

Outcome of Percutaneous Nephrolithotomy and SWL in the Treatment of Complex Renal Stones

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Abstract: Purpose: To assess the outcome of combined percutaneous nephrolithotomy (PNL) and SWL for the treatment of complex renal stones and its short term impact on the function of the operated kidneys. **Patients and Methods:** The outcome of 50 patients with complex renal stones submitted to PCNL and complementary SWL for significant residuals between June 2013 and May 2016 were prospectively reviewed. Preoperative evaluation included routine investigations, KUB, U/S, IVP or low-dose NCCT and diethylenetriaminepentaacetic acid (DTPA) renography. Patients evaluated for stone clearance and perioperative complications as well as GFR changes at 3 months postoperatively. Follow-up with KUB and low-dose NCCT for radiolucent stones were performed. Renal radioisotopic scan was performed for patients who had already undergone this study before PNL. **Results:** The study included 50 patients (39 male and 11 female) with mean age 41.5 years. They underwent 51 PNL procedures (one patient had bilateral stones). Among the 51 kidneys, 22 (43.13%) rendered stone free after one session PNL elevated to 58.8% after 2nd session when performed. At 3 months, the stone-free rate increased to 92.1% after shock wave lithotripsy. Independent risk factors for residual stones were stone volume, number of access tracts and surgeon experience. The complication rate was 55%. Independent risk factors for development of complications were performance of the procedure by urologists other than experienced endourologist, positive urine culture and stone burden. Only 40 patients underwent 41(80.4%) procedures completed the functional evaluation with DTPA renogram. The total number of renal units that showed improvement in their GFR were 15; 12 renal units had improvement above 10% of their preoperative GFR value while 3 renal units below 10%. On the other side, the total numbers of renal units that showed deterioration were 26; 20 renal units had deterioration more than 10% of their preoperative GFR value while 6 renal units below 10%. All renal units with obstructed curves in the preoperative renal isotope scan showed relief of the obstruction and proper trace drainage. **Conclusion:** PNL and complementary SWL are effective in achieving an acceptable stone-clearance rate in patients with complex renal calculi. Factors affecting the incidence of residual stones after PNL and SWL are stone volume, number of access tracts and surgeon experience. Complications are significantly high if PNL is not performed by an experienced endourologist as well as positive urine culture and large stone burden. This study reported that PNL in complex stones does not cause a statistically significant impact on the function of the targeted kidney during short term follow up.

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1. Introduction:

The goals of surgical treatment of complex renal stones are complete stone clearance with minimal morbidity. Percutaneous nephrolithotomy (PNL) has become the recommended treatment for such stones [1,2]. However, it is challenging to achieve a stone free status using PNL because multiple percutaneous tracts may be needed to remove all stone branches [3]. These multitract PNL may lead to higher complication rates, such as bleeding [4] and other major complications are sepsis and adjacent organ injuries [5]. Achieving a stone-free status may also require multi-puncture or multiple sessions of PNL as well as using secondary procedures, such as extracorporeal shock wave lithotripsy (SWL) for treatment of residual fragments.

Urolithiasis can lead to some degree of kidney function impairment, primarily due to infective or obstructive mechanisms. Moreover, urolithiasis is commonly associated with some other important chronic diseases, such as hypertension and diabetes which also negatively affect renal function. Also the patients are highly prone to suffer from recurrences, therefore receiving several stone treatments in their lifetime [6]. Accordingly, the goal of stone treatment should not only focus on leaving the kidney stone-free, but also on bringing about the least damage to it. In this regard, minimally invasive techniques in kidney stone management, such as percutaneous nephrolithotomy PNL, have prevailed over other more morbid procedures, like open surgery [7]. Many authors have previously tried to assess PNL impact on

renal function and they coincide that PNL has a little or no impact on renal function. [8,9].

2. Patients and methods:

Patients who had general contraindications for surgery as well as congenital renal anomalies were excluded. We prospectively studied 50 patients, who were submitted to 51 PNL procedures as one patient underwent bilateral PNL between June 2013 and May 2016. Complex renal calculi could be an extension of a pelvic stone into the calyceal groups which is called staghorn calculi as well as multiple primary or secondary renal calculi occupying the calyceal groups. In this study, we had 39 males and 11 females, with a mean age of 41.5 years with a mean body mass index (BMI) 21.6.

Preoperatively, all patients were evaluated with urine analysis and culture plus routine laboratory investigations. Radiological evaluation included KUB film, abdominal and pelvic ultrasonography. Randomly, Intravenous urography (IVU) or low-dose NCCT were asked for the patients. Functional evaluation of the operated renal units with renal radioisotope scan (^{99m}Tc -DTPA) was done.

