

Single versus Multiple Mini-tract Percutaneous Nephrolithotomy for Staghorn Renal Stone: A Single-Center Study

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Abstract: Staghorn stones are difficult to treat, which may cause severe complications in the urinary tract. So surgical intervention is necessary. **Objective:** This study aimed to determine the outcomes of Single versus multiple mini-tract percutaneous nephrolithotomy for Staghorn Renal Stones. **Methods:** The present randomized controlled trial was conducted at the Department of Urology, Postgraduate Medical Institute (PGMI), Quetta, from January 2025 to June 2025, following permission from the hospital's ethical committee. Individuals of both genders and different age groups with complete or partial staghorn stones and scattered renal stones involving both renal pelvis and calyces were included. The study participants were divided into two groups: Group A and Group B. Each group has 55 individuals. Group A received a single mini-tract (21-Fr sheath) via the percutaneous method, and Group B required multiple mini-tracts (two). To determine the location, dimensions, and hardness of the stones, as well as the anatomy of the renal collecting system, for continuous variables (such as patient characteristics and perioperative data), an independent-sample t-test was employed. The perioperative findings and postoperative outcomes were compared. Statistical analysis was performed using SPSS. **Results:** A total of 110 individuals with staghorn stones were enrolled in this study, which were randomly divided into single (A) and multiple (B) tract PCNL groups. In a single tract, the mean stone size was 11.68 ± 8.07 , whereas in multiple tracts, it was 16.24 ± 10.50 . Consequently, there was a notable variation in stone size between the two groups ($P = 0.005$). When comparing the two groups' operative times, the mean time for a single tract was 101 ± 11.0 minutes, while the mean time for multiple tracts was 121 ± 23.6 minutes (p -value of 0.005). A single-tract hospital stay lasted 4.20 ± 2.21 days, while a multiple-tract hospital stay lasted 4.21 ± 2.10 days. Likewise, 28% of blood transfusions occurred in a single tract, while 16% occurred in multiple tracts. Clavien-Dindo was assigned to the complication of blood transfusion and bleeding, which were the most serious adverse effects associated with the multiple-tract strategy compared to single-tract therapies. **Conclusion:** The present study concluded that a safe and effective technique for treating staghorn kidney stones is multiple-tract access during PCNL.

Keywords: Single; Percutaneous Nephrolithotomy; Staghorn Renal Stone

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Introduction

Staghorn calculi are branching stones that occupy a significant amount of space in the urinary system and have more than two calyces. (1) If these stones are not removed, they can lead to potentially fatal infections, renal damage, and parenchymal destruction. Therefore, total removal and clearance rates are mainly focused on while treating them. (2) Individuals with staghorn stones are recommended to undergo percutaneous nephrolithotomy (PCNL), a safe and efficient procedure. (1) PCNL has a lower incidence of morbidity and a greater rate of stone removal when compared to other procedures, including open surgical procedures, extracorporeal shock wave lithotripsy (ESWL), and combined surgery. (3) Slender nephroscopes are one of the improvements and adjustments made to PCNL since it is an effective technique for removing kidney stones, improving results, and lowering morbidity. Sheaths between 11 and 21 Fr are used in miniaturized PCNL, often known as mini PCNL or mPCNL. According to recent research, mPCNL is a safe and effective alternative to traditional PCNL in both adult and pediatric settings. Additionally, mPCNL is safe and practical even in cases of kidney anomalies, such as transplanted, polycystic, and horseshoe kidneys. (4) But when the size and intricacy of renal stones rise, longer operating periods, higher irrigation pump pressure, and several tracts become required techniques for completing full stone removal. (5) There is still debate about whether procedures utilising a single percutaneous tract can result in fewer complications and less bleeding than those needing numerous tracts. (6) Furthermore, because mPCNL has a smaller access sheath and a relatively lower visibility & stone-free rate (SFR), it has been

challenged when managing individuals who have big, complex staghorn stones. (7) The present study was carried out to find out the efficacy of single versus multiple mini-tract percutaneous nephrolithotomy for staghorn renal stones.

