Outcome of Percutaneous Nephrolithotomy for Staghorn Stones: Al-Azhar 5-Years Experience

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Abstract: Objective: To evaluate the outcome of percutaneous nephrolithotomy (PCNL) in the treatment of patient with staghorn stone at Al-Azhar University Hospitals. **Materials and methods:** From October 2010 to September 2015, all patients with staghorn stones were enrolled in this study. Beside routine laboratory investigation, all patients underwent abdominal X-ray for kidney, ureters and urinary bladder (KUB), pelvi abdominal ultrasonography, and intravenous urography (IVU) or Non-contrast Computed Tomography (NCCT). Patients with uncorrected coagulopathies or ureteral pelvic junction obstruction were excluded from the study. **Results:** Overall 255 PCNL procedures were done for 210 patients (138 males and 72 females); one stage PCNL procedure in 165 (78.5%), two stages in 31 (14.7%) and three stages in 14 (6.6%). Single puncture was performed in 109 (51.9%), two punctures in 70 (33.3%) and three punctures in 31 (14.7%) patients. Out of 255 procedures, 196 (76.9%) PCNL procedures were performed by senior surgeons and 59 (23.1%) by juniors. The overall stone free rate was 79.1%. Bleeding and pelvicalyceal perforation were the most common intra-operative complications; 32 (15.2%) and 16 (7.6%) respectively. Nine (4.3%) patients needed open surgery due to severe bleeding. From them, two patients underwent nephrectomy. Post-operative auxiliary procedures (e.g. ESWL, URS, JJ ureteral stenting) were needed in 46 (26.7%) patients. **Conclusions:** PCNL is a safe and effective procedure in the management of staghorn stones. It can be used as an alternative procedure to open surgery.

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Key Word: Staghorn calculi, percutaneous nephrolithotomy, stone free rates, and urinary tract stone.

1. Introduction:

Urinary stone is worldwide disease with approximately 5% new cases every years.[1] In the last two decades the staghorn stones treatment has changed from open surgery to minimally invasive methods such as percutaneous nephrolithotomy (PCNL), extracorporeal shock wave lithotripsy (ESWL) and combination of PCNL and ESWL. PCNL is the most commonly used operation for staghorn calculi.[2] Multi-stage and multi-channel operation combined treatment are necessary to remove the stone completely. However, multi-stage operation has more potential complication, such as haemorrhage, urinary extravasion, and injury of adjacent organs.[4] The key factors affecting stone free rate (SFR) are the stone size, location, complexity, kidney structure, puncture channel and surgeon's skill.[5,6] In the present study we evaluated the outcome of PCNL in the treatment of patient with staghorn stone, over 5-year period, at Al-Azhar University Hospitals.

2. Patients and Methods

This study was conducted at Al-Azhar University Hospitals, Cairo, Egypt, in the period from October 2010 to September 2015. All patients with partial or complete staghorn stone were evaluated for possible study participation.

Pre-operative evaluation: All patients were subjected to complete medical history and physical examination, standard laboratory investigation such as urine alysis, urine culture and sensitivity, complete blood count (CBC), blood urea, serum creatinine, liver function tests and coagulation profile. Radiological study included plain abdominal X-ray for kidney, ureters and urinary bladder (KUB), pelvi-abdominal ultrasonography and non-contrast computed tomography (NCCT) or intravenous urography (IVU).

PCNL technique: All PCNL procedures were performed under general anesthesia with patients in prone position. Preliminary, with the patient in lithotomy position a ureteral catheter was endoscopically introduced into the ipsilateral ureter and reterograde ureteropyelography was performed to visualize the pelvi-calyceal system. Under fluoroscopy, the access to the desired calyx was achieved using an 18 gauge needle to get the best access to the whole of most of stone burden. The needle tip was directed towards the tip of the calyx. Level of puncture on the skin was at the posterior axillary line below the last rib. In cases where a supra-costal puncture was required, it was performed two finger breadths medial to posterior axillary line at 11th intercostals space. The working channel was dilated by using the metal dilator system up to 30 Fr before

placement of an Amplatz sheath in to the collecting system. A 26 Fr nephroscope was introduced into the pelvicalyceal system through the established tract and pneumatic lithotripsy was used for stone fragmentation in all cases. The stone fragments were extracted by using Peanut or Alligator stone forceps. At the end of the procedure, the ureteric catheter was maintained in the ureter or a double J stent was placed instead if there was indication for stenting. A Nelaton's catheter was inserted into the renal pelvis or the involved calyx as nephrostomy tube with performance of descending nephrostogram to check for extravasation. For patients with a supra-costal access, the chest was screened, on table, before the patient was extubated, and an additional plain chest X-ray was obtained post-operatively.