The most important steps in PNL were; performance of the percutaneous access under fluoroscopic guidance and placement of guidewires through all planned tracts before dilatation of the first tract. A second session of PNL was performed in cases of significant residual stones if they were accessible through the present tracts. SWL was used for residual fragments that were inaccessible through the

nephrostomy tracts and follow-up was elected for residual fragments smaller than 4 mm. The outcome was evaluated with KUB or low-dose NCCT for radiolucent stones immediately and 3 months after PNL. Stone-free was defined as no significant residual stones. Complications were classified according to the modified Clavien classification system [10]. At 3 months post PNL, 40 patients underwent 41 (80.4%) procedures completed the functional evaluation with renal radioisotope scan (^{99m}Tc -DTPA) to assess the functional changes that happened in the targeted renal units.

Statistical analysis

All analyses were carried out using SPSS 15.0 (SPSS Inc., Chicago, IL, USA). The Wilcoxon signed-rank test for paired data was used to seek differences between pre- and post-PCNL measurements. Values of $p < 0.05$ were considered as statistically significant.

3. Results

The study included 50 patients (39 male and 11 female) with mean age 41.5 years. They underwent 51 PNL procedures (one patient had bilateral stones). In 33 procedures (64.7%) multitract PNL was used (2 tracts in 29 PNL cases and 3 tracts in 4). Multiple sessions of PNL were needed in 9 cases. The stone-free rate of PNL monotherapy was 58.8%. SWL was performed after 17 PNL (33.3%). At 3 months, the stone-free rate increased to 92.1%. Overall complication rate was 55% (28 PNL). Modified Clavien classification results are summarized in table (1).

Table 1: Modified Clavien classification

Number of procedures:	Number of procedures followed by complications	Percent of procedures followed by complications (%)
51		
Grade I	11	23.5
Grade II	15	25.5
Grade III	A	6
	B	2
Grade IV	A	0
	B	0
Grade V	0	0

Bleeding is the most worrisome complication it was reported in 19.6% of our procedures. Blood transfusion was required in 11.7% of the procedures. This included 6 cases of intraoperative bleeding, 4 cases of postoperative hematuria. Bleeding was successfully treated with clamping of the nephrostomy and hemostatic drugs, whereas one case (2%) required angiographic embolization. Urinary leakage was considered when leakage of urine through the nephrostomy site after removal of the nephrostomy tube remained for more than 24 hours. Nine patients

recorded prolonged leakage, 5 patients were managed conservatively while the other 4 patients required stent insertion. Fever was reported in 15 cases (29.4%) so it was the most common perioperative complication and was treated with culture specific antibiotics and antipyretics. Unplanned auxiliary procedures were needed in 14 PNL (27.5%) in the form of double-J stent for 13 patients and ureteroscopy plus double-j stent for one patient. The mean hospital stay was 4 days (range, 2-10 days). As regards functional outcome the total number of renal units that showed

improvement in their GFR were 15 (29.4%); 12 renal units had improvement above 10% of their preoperative GFR value while 3 renal units below 10%. On the other side, the total numbers of renal units that showed deterioration were 26 (51%); 20 renal units had deterioration more than 10% of their preoperative GFR value while 6 renal units below

10%. According to *Shokeir et al., (2003)* [11], the renal function was preserved in 22% of renal units and improved in 29% while deterioration occurred in 49%. Moreover, all renal units with obstructed curves in the preoperative renal isotope scan showed relief of the obstruction and proper trace drainage.

Table (2): Complications according to Clavien grade in other series as compared to the current study

Study	Tefekli et al.	Wezel et al	De la rosette et al.	Shin et al.,	Labate et al.,	El-Nahass et al.,	de Fata et al.,	Fei et al.,	Posada et al.,	Current study
Year	2007	2009	2011	2011	2011	2012	2013	2014	2015	2016
No.	811	200	5724	698	5724	251	397	55	2318	51
I	4	37	11.1	12.6	11.1	3.6	16.4	18.2	13.8	23.5
II	16.3	12	5.3	20.8	5.4	12.4	4	10.9	2.2	25.5
IIIa	6.6	3	2.3	4.4	2.3	9.6	1.5	0	1.4	11.7
IIIb	2.8	0	1.3	0.7	1.3	0.4	0.8	0	0.6	3.9
Iva	1.1	0	0.3	0.9	0.3	0.4	1	0	0.1	0
IVb	0.3	0.5	0.2	0.6	0.2	0.4	0	0	0.1	0

4. Discussion

Complex renal calculi often present a formidable challenge to the endourologist, as it may necessitate supra-costal access, multiple tract procedures, prolonged operative time, more manipulation, larger volumes of irrigate fluid, and often multiple sessions of PNL to achieve complete stone clearance. PNL has largely replaced open stone renal surgery because of its good stone-free rates as well as lower invasiveness [12].

In this study the stone free rate was 58.8% after PNL monotherapy. This is comparable with ratios published in previous literatures in which the stone free rates was 56.9%, 69.9%,56%. [3,8,9]. While incomparable with (82%) obtained by *Hossain et al., (2013)* and *Singh et al., (2015)* [12,13]. Nevertheless, lower than published in AUA nephrolithiasis guidelines panel on staghorn calculi that reported an overall stone-free rate in 78% of cases.

