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Effects of Single Versus Multiple Tracts on Percutaneous Nephrolithotomy Outcomes

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Abstract
Objectives: The study designed to compare outcomes and morbidities in patient undergoes multi tracts percutaneous nephrolithotomy (PCNL) versus single tract PCNL.
Methods: From October 2019 to September 2020, 50 patients were prospectively investigated at Azadi Teaching Hospital and Vajeen Private Hospital in Duhok, Iraq. Group A included 25 patients who received single tract PCNL while group B had 25 patients who underwent multiple tract PCNL. Complex renal stones are treated with single or multiple tract PCNL depending on stone configurations and urinary system architecture utilising Guy's stone score. Laboratory and imaging data were correlated with stone size, stone-free rate, mean haemoglobin decrease, operation time, hospital stay, and postoperative problems.
Results: 64% of cases are male and 36% are female. The mean stone size in Group A was 3.3 cm (ranges 2.0–4.9 cm), but in Group B it was 5.1 cm (ranges 3.3–7.4 cm), which is substantially bigger. Group A's mean operational time was 64.4 minutes (ranges from 30–115 minutes), which is statistically significant compared to multiple tracts' 80.2 minutes (ranges from 45–120 minutes). The decline in mean hemoglobin between the two groups is statistically significant. Group A and B had 8% and 12% blood transfusions, which is not significant. Group A had a mean hospital stay of 28.2 hours (20–48 hours), whereas group B had 40.8 hours (ranges 24–96 hours). In group A, 16% of patients experienced post-operative fever, whereas in group B, 20% did. 84% of single tract PCNL and 88% of multiple tract PCNL were stone-free.
Conclusion: Complex renal stones treated by multiple tracts PCNL; is efficient and safe with acceptable postoperative outcomes and complications in comparison to single tract PCNL.
Keywords: Effects, nephrolithotomy, percutaneous, outcomes

Introduction

Percutaneous nephrolithotomy (PCNL) is considered nowadays as a standard endoscopic treatment for large and complex kidney calculi and replacing to a large degree open surgical management of these stones.[1] Despite being a minimally invasive procedure with high stone free rate, PCNL is not devoid of complications and stone free rate is not 100%.[2] Many parameters were used to predict the out-come of the procedure like stone diameter or burden, stone location, association of hydronephrosis, however, when these parameters are used separately, they are not reproducible and do not give precise idea about the outcome.[3] For that reason, nephrolithometric scoring systems were developed based on preoperative data like stone size and site, renal anatomy and patients' conditions to predict the outcome (stone free rate and complications).[4,5] Defining stone complexity by grading or scoring systems has other benefits beside prediction of the outcome, like patients counseling, adjustment of training program, and monitoring the technical refinement of the procedure.[6,7] In complex renal stones, the number of accesses is defined by the size of the stone, anatomy of the pelvi-calyceal system (PCS), stone distribution, and general condition of the patient and the skills of the surgeon. PCNL uses prone, supine, or modified postures. Effective stone removal requires optimal access, which reduces problems and auxiliary procedures. PCNL is done prone. It has less visceral organ damage, a big puncture site, several accesses, and more instrument adjustment space.[8,9] This strategy has limitations, though. It lowers blood circulation and pulmonary function, particularly in obese people, prolongs operation time, and if performed under spinal or epidural anaesthesia, conversion to general anaesthesia is difficult. Ankylosing spondylitis, severe lordosis, or kyphosis make it difficult for patients to lay prone. Prone posture increases radiation exposure.[10] When prone PCNL is done under fluoroscopy, the targeted calyx is better reached by "bull's eye" approach, allowing surgeons superior needle control and tract dilatation.[11] PCNL requires dilatation and sheath insertion. One-step balloon dilation, Alken reusable telescoping dilators, and Amplatz sequential fascial dilators are used for tract dilatation. All right approaches are safe. Telescoping metal dilators cause some blood loss.[12] PNL causes residual stones. Multi-tract PNL is recommended for complicated renal stones when single-tract clearance is insufficient.[13] Multiple punctures may cause excessive blood loss.[14] Multiple tracts may be safer and essential for big stone load, according to Tuna et al. Multiple tracts are more successful in treating staghorn and other big calculi with comparable blood loss and complications than single tract PCNL.[15] The study designed to compare outcomes and morbidities in patient undergoes multi tracts percutaneous nephrolithotomy (PCNL) versus single tract PCNL.