Post-operative follow-up: All patients were under strict clinical observation during the first 24 hours, including observation of vital signs, abdominal rigidity, urine color and nephrostomy tube. Laboratory investigation in the form of CBC, serum creatinine, blood urea and serum Na and K level were performed after 24 hours. Abdominal X-ray KUB and/or abdominal ultrasonography were performed on the first post-operative day to evaluate the outcome of PCNL. A residual fragment (s) < 5 mm was considered stone free. The nephrostomy tube was left in place if a second PCNL session due to residual stone was planned.

Statistical analysis:

IBM SPSS statistics 21.0 software (statistical package for social sciences, SPSS, IBM cooperation, New York, NY, USA) was used for statistical analysis. *P* value < 0.05 was considered statistically significant. Fisher exact chi-square and logistic regression analysis test were used for evaluation of various factors affecting efficacy.

3. Results:

The study included 210 patients, 138 males and 72 females. Their ages ranged from 9 to 72 years (mean ± SD 49.2±15). From them, 92 (43.8%) had complete staghorn and 118 (56.2%) had partial staghorn stones. The stones were radio opaque in 185 (87.1%) and radiolucent in 27 (12.9%); unilateral in 186 (88.5%) and bilateral in 24 (11.5%) cases (Table 1).

Table (1): Stone characteristics in the studied patients.

Stone characteristics		**No.**	**%**	***P* value**
Stone pattern	Complete staghorn	92	43.8	0.212
	Partial staghorn	118	56.2	
Stone opacity	Radio opaque	183	87.1	
	Radiolucent	27	12.9	
Laterality	Unilateral	186	88.5	
	Bilateral	24	11.5	

Overall 255 PCNL procedures were performed; one stage procedures in 165 (78.5%), two stages procedures in 31 (14.7%) and three stages procedures in 14 (6.7%). Single puncture was performed in 109 (51.9%) cases, two punctures in 70 (33.3%) and three punctures in 31 (14.7%). Supra costal punctures access through the intercostal space was performed in 27 (12.8%) procedures. From the 255 procedures, 196 were done by senior surgeons and 59 by juniors (Table 2).

Table (2): Stage of PCNL procedures, number of punctures and surgeons experience

PCNL procedure characteristics		**No.**	**%**	***P* value**
No. of stages	One stage	165	78.5	0.501
	Two stage	31	14.7	
	Three stage	14	6.6	
No. of punctures	Single	109	51.9	
	Two punctures	70	33.3	
	Three punctures	31	14.7	
Surgeon experience	Senior surgeons	196		
	Juniors	59		

Out of the 210 studied cases, 107 (51%) were rendered stone free. Among the remaining 103, 78 (37.4%) had clinically significant residual fragment (s) (≥5mm) and 25 (11.9%) had clinically insignificant residual fragment (s). Thirty eight (18.1%) patients with significant residual fragment (s) underwent staged PCNL and 20 cases (9.5%) were stone free after the second session and 14 (6.7%) were stone free after the third session. Therefore, the overall stone free rate after PCNL in our study was 79.1%.

Out of 255 procedures, 196 (76.9%) PCNL procedures were performed by senior surgeons and 59 (23.1%) by juniors. No significant correlation were observed between surgeon experience and PCNL outcome ($P = 0.332$).

Bleeding (32 cases; 15.2%) and perforation of pelvicalyceal system (16 cases; 7.6%) were the most common intra-operative complications. Out of 32 cases with intraoperative bleeding, 32 (15.2%) needed blood transfusion and 9 (4.3%) needed open surgery due to severe bleeding. From them, two patients underwent nephrectomy. The most common post-operative complication was post-operative fever (26 cases; 12.8%) followed by urinary leakage (25 cases; 11.9%). The intra- and post-operative complications are summarized in table 3.

Table (3): Intra operative complication bleeding and pelvi calyceal perforation are the most common intra operative complication

	No.	**%**
Intra operative complication		
Bleeding dictating blood transfusion	12	5.7
Bleeding dictating stop page procedures	7	3.3
Bleeding dictating both	4	1.9
Bleeding dictating open surgery and blood transfusion	9	4.2
Nephroctomy due to excessive bleeding	2	0.9
Pelvi calyceal perforation	16	7.6
Colonic injury	4	3.3
Post-operative complication		
Leakage	25	11.9
Fever	26	12.8
Bleeding not dictating blood transfusion	6	2.8
Bleeding dictating blood transfusion	2	0.95
Pleural injury	3	1.4
Pneumonia	3	1.4
Death	2	0.95
Pyelonephritis	8	3.8
Uretero pelvic junction obstruction	5	2.4
Stricture ureter	3	1.4

*Some patients have more than one complication.