The difference in the stone free rates after PNL monotherapy between this study and others may be referred to many factors as the majority of the stones that we operated on were branched into 2 or more major calyces and 40% of procedures were done by surgeons of limited experience. On the other hand, studies with higher stone free rates might have lower stone burden, lower stone distribution, or more aggressive approaches performed like using more access tracts, available flexible nephroscopy or ureteroscopy as well as more experienced hands.

When SWL applied to 33.3% of renal units having significant residuals including one case with residual fragments post 2nd look PNL. The overall stone free rate became 92.1% while *Shin et al. (2011)* [14] recorded improvement in stone free rate after SWL on residuals post PNL from 69.9% to 88.8%. *Hossain and coworkers (2013)* [12] applied SWL in (7.8%) of renal units with significant residuals with ultimate success rate 93%. The requirement of multiple sessions of PNL in 17.6% and SWL in 33% in addition to the 27.4% incidence of unplanned secondary procedures in the present study highlights the importance of patient's counseling before PNL of complex stones. The surgeon must explain to the patients the need of multiple interventions.

Perioperative complications was reported in 28 (55%) procedures with the possibility of more than one complication in the same patient and most of these complications resolved without sequelae. There was no statistically significant relation between associated comorbidities e.g. diabetes mellitus, hypertension and risk of perioperative complications. The most common perioperative complications were fever in (29.4%) then prolonged leakage from the nephrostomy tract in (17.6%) of procedures. Bleeding is the most worrisome complication resulting from PNL; it was reported in 19.6% of our procedures. Blood transfusion was required in 11.7% of the procedures. No mortality recorded among our patients.

Our results were compatible with *Resorlu and coworkers, (2011)* [15] who recorded the same perioperative complication rate (55%) while not resemble that obtained by *EL-Nahas et al., in (2010 and 2012)* [16, 17] 22% and 27% respectively. Variability in the perioperative complication rates with other series referred to the diversity in the number of procedures, surgeon experience, access tracts, stone and patient characteristics among the studies.

According to the modified Clavien classification we recorded grades I, II, IIIa and IIIb in 23.5%, 25.5%, 11.7% and 3.9% of our procedures respectively. No patients were recorded in grades IVa, IVb and V.

Many authors have studied the effects of percutaneous stone surgery on kidney function. Several blood and urine markers have been used, with diverging results. The main drawback of these analyses is the compensatory effect of the contralateral kidney, which might counterbalance a functional decline in the operated one [18–20]. In this study renal radioisotope scan (^{99m}Tc -DTPA) used to assess the GFR changes that happened in the targeted renal units. The total number of renal units that showed improvement in their GFR were 15 (29.4%); 12 renal units had improvement above 10% of their preoperative GFR value while 3 renal units below 10%. On the other side, the total numbers of renal units that showed deterioration were 26 (51%); 20 renal units had deterioration more than 10% of their preoperative GFR value while 6 renal units below 10%. The renal function was preserved in 22% of renal units and improved in 29% while deterioration occurred in 49%. There were no significant changes in GFR of targeted renal unit ($p=0.19$). The mean GFR drop was 1.8 (8.1) mL/min. Our results were parallel with those recorded by *Pérez-Fentes and associates (2014)* [21] in three months after PNL; we did not find statistically significant differences in GFR of operated kidneys. Also *Fayad et al. (2014)* [22] reported no statistically significant change in GFR 12 months after PNL in patients with normal baseline serum creatinine. In this study we, noticed that the perioperative complications, poor preoperative GFR and surgeon experience are independent risk factors for renal function deterioration after PNL for complex renal stones. The results of *EL-Nahas et al. (2010) and Pérez-Fentes et al. (2014)* [16,21] corresponds with our results with regard to development of complications is a risk factor for GFR deterioration after PNL for complex renal stones ($P=0.003$).

Conclusion

PNL and complementary SWL are effective in achieving an acceptable stone-clearance rate in patients with complex renal calculi. It provides a

higher safety and a lower morbidity plus a relatively low incidence of significant complications to such patients. Patients with complex renal stones who will be treated with PNL need to know that the probability of requiring auxiliary procedures like multiple sessions of PNL and complementary SWL. We reported that complications are significantly high if PNL is not performed by experienced endourologist or positive preoperative urine culture. This study documented that PNL in complex stones does not cause a statistically significant impact on the function of the targeted kidney during short term follow up but the advent of postoperative complications revealed a negative effect. Consequently, PNL is a minimally invasive technique, which could be carried out even in kidneys with some degree of functional impairment. It is recommended to improve the expertise of the urologists in PNL in order to raise the success rates and lower the complication rates therefore increasing kidney function lifespan.

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