Method

Hospital based prospective comparative study was done in Azadi Teaching Hospital and Vajeen Private Hospitals from October 2019 to the end of September 2020, with a total of 50 patients being studied for their renal stones. Patients were divided to two main groups based on their stone complexity, size and distributions. Patients outcomes and complications are estimated by using Guy's stone score.[8] ***Inclusion criteria:*** Stone size ≥ 2 cm, All types of renal stones, Age > 18 years. ***Exclusion criteria:*** Pediatric age < 18 years, Abnormal renal functions, Patient with bleeding tendency (congenital and

acquired), Single kidney, Spinal and vertebral anomalies. Preoperatively, Patients' histories and physicals, including local exams. Complete blood count, renal functions, random blood sugar, virology profiles, bleeding propensity profile, and urinalysis. Ultrasonography, plain abdominal x-ray (KUB), intravenous urography, or CTU are used to examine urinary system architecture, stone load, and placement. ECG, echocardiography, chest X-ray, and pulmonary function tests are used to determine cardiopulmonary risk. All patients provide written permission before surgery. In the ward, patients got IV cephalosporins one hour before surgery. C-arm fluoroscopy, thromboembolic elastic stocking or compressor, and an operation table. Patients are placed in lithotomy posture for insertion of a 5-French ureteral catheter to outline the renal collecting system pertinent to the renal stone. Patient put prone with Foleys catheter in ureter. Percutaneous access was made utilising a C-arm and 18 G needle under fluoroscopic supervision. After selecting the optimum plane, a.038-inch floppy-tipped J guide wire was introduced into the pelvicaliceal system. Alken coaxial dilators were used to dilate the nephrostomy tract, and a 28 Fr Amplatz sheath was inserted into the renal collecting systems. A 24-Fr rigid nephroscope was used. Pneumatic lithotripter fragmented stones. Small stones are removed using grasper forceps, while large stones are smashed with pneumatic Lithoclast and cleaned. If further tracts are needed, a decision is made before the first so contrast material does not extravasate from the pelvi-caliceal system. Mean pinprick-to-nephrostomy tube placement time. Patients get a nephrostomy tube, JJ stent, or both. After the surgery, intravenous hydration, antibiotics, and analgesics were given. After 24 hours, the nephrostomy tube and Foley catheter are withdrawn. Hospitalized patients' haemoglobin and temperature were examined. Intraoperatively, nephroscopy and fluoroscopy for radio-opaque stones; postoperatively, ultrasonography and KUB. Surgical success was defined as asymptomatic, non-infectious, non-obstructive remaining fragments less than 4 mm. Differentiation between groups was assessed by a chi-square test (X^2) for categorical variables, Student's *t*-test. And Usage of Statistical Package of Social Science Software program (SPSS), for statistical analysis. In this study *P*-value < 0.05 was regarded as statistically significant.

Results

Mean age of patients in group A is 44.6 ± 14.1 and in group B is 44.2 ± 12.9, which is statistically not significant, (*P*-value = 0.45). (Table 1).

In group the majority of patients is male (64%) while female account 36% in group B; male to female is 68% and 32% respectively, which is statistically not significant, (*P*-value = 0.55). (Table 2).

The mean stone size in Group A was 3.3 cm (ranges 2.0–4.9 cm) while in group B the mean was 5.1 cm (ranging 3.3–7.4 cm) which has significantly larger size (*P*-value = 0.010), (Table 3).

The mean operative time for group A was 64.4 minutes (ranges from 30–115 minutes) which is statistically significant when compared to multiple tracts 80.2 minutes (ranges from 45–120 minutes). (*P*-value = 0.010). (Table 4).

The mean drops in hemoglobin in single tract were 1.49 gm while in multiple tracts was 2.04 gm, therefore the drop in mean hemoglobin level between the two groups is statistically significant (*P*-value = 0.010). (Table 5).

The rate of blood transfusion was 8% and 12% in group A and B respectively, which is statistically not significant (*P*-value > 0.05), (Table 6).

After conducting the operation, patient's hospital stay was estimated. The mean hospital stay duration in group A was 28.2 hours (ranges 20–48 hours) while in group B it was 40.8 hours (ranges 24-96 hours). (Table 7).

The percentage of patients developed post-operative fever was 16 % in group A while in group B was 20 % which is regarded as not significant, without concentrating to identify the cause of fever in this study. (*P*-value = 0.46), (Table 8).

The percentage of stone free rate estimated for both groups which was 84% in single tract PCNL and 88% in multiple tracts PCNL. (*P*-value = 0.41). (Table 9).

Discussion

Untreated patients with complicated renal calculi risk recurrent UTIs, renal degeneration, and kidney failure.

Table 1. **Comparison between single and multiple tracts PCNL relates to age**

Technique	*n*	Age (year): SD	*P*-value
Single tract	25	44.6 ± 14.1	
Multiple tracts	25	44.2 ± 12.9	0.45

Table 2. **Gender difference between single and multiple tracts PCNL**

Technique	Single tract	Multiple tracts
n	25	25
Male		
F	16	17
%	64	68
Female		
F	9	8
%	36	32
P-value	0.55	

Table 3. **Comparison between the two groups; relates to stone clearance**

Technique	*N*	Stone size (cm): SD	*P*-value
Single tract	25	3.33 ± 0.69	
Multiple tracts	25	5.1 ± 1.08	0.41

Table 4. **Comparison between group A and B; in relation to stones burden and duration of operation**

Technique	*n*	Stone burden (cm): SD	Mean operation time (minute): SD	*P*-value
Single tract	25	3.33 ± 0.69	64.4 ± 27.1	0.010*
Multiple tracts	25	5.1 ± 1.08	80.2 ± 17.2	

*Significant correlation.