Methodology

The present randomized controlled trial was conducted at the Department of Urology, Postgraduate Medical Institute (PGMI), Quetta, from January 2025 to June 2025, following approval from the hospital's ethics committee. Individuals of both genders and different age groups with complete or partial staghorn stones and Scattered renal stones involving both renal pelvis and calyces were included. Individuals with simple stones (< 2cm) or without CT images were excluded. Individuals who met the inclusion criteria gave their informed consent. A consecutive non-proportional sampling method was used. The study participants were divided into two groups: Group A and Group B. Each group has 55 individuals. Group A received a single mini-tract (21-Fr sheath) via the percutaneous method, and Group B required multiple mini-tracts (two). Body mass index, height, weight, age, gender, preoperative serum creatinine, estimated glomerular filtration rate, urine pH, stone burden (cm³), and stone complexity (S. T. O. N. E. score) were all noted. Body mass index, height, weight, age, gender, preoperative serum creatinine, estimated glomerular filtration rate, urine pH, stone burden (cm³), and stone complexity (S. T. O. N. E. score) were all noted. The clinical results included postoperative creatinine and hemoglobin levels, SFRs, operation duration, problems that prolonged hospital stays, and pain medication

prescriptions. Along with a quick history collection, the preoperative workup included blood analysis (e.g., serum creatinine and Hb values, platelet count, and coagulation screening). The radiological evaluation included both plain radiography and ultrasound of the kidney, ureter, and bladder (KUB). To determine the location, dimensions, and hardness of the stones, as well as the anatomy of the renal collecting system, for continuous variables (such as patient characteristics and perioperative data), an independent-sample t-test was employed. Statistical analysis was performed using SPSS. Chi-square or Fisher's exact tests were applied to analyze the categorical data between the two groups. A $P < 0.05$ was considered statistically significant.

Results

A total of 110 individuals with e-horn stones were enrolled in this study, who were randomly divided into single (A) and multiple (B) tract PCNL groups. The mean age in group A was 57.7 ± 3.6 and in group B was 58.8 ± 1.3 years. In single PCNL group females were 25(45.4%) and male were 30(54.4%) and in multiple tract female were 20(36.6%) and men were 35(63.6%) respectively. In a single tract, the mean stone size was 11.68 ± 8.07 , whereas in multiple tracts, it was 16.24 ± 10.50 .

Consequently, there was a notable variation in stone size between the two groups ($P = 0.005$). Furthermore, the Stone-Hounsfield unit, the mean score for a single tract was 918.72, while the scores for multiple tracts were 1060.10. Group B's S. T. O. N. E. score was considerably greater ($P = 0.001$) as presented in Table 1. When comparing the two groups' operative times, the mean time for a single tract was 101 ± 11.0 minutes, while the mean time for multiple tracts was 121 ± 23.6 minutes, with a p-value of 0.005 and a range of (min) 71-151 to 86-141. Furthermore, in a single tract, the stone-free rate (residual stone < 0.4 cm) (%) was 46, and in multiple tracts, it was 57. A single-tract hospital stay lasted 4.20 ± 2.21 days, while a multiple-tract hospital stay lasted 4.21 ± 2.10 days. Likewise, 28% of blood transfusions occurred in a single tract, while 16% occurred in multiple tracts, as presented in Table 2. The comparison of tract details, including the average stone complexity and complications, as well as the stone-free cases, is shown in Table 3. The Clavien-Dindo classification was assigned to the complication. Furthermore, angiography was performed owing to persistent bleeding in patients with pseudoaneurysm in the single-tract group. Finally, the patient recovered fully after undergoing transarterial angioembolization treatment.

Table 1: Demographic features of the study participants

Features	Single tract	Multiple tract	P value
Age			
Mean	57.7±3.6	58.8±1.3	0.012
Gender wise distribution			
Male	30(54.4%)	35(63.6%)	0.013
Female	25(45.4%)	20(36.6%)	
BMI			
Mean	24.1±2.24	23.5±2.15	0.000
Stone Hounsfield unit			
Mean	918.72	1060.10	0.014
Stone complexity			
Mean	8.4±1.7	10.6±1.3	0.014
Stone size (cm3)			
Mean	11.68±8.07	16.24±10.50	0.031
Preoperative hemoglobin (g/Dl)			
Mean	13.85±2.18	12.68±1.72	0.001
Preoperative serum creatinine (mg/dL)			
Mean	1.21±0.60	1.21±0.71	0.002
e-GFR			
Mean	67.38±24.68	66.47±23.31	0.004
Urine pH	6.47±0.61	6.53±0.69	0.003

Table 2. Postoperative parameters and details of the operation

Features	Single tract	Multiple tract	P value
Operative time in minutes			
Mean	101±12.0	121±23.6	0.0005
Range	71-151	86-141	
Stone free rate (residual stone)<0.4 cm (%)			
Percentage	46%	57 %	0.001
Stay in the hospital for days.			
Mean	4.20±2.21	4.21±2.10	0.003
Percentage of blood transfusion	28%	16%	0.003
Hb dropped	2.15±0.96	1.59±0.69	<0.05

Table 3. Comparing the features and complications of the tract (Clavien-Dindo classification)

