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Original Research Paper

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COMPARE SAFETY AND EFFICACY OF MULTIPLE-TRACT VS SINGLE-TRACT PERCUTANEOUS NEPHROLITHOTOMY: A SINGLE-CENTRE EXPERIENCE.

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is established as the standard minimally invasive approach for the management of large and complex renal calculi. The choice between single-tract and multiple-tract access remains debated, with concerns about safety, efficacy, and complication rates. **Objective:** To compare the safety and efficacy of multiple-tract versus single-tract PCNL in patients with complex renal calculi at a single tertiary care centre. **Methods:** A retrospective analysis was conducted of 500 adult patients who underwent PCNL between January 2014 and December 2022. Patients were divided into single-tract (n=400) and multiple-tract (n=100) groups. Baseline characteristics, operative parameters, complications, and follow-up outcomes were compared. Statistical analysis was performed using t-test and chi-square tests, with $p < 0.05$ considered significant. **Results:** Patients in the multiple-tract group had significantly larger mean stone size (28.5 ± 10.2 mm vs 19.8 ± 7.5 mm, $p<0.001$) and higher stone burden >2 cm (65% vs 30%, $p<0.001$). Operative time (108.3 vs 82.5 min, $p<0.001$), mean blood loss (350 vs 190 mL, $p<0.001$), and transfusion requirement (15% vs 4.5%, $p=0.002$) were significantly higher in the multiple-tract group. The stone-free rate was slightly lower in the multiple-tract group (78% vs 85%, $p=0.08$). Postoperative complications, including fever (11% vs 5%, $p=0.04$) and Clavien–Dindo ≥III events (6% vs 2%, $p=0.03$), were more frequent with multiple tracts. Hospital stay was longer (5.4 vs 3.8 days, $p<0.001$). On follow-up, re-treatment (8% vs 4%, $p=0.04$) and renal function deterioration (6% vs 2.5%, $p=0.02$) were also more common in the multiple-tract group. **Conclusion:** Multiple-tract PCNL is associated with increased operative time, blood loss, complications, and hospital stay, though it remains an effective strategy for achieving acceptable stone clearance in complex cases. Careful patient selection and surgical planning are essential to optimize outcomes.

KEYWORDS :

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is now considered the standard of care for large, complex, and staghorn renal calculi, replacing open surgery in most cases. Despite being minimally invasive with high stone-free rates (SFR), PCNL is not devoid of complications, and the SFR is not 100%. Several factors, including stone size, burden, location, and hydronephrosis, influence outcomes. However, when these parameters are used in isolation, they lack reproducibility and predictive accuracy. To address this, nephrolithometric scoring systems were developed to integrate preoperative stone and patient characteristics for outcome prediction.

One critical technical consideration in PCNL is whether to use a single-tract or multiple-tract approach. Single-tract PCNL is less invasive but may not allow complete clearance in patients with staghorn or multiple calyceal stones. Conversely, multiple-tract access may improve clearance but carries potential risks of increased bleeding and complications. The optimal approach continues to be debated. (1-4).

This study aims to compare the safety and efficacy of single- versus multiple-tract PCNL in patients with large or complex renal stones, based on a retrospective single-centre experience.

METHODS

Study Design And Population

This retrospective study analysed pre-existing records of 500 patients who underwent PCNL between January 1, 2014, and December 31, 2022, at a single tertiary hospital. Patients were divided into two groups: single-tract (n=400) and multiple-tract (n=100).

Inclusion Criteria

- Age ≥18 years
- Partial or complete staghorn calculi
- Multiple renal stones involving more than one calyx

Exclusion Criteria

- Age <18 years
- Radiolucent stones
- Coexisting renal anomalies
- Uncorrectable bleeding disorders
- Febrile urinary tract infection
- Solitary functioning kidney
- Significant musculoskeletal deformities
- Pure ureteral stones or ureteral obstruction

Surgical Technique

All procedures were performed under general anaesthesia using fluoroscopic guidance in supine position. Access was achieved via single or multiple tracts depending on stone burden and calyceal distribution. Dilation was performed using serial fascial dilators, and stones were fragmented using ultrasonic or pneumatic lithotripters. A nephrostomy tube was placed at the end of the procedure based on surgeon preference.

Data Collection

Baseline demographics, stone characteristics, intraoperative parameters, postoperative outcomes, complications (Clavien–Dindo classification), and follow-up results were recorded.

Statistical Analysis

Continuous variables were compared using independent-samples t-test. Categorical variables were analysed with chi-square or Fisher's exact tests. A p-value <0.05 was considered statistically significant. Analysis was performed using SPSS v24.

RESULTS.

Patients in the multiple-tract group had larger stones and a higher proportion of stone burden >2 cm. Other baseline characteristics were comparable between groups.