Table 5. **Mean hemoglobin drops between single and multiple tracts PCNL**

Technique	Single tract	Multiple tracts
Number of patients	25	25
Number of tracts	25	59
Mean hemoglobin (gm.)		
Pre-operative:		
%: SD	14.38 ± 1.95	14.4 ± 1.9
Post-operative:		
%: SD	12.88 ± 1.87	12.36 ± 1.95
Mean change in Hb%	1.49	2.04
P-value	0.004*	0.0002*

*Significant correlation.

Table 6. **Rate of blood transfusion relates to number of tracts**

Technique	Single tract	Multiple tracts
Number of tracts	25	59
Blood transfusion: Transfused F: % Not transfused F: %	3 (12) 22 (88)	4 (16) 21 (84)
P-value	0.41	

Table 7. **Hospital stays relation to number of tracts**

Technique	*n*	Total Number of tracts	Mean hospital stay (hours): SD	*P*-value
Single tract	25	25	28.5 ± 8.3	
Multiple tracts	25	59	40.8 ± 15.5	0.0007*

*Significant correlation

Table 8. **Relation of number of tracts and stone size to post-operative fever**

Technique	Single tract	Multiple tracts	*P*-value
Stone size	3.33 ± 0.69	5.1 ± 1.08	
Cm: SD			
Total Number of tracts	25	59	
Postoperative fever Fever:	4 (16)	5 (20)	0.46
F: %			
No fever	21 (84)	20 (80)	
F: %			

Table 9. **Stone free rate between single and multiple tracts PCNL**

Technique	Single tract	Multiple tracts	*P*-value
n	25	25	
Stone free rate			
*Free of stone: F (%)	21 (84)	22 (88)	0.41
*No free of			
Stone:			
F:%	4 (16)	3 (12)	

Percutaneous nephrorolithotomy may be done in single or multiple tracts, in one or more sessions, to acquire a greater stone-free rate. Complete stone removal prevents additional stone formation and preserves renal function (Glenn et al, 2005).[16] Incomplete stone clearances impact postoperative patient health and may lead to early stone development and recurrence. Open surgery, ESWL, RIRS, PCNL, or combination therapies are options for complicated calculi. Percutaneous monotherapy utilising several tracts is recommended by the American Urological Association Nephrolithiasis Guidelines Panel on Staghorn Calculi.[17] Although constructing perfect percutaneous renal pathways is safe, numerous routes for treating complicated calculi are not (Alken et al, 1984).[18] We utilised a Guy's score on pre-operative imaging to evaluate PCN outcomes and complications. Guy's score includes quantity of stones, stone position (calyces involved), aberrant anatomy, partial or total staghorn stones, and spinal injury/bifida. Stone size is an important determinant of PCNL performance. Group B had substantially bigger stones (p 0.03593) than Group A (3.3 cm vs. 2.0–4.9 cm). Hegarty and Desai[19] found that the mean stone size in single and multi-tract PCNL was 4.232.9 cm and 21.51.4 cm, respectively. Mean PCNL operation time from pinprick to nephrostomy tube installation showed a significant difference between groups ($P = 0.01$). This disparity may be due to stone complexity and distribution. Rodrigues Netto et al.[20] found that single tract PCNL took 139.1 minutes and multiple access took 134.9 minutes. Aron and colleagues found that multiple tracts averaged 146 minutes. Liatsikos and colleagues showed that several angular approaches averaged 110 minutes in 2005. (180-90).[21] Liu et al. 2016[22] showed Hemoglobin decreases of 2.2 gm% in multiple tract approach against 1.2 gm% in single tract PCNL. Multiple tract patients had a greater transfusion rate (12%) than single tract patients (8%), although the difference was not significant ($P = 0.41$). Similar to earlier studies, 18.8% of patients in the multiple tract group and 11.2% in the single tract group required blood transfusions.[23] Multiple tract patients had a lengthier hospital stay ($P = 0.0006$) than single tract patients. Multiple tract and single tract groups had mean hospital stays of 4.67 0.21 and 3.42 0.22 days, respectively.[24] Group B had a greater risk of postoperative fever (temperature > 38 C) than group A, perhaps owing to several percutaneous nephrostomy tubes, kidney operations, blood transfusions, or infections. Aron and colleagues, 2005[21] observed that 21% of patients treated with multi tract PCNL for big complete staghorn calculi experienced fever. Thomas et al.[25] found a high prevalence of post-operative fever in multiple tract PCNL patients. The total stone-free percentage was greater in group B (88%), but statistically insignificant ($P = 0.41$), owing to ease access to stones in diverse anatomical regions. In 2005,[20] Rodrigues Netto and coworkers found that stone clearing was 80% successful. Muslumanoglu et al. (2006) found that single tract and multiple tract PCNL had success rates of 96.7% and 89.2%, respectively.[26]

Conclusion

Multiple tracts percutaneous neprolithotomy in one session for the treatment of complex renal stones in selected patients is achievable, relatively safe and it is efficient for stone clearance, no significant difference in blood transfusion rate and with acceptable post-operative complications rates.

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