(years)	41.13	11.82	39.50	25.00	65.00	46.43	13.15	44.00	25.00	65.00	0.106
SSD (cm)	10.24	1.65	10.55	7.50	12.60	9.18	1.35	8.90	7.00	11.50	0.008
HU	1266.95	158.15	1277.50	1017.00	1500.00	284.53	51.69	310.00	1010.00	1490.00	0.662
Stone size	1.68	.29	1.70	1.00	2.20	1.73	.27	1.70	1.20	2.20	0.489
BMI	27.33	2.83	27.05	22.60	33.50	24.78	2.06	24.45	21.80	28.30	<0.001

Table 3: demography of enrolled patients based on stone composition HU

		Procedure			
		PNL		non-stented ESWL	
		Count	%	Count	%
HU	**>1200**	22	73.3%	22	73.3%
	<1200	8	26.7%	8	26.7%

Table 4: role of stone composition HU in predicting SFR outcome

		PNL				non-stented ESWL			
		HU >1200		HU <1200		HU >1200		HU <1200	
		Count	%	Count	%	Count	%	Count	%
SFR	**single session**	22	100.0%	8	100.0%	5	22.7%	0	.0%
	2nd session	0	.0%	0	.0%	7	31.8%	3	37.5%
	3rd session	0	.0%	0	.0%	4	18.2%	5	62.5%
	4th	0	.0%	0	.0%	6	27.3%	0	.0%

DISCUSSION

In the present study, the mean attenuation value was 1275.74 ± 153.89 HU that was supported by other studies as the probability of achieving a stone free outcome peaked at approximately 1250 HU in which far below or far above this density resulted in lower treatment success, particularly at very low HU values [14, 15].

In the present study, there was no significant difference in HU for both ESWL vs. PNL (1266.95 ± 158.15 vs. 1284.53 ± 151.69, P=0.662).

A cutoff value of 1200 was used for the HU in the receiver operating characteristics analysis. In addition to the size and location of the stones, the HU value determined in the Non-enhanced Helical CT scan may be one of the parameters affecting PNL outcomes. PNL is a more efficient method in stones with higher HU values. Therefore, the HU values may be a useful tool for the selection of the treatment modality in patients with renal stones. A HU>1200 was best managed by PNL from the start without the need for auxiliary procedures and HU<1200 can be managed by ESWL.

In this study, patient's demography, stone characteristics and outcomes in ESWL group were studied. The ESWL outcomes in the present study were initial SFR after single maneuver; only 5 patients (16.7%) in the ESWL group showed with high significance (< 0.001). Twenty five (83.3%) patients completed stone patients with auxiliary ESWL sessions. Final SFR was (91.7%), Overall SFR after 3 months were similar in both groups of patients and they were comparable to other similar studies except SFR were 83.5% [16], 75% [17] and 33.33% [18] . But in our study, the final SFR was

higher 91.7% because we excluded isolated lower calyceal stone and used electromagnetic lithotripter Dornier S which known to have high energy flux density with narrow focus, well trained operators. In the present study, ESWL was performed with Electromagnetic Dornier S lithotripter; other used Electroconductive Healthtronics lithotron ultra [19], Medispec Econolith Lithotripter [18], Electromagnetic Dornier S Lithotripter [17].

In the present study, there was a highly significant difference in SSD for both ESWL vs. PNL (10.24 vs. 9.18, P =< 0.008).

In the present study, the methods of stone localization were fluoroscopy like Deem Study [18] and other used both fluoroscopy and ultrasonography [17].

Our ESWL strategy was using power ramping aiming powederization rather than disintegration. The use of principles of multiple windows of ESWL [16], use of our strategy of staged disintegration with lower total energy per session rather than single session with high total energy to avoid SW session with high total energy to avoid SW related bio effects on both renal and extrarenal tissues.

In the present study in PNL group, patients' demography, stone characteristics and outcomes were illustrated, the outcomes of presenting study, almost all patients (96.6%) who underwent PNL rendered stone free with one maneuver regardless of the clinically insignificant renal fragment ≤4 mm which were detected in 3 cases and passed in control film one month postoperatively. The global studies have different criteria for measuring the outcomes, follow-up period, different generation types of ESWL were used, different methods of dilations and disintegrations for PNL and differ in whom who did the operations for PNL and ESWL patients which all affect the results of treatment and make the comparison difficult [19]. In the present study, we excluded isolated lower calyceal stone like other study [18]; others focused on lower pole kidney stones [20], while old study did not specify stone location [21].

The SFR after ESWL is affected by many factors including stone size, HU attenuation value and BMI [22, 23]. However, the SFR after PNL is not affected by these factors, as the intracorporeal lithotripsy device scan disintegrate any type of renal stone of any size, and regardless of the patient's BMI [24, 25].

In the present study, there was a highly significant difference in BMI for both ESWL vs. PNL (27.33 vs. 24.78, P =< 0.001) like others who claimed that BMI was an independent factor for success rate because they tested it separately and in large number of patients [25, 26]. But, another study [17] (31.9 vs. 31.6, P =0.589) there was no significant difference in BMI for both ESWL vs. PNL [17].

CONCLUSION

PNL is the modality of choice in medium sized (1-2cm) lower calyceal renal stone. PNL was more effective than ESWL for treating medium sized (1-2 cm) non lower polar renal stone, it has advantages of higher initial SFR with short time of treatment and lower auxiliary procedures (lower retreatment rate).However, ESWL was associated with fewer complications.

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