Post-operative auxiliary procedures were needed in 46 (26.7%) patients; ESWL in 37 (17.6%), Double-J ureteral stent in 13 (6.2%), ureteroscopy in 6 (2.8%) and angioembolization in 2 (0.95%).

4. Discussion:

PCNL is the most commonly used treatment modality for staghorn stones. Even the complete removal of staghorn calculi by PCNL is challenging for the urologist. Since the introduction of PCNL treating renal stones there have been marked improvements in the techniques and instruments that have resulted in using PCNL for treating complex and staghorn stones. Currently it has become the first choice for patients with large, complex and staghorn renal stones. The goal of treatment of a staghorn stone is complete stone clearance with minimal morbidity. Multi-stage and multi-channel operation combined treatments are necessary to remove the stone effectively. However, due to many complications of multi-stage operation, it was avoided.[3]

Desai et al., conducted that achieving a complete stone clearance continued to be a challenging task, despite multiple puncture and multiple tracts.[7]

In our study there were 210 patients (138) male and (72) female underwent 255 PCNL procedures.

From them, 196 procedures were done by experienced hands and 59 by juniors. Supracostal percutaneous access was performed through 11th intercostal space in 27 procedures.

The outcome of PCNL can be interpreted in terms of success and complication rates. "success" is often defined as the absence of residual stone fragments under conventional X-ray or computed tomography or when clinically insignificant residual fragments (CIRFs) are absorved.[8]

The AUA nephrolithiasis guidelines panel on staghorn calculi reported an overall estimated stone-free rate following treatment is highest for PCNL (78%) and lowest for ESWL (54%).[9]

In our study, the overall stone free rate after PCNL was 79.1%. These results are comparable to ratios published by Desai *et al.*[7], El-Nahas *et al.*[10] and Shin *et al.*[11], who reported the stone free rate of 56.9%, 50% and 69.9% respectively. On the other hand, a higher stone-free rate was reported by others as Liatsikas *et al.*[12], Musiumanoglu *et al.*[13] and Fei *et al.*[14], who reported stone free rates (87%, 89.2% and 78.18%) respectively.

In our study as well as in others[15], the most common major intra-operative complication during PCNL procedures was the bleeding. Bleeding during PCNL may occur during any step of PCNL but acute haemorrhage due to injury to great vessels or main renal vessles is uncommon and occurs in less than 0.5% of cases[8]. In our study 32 (15.2%) needed blood transfusion due to severe bleeding during the PCNL procedures and conversion to open surgery was needed in 11 (5.2%) of patient to control bleeding and two of them needed nephrectomy.

Blood transfusion was required in (15.2%) of our cases which is similar to that reported by El-Nahas *et al.*[10] (16%) but is higher than that reported by Shin *et al.*[11] (609%). The second most common complication reported during PCNL procedures in our study was the pelvicalyceal perforation and fluid collection. In our study 16 procedures (7.6%) were reported with pelvicalyceal system perforation. It is importance to avoid perforation of pelvicalyceal system during PCNL, as it is common reason for fluid extravasation systemic absorption of irrigant fluid.[16]

Fever and sepsis were the most common post-PCNL complications (52 cases; 24.7%). Labate *et al.*[17] reported a 13.6% incidence of post-PCNL fever in their large retrospective study on 5724 patients.

The use of auxiliary procedures as JJ, ESWL and URS may be necessary to improve stone free rate and the surgeon should explain to the patient with staghorn stones the possibility of needing such auxiliary procedures to achieve satisfactory outcome.

In our study, ESWL was required in 37 (17.6%) of cases, JJ stent in 13 (6.2%) of cases, ureteroscopy in 6 (2.8%) of cases and angio-embolization in 2 (0.95%). Our finding confirms the observations obtained by Goldwasser *et al.*[18] and El-Nahas *et al.*[10]. Cho *et al.*[19] reported that the need for auxiliary procedures was common in patients undergoing PCNL for staghorn stones multiple-tract PCNL.

5. Conclusion:

PCNL is a safe and effective procedure in the management of partial and complete staghorn renal stones and can be used as an alternative procedure to open surgery.

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