Features	Single tract	2 tract	3 tract	4 tract	5 tract
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Number of patients	55	21	12	6	2
Stone free case n(%)	38(69)	16(76.1)	8(66.6)	4(66.6)	2(100)
Average stone complexity (S.T.O.N.E score)	8.52	9.88	12	12.6	13
Grade I: Fever, n (%)	4(7.2)	4(19)	2(16.6)		zero
Grade II: SIRS + blood transfusion, n (%)	4+5(16.3)	0+1(4.7)	0+2(16.6)	1+0(16.6)	zero
Grade III: Pseudoaneurysm, n (%)	4(7.2)	Zero	Zero	zero	zero
SIRS: Systemic Inflammatory Response Syndrome					

Discussion

It is accepted that the first-line therapy for staghorn calculi and urinary tract stones larger than two centimeters is percutaneous nephrolithotomy. (8) "It is still challenging to achieve stone-free standing in patients with complex stone disease because of the speculative stone formers that are characterized by stone formation linked to anatomical abnormalities, diseases, genetic determination, and medications. These individuals have a somewhat inflated prevalence of forming multiple calculi, a massive stone burden, or a staghorn stone. The distribution and amount of stones, the architecture of the pelvic-ureteral system, comorbidities, and, consequently, the surgeon's skill determine the number of accesses or operations. (9) PCNL has a lower frequency of morbidity and a greater rate of stone removal when compared to other procedures, including open surgical procedures, extracorporeal shock wave lithotripsy (ESWL), and combined surgery. The present study was carried out to compare the outcomes of Single versus multiple mini-tract percutaneous nephrolithotomy for Staghorn Renal Stones. A total of 110 individuals with stage horn stones were enrolled in this study. In the single PCNL group, females comprised 45.4% and males 54.4%, while in the multiple tract group, females accounted for 36.6% and men for 63.6%, respectively. The gender-wise distribution of our study was similar to the findings of Ijaz et al. (10). In our study, the mean operative time for a single tract was 101 ± 11.0 minutes. In contrast, the mean time for multiple tracts was 121 ± 23.6 minutes, with a p-value of 0.005 and a range of (min) 71-151 to 86-141. Furthermore, in a single tract, the stone-free rate (residual stone <0.4 cm) was 46%, and in multiple tracts, it was 57%. A single-tract hospital stay lasted 4.20 ± 2.21 days, while a multiple-tract hospital stay lasted 4.21 ± 2.10 days. Likewise, 28% of blood transfusions occurred in a single tract, while 16% occurred in multiple tracts. These findings are comparable to those of previous studies conducted by Ijaz et al. and Tsai et al. (10-11). Clavien-Dindo classification was assigned to the complications of blood transfusion and bleeding, which were the most serious adverse effects associated with the multiple-tract strategy compared to single-tract therapies. Participants in this research were linked to UTIs. To determine the need for a blood transfusion, postoperative symptomatic anaemia (Hb levels of 8 g/dL) was used as the criterion. Each patient recovered completely following treatment with intravenous antibiotics and additional supportive measures. These findings are comparable to those of Ijaz et al. (10). A recent study by Kukreja (12) found that the mean Hb drop was comparable in the two groups (2.08 vs. 2.32 g/dL for single and multiple tracts, respectively). This outcome diverges from the study's findings. Additionally, Martin et al (14) revealed that there were substantial differences in the transfusion rates as well, with patients with fewer than or more than two tracts needing transfusions for stone removal (20%) and 41.6%, respectively. The puncture location and additional smaller tracts employed may be the cause of the decreased Hb decline in the multiple-tract group. Finding the quickest path from the epidermis to the renal papilla is the fundamental idea of puncture. However, experts remain uncertain about the primary entrance point of the pelvicalyceal system. In our research, Fever, pseudoaneurysm, and systemic inflammatory response syndrome were identified as other potential consequences of PCNL. According to prior research and the American Urological Association's criteria, the complication rate of PCNL monotherapy ranged from 15% to 28%. (15) A higher sample size is required to assess the relationship among tract number, stone complexity, SFR, and complexity. This study has several limitations, the first of which is its small sample size. To reduce the

prejudice caused by the experience of several surgeons, patients underwent either multiple-tract PCNL or single-tract PCNL, both procedures performed by the same skilled surgeon. Therefore, for future research, a bigger study population is required. Second, although the blood is combined with irrigation fluid throughout the procedure, it is challenging to assess actual blood loss. As a result, postoperative haemoglobin can only be assessed to assess potential blood loss.

Conclusion

The present study concluded that a safe and effective technique for treating staghorn kidney stones is multiple-tract access during PCNL. A suitable alternative for treating staghorn stones with multiple calyces is a mini PCNL with multiple-tract access.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC--24)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

JAK (Assistant professor)

Manuscript drafting, Study Design, Review of Literature, Data entry, Data analysis, and drafting articles

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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