Mean operative time and blood loss were significantly higher in the multiple-tract group, with increased transfusion requirement. The SFR was slightly lower but not statistically significant. Complication rates, especially higher-grade events, and hospital stay were greater in the multiple-tract group. Table 1,2

Follow up at a median follow-up of 12 months, recurrence rates were slightly higher in the multiple-tract group, though not statistically significant. Re-treatment and renal function deterioration occurred more frequently among multiple-tract patients. Table 3

Table 1. Baseline Characteristics

Variable	Single tract (n=400)	Multiple tract (n=100)	p-value
Patients (n)	400	100	–
Age, mean ± SD (years)	48.6 ± 12.5	49.2 ± 11.8	0.65
Male sex, n (%)	260 (65%)	62 (62%)	0.72
Laterality (Left/Right)	210 / 190	54 / 46	0.84
Mean stone size (mm)	19.8 ± 7.5	28.5 ± 10.2	<0.001
Stone burden > 2 cm, n(%)	120 (30%)	65 (65%)	<0.001
Mean HU (CT density)	950 ± 210	980 ± 240	0.44
Comorbidities (HTN/DM), n (%)	140 (35%)	40 (40%)	0.50

HTN = Hypertension; DM = Diabetes mellitus; HU = Hounsfield units; SD = Standard deviation.

Table 2. Operative And Outcome Parameters

Variable	Single tract (n=400)	Multiple tract (n=100)	p-value
Mean operative time (min)	82.5 ± 24.2	108.3 ± 31.6	<0.001
Mean blood loss (mL)	190 ± 110	350 ± 160	<0.001
Transfusion required, n (%)	18 (4.5%)	15 (15%)	0.002
Stone-free rate (SFR), n (%)	340 (85%)	78 (78%)	0.08
Auxiliary procedures (URS/RIRS), n (%)	28 (7%)	12 (12%)	0.11
Post-op fever (>38.5°C), n (%)	20 (5%)	11 (11%)	0.04
Clavien–Dindo Grade I–II complications	26 (6.5%)	12 (12%)	0.05
Clavien–Dindo Grade ≥III complications	8 (2%)	6 (6%)	0.03
Mean hospital stay (days)	3.8 ± 1.2	5.4 ± 1.5	<0.001

SFR = Stone-free rate; URS = Ureteroscopy; RIRS = Retrograde intrarenal surgery; Clavien–Dindo classification used for postoperative complications.

Table 3. Follow-up Results

Variable	Single tract (n=400)	Multiple tract (n=100)	p-value
Follow-up duration (months)	12 (IQR 9–18)	12 (IQR 8–17)	0.72
Recurrence rate, n (%)	24 (6%)	10 (10%)	0.18
Re-treatment required, n (%)	16 (4%)	8 (8%)	0.04
Renal function deterioration, n (%)	10 (2.5%)	6 (6%)	0.02

IQR = Interquartile range; Recurrence = new stone formation during follow-up.

DISCUSSION.

In this single-centre study of 500 patients, we observed that multiple-tract PCNL, although effective for achieving adequate clearance in patients with complex calculi, was associated with increased operative time, blood loss, transfusion requirements, complication rates, and longer hospital stay compared with single-tract PCNL.

Our findings are consistent with several meta-analyses and comparative studies. A recent systematic review and meta-analysis confirmed that multiple-tract PCNL was associated

with significantly higher complication rates and blood transfusion needs, without offering a major advantage in terms of stone-free rates (5). Similarly, Jiao et al. found that although stone clearance was slightly improved with multiple tracts, complication rates, particularly bleeding, were considerably higher (6).

Other large retrospective series also support this. Savko et al. compared 391 patients and found that multiple-tract access resulted in significantly longer operative times and higher morbidity, but without a major difference in overall stone-free rate, suggesting that while safe, it should be reserved for selected cases (7). Balaji et al. further emphasized that multiple tracts are particularly useful in patients with staghorn calculi, but at the cost of increased invasiveness (8).

Increased complications in our multiple-tract group are in line with predictors identified in other studies. Singh et al. demonstrated that multiple punctures, stone burden >3 cm, and operative time >90 minutes were independent risk factors for bleeding and infection following PCNL (5). Similarly, a large cohort analysis of 1,066 patients confirmed that multiple tracts, higher Guy's Stone Score, and upper pole access independently predicted complications (9).

In our study, stone-free rates were slightly lower in the multiple-tract group (78% vs 85%), though not statistically significant. Previous reports have shown conflicting finding and some suggesting multiple tracts increase clearance (11,12), while others find no significant benefit (13). Auxiliary procedures such as RIRS and URS remain important adjuncts for residual fragments, especially when single-tract PCNL is chosen to minimize morbidity (14).

Miniaturization of PCNL has been studied extensively. Qin et al. found that mini-PCNL (<18 F) resulted in lower bleeding and shorter hospital stays without significantly compromising stone clearance (15). This approach may help mitigate the morbidity of multiple-tract procedures. Advances in tubeless PCNL techniques have also reduced postoperative pain and recovery time (116).

Technological innovations are shaping the future of PCNL. Robotic-assisted puncture and augmented reality-based access have demonstrated improved accuracy and reduced surgeon fatigue, which may improve outcomes and reduce complications in multi-tract PCNL (17). Furthermore, refinement of scoring systems such as the CROES nomogram and Guy's Stone Score help in predicting complications and tailoring surgical planning (18,19).

Strengths And Limitations

Strengths of this study include the relatively large cohort and consistency of surgical techniques in a single-centre setting. Limitations include the retrospective design, potential selection bias in tract number decision-making, and absence of long-term renal functional follow-up beyond one year.

CONCLUSION

Both single- and multiple-tract PCNL are effective approaches for complex renal stones. Single-tract PCNL is associated with reduced operative time, blood loss, complications, and shorter hospitalization, making it preferable when feasible. Multiple-tract access, while riskier, remains an important strategy in selected patients with staghorn or extensive calculi where complete clearance cannot be achieved through a single tract.

Declaration.
Financing. The study was not sponsored.

Conflict Of Interest. The authors declare no conflicts of interest.

Ethical Approval. The study was approved by the MRC.

Authors Contribution:

All authors contribute equally to study design development, data
analysis, drafting the manuscript. study concepts, scientific editing,
literature review, data acquisition and data analysis

REFERENCES.

1. Fernström I, Johansson B. Percutaneous pyelolithotomy: A new extraction technique. Scand J Urol Nephrol. 1976;10(3):257–259.
2. Türk C, Pet ík A, Sarica K, et al. EAU Guidelines on Interventional Treatment for Urolithiasis. Eur Urol. 2016;69(3):475–482.
3. Okhunov Z, Friedlander JI, George AK, et al. nephrolithometric nomograms to predict stone-free status after PCNL. J Endourol. 2013;27(11):1440–1445.
4. Savko L, et al. Comparative assessment of multiple-tract vs single-tract percutaneous nephrolithotomy. Asian J Endosc Surg. 2022.
5. Zhang D, Qin P, Huang T, Fang L, Cheng Y. Comparison of single- vs multiple-tract PCNL: systematic review and meta-analysis. Int Braz J Urol. 2022;48(4):637–648.
6. Jiao B, Ding Z, Luo Z, Lai S, Xu X, Chen X, Zhang G. Single- versus multiple-tract percutaneous nephrolithotomy for complex calculi: a systematic review. Biomed Res Int. 2020;2020:8817070.
7. Savko L, et al. Comparative assessment of multiple-tract vs single-tract percutaneous nephrolithotomy. Asian J Endosc Surg. 2022;15(3):435–442.
8. Balaji S, Ganpule A, Herrmann T, Sabnis R, Desai M. Contemporary role of multi-tract PCNL. Asian J Urol. 2020;7(2):102–109.
9. Singh U, Singh VK, Singh V, et al. Complications of PCNL: prospective analysis at a tertiary center. Cureus. 2024;16(9):e69096.
10. Huang J, Xun Y, Wang J, et al. Factors associated with complications after PCNL: analysis of 1,066 cases. World J Urol. 2023;41(5):1321–1329.
11. El-Nahas AR, et al. Multi-tract PCNL for staghorn calculi: impact on stone clearance and complications. J Urol. 2016;195(1):56–61.
12. Hegarty NJ, Desai MM. Percutaneous nephrolithotomy requiring multiple tracts: comparison to single-tract cases. J Endourol. 2006;20(10):753–760.
13. Liatsikos EN, et al. Minimally invasive PCNL vs standard approaches in complex calculi. Eur Urol. 2009;55(6):1172–1178.
14. Zeng G, et al. Flexible ureteroscopy as an adjunct after PCNL. Urolithiasis. 2019;47(5):465–471.
15. Qin P, Zhang D, Huang T, et al. Mini-PCNL vs standard PCNL for stones >2 cm: meta-analysis. Int Braz J Urol. 2022;48(4):637–648.
16. Canales BK, et al. Tubeless PCNL and nephrostomy drainage strategies: an update. Int J Urol. 2019;26(11):1061–1068.
17. Fu J, Pecorella M, Iovene E, et al. Augmented reality-guided percutaneous nephrolithotomy with human-robot collaboration. arXiv preprint. 2024.
18. Thomas K, Smith NC, Hegarty N, Glass JM. The Guy's Stone Score: A new scoring system for predicting PCNL outcomes. J Urol. 2011;185(6):2194–2199.
19. Smith A, et al. CROES PCNL Global Study: nephrolithometric nomograms to predict complications. Eur Urol. 2012;62(2):246–252.