Addressing Concerns: A Look Back at Supracostal Access in Percutaneous Nephrolithotomy"

Adeel Arain, MBBS, MS [1], **Arshia Adeel Arain**, DMRT [2]

ABSTRACT

Background: Percutaneous renal surgery using the supracostal approach offers a direct route and has displayed promising outcomes. Nonetheless, apprehensions regarding complications have hindered its widespread adoption. This retrospective descriptive study aims to assess the safety and effectiveness of supracostal access in percutaneous nephrolithotomy (PCNL) for the treatment of renal stones.

Methods: Among 597 patients who underwent PCNL between November 2020 and October 2022, 103 chose supracostal access. All procedures were conducted in a single session under general anesthesia at a private hospital. Patient records were retrospectively reviewed for indications, stone clearance rates, and perioperative and postoperative complications.

Results: Indications for supracostal access comprised pelvic stones in 54 patients, partial staghorn stones in 28 cases, complete staghorn stones in 16 cases, and lower pole stones in 5 cases. Patient ages ranged from 3 to 62 years (mean: 27.45 years), with a mean stone size of 2.8 cm (range: 0.8 cm to 6 cm). A single tract access via a supracostal puncture at the posterior calyx was employed in all cases, with no requirement for a secondary puncture. Complete stone clearance was accomplished in 76.7% of patients, while 23.3% necessitated ancillary procedures, including Shock Wave Lithotripsy (SWL) in 17.4%, Ureteroscopy (URS) in 1.9%, and Double J stent (DJ) insertion in 3.8%. Complications were graded based on the Clavien grading system, with 4 patients classified as Grade I, 18 as Grade II, 1 as Grade III-b, and 1 as Grade IV-a.

Conclusion: The supracostal approach demonstrates a favorable safety profile and acceptable morbidity, indicating its potential suitability for specific cases of PCNL.

Keywords: PCNL, renal stones, shock wave lithotripsy, nephrolithiasis

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Author Affiliation:
Liaquat University Hospital, Jamshoro
NIMRA Jamshoro

Corresponding Author:
Dr. Adeel Arain
aarain1979@gmail.com
House 2598 Airport Road
Latifabad Unit 12, Hyderabad
03361277740

INTRODUCTION:

The global escalation in the prevalence and incidence of nephrolithiasis, particularly prevalent in the Afro-Asian stone belt region, impacts millions worldwide [1]. According to the National Health and Nutrition Examination Survey, renal stone disease's prevalence in the United States has notably increased over the years, with 10.6% of men and 7.1% of women affected in 2012 compared to 6.3% of men and 4.1% of women in 1994 [1]. Although current data on stone disease prevalence in Pakistan is not readily available, a significant stone center in the country reports a prevalence of 16% for renal stone disease [2].

Percutaneous nephrolithotomy (PCNL) emerges as the preferred treatment for managing sizable renal calculi and certain upper ureteric stones. Despite its adaptability to various positions, the prone position typically garners preference [3]. However, the selection of the access site hinges on factors such as surgeon preference, stone location and burden, and calyceal system anatomy. The standard puncture site prescribed for PCNL lies in the posterior axillary line, midway between the 12th rib and the ileal crest [4].

In a comprehensive multicenter study conducted by the Clinical Research Office of the Endourological Society (CROES), access above the 11th rib was employed in merely 1.5–2.2% of cases, with 68–83% of punctures being infracostal [5]. The supracostal approach presents a more direct access route and enhanced endoscopic visualization of the kidney [6].

This study aims to scrutinize the efficacy and morbidity associated with supracostal access for PCNL at a singular tertiary care center.

METHODS:

The study comprised a single-center observational descriptive analysis, entailing the retrospective review of medical records of all consecutive patients who underwent PCNL between November 2020 and October 2022. Conducted a the private hospital, all procedures occurred in a single session under general anesthesia. The collected data included indications, stone clearance rates, and postoperative complications. PCNL was executed as a single-stage procedure in all cases. Stone position and renal functions were evaluated using radiological and biochemical investigations.

The PCNL technique involved several steps. Following induction of general anesthesia, patients were positioned in lithotomy, and a 6F ureteral catheter was transurethrally inserted into the renal pelvis under rigid cystoscopic guidance. Contrast injection facilitated confirmation of stone position and exploration of the collecting system anatomy relative to the 12th rib. Subsequently, patients were repositioned in the prone position for percutaneous access creation using an 18-gauge needle under fluoroscopic guidance at the predetermined puncture site, consistently above the 12th rib. Tract dilatation was executed using Amplatz™ fascial dilators ranging from 8F to 27F in adults and up to 24F in pediatric patients. Stone fragmentation was achieved using pneumatic lithotripsy, followed by fluoroscopy to assess stone-free status and exclude pleural fluid collection. Nephrostomy was established using 22F Foley catheters in adults and 15F in pediatrics.

Post-procedure, patients were closely monitored, with assessments including chest auscultation, pulse oximetry every 4-6 hours, and chest radiography immediately after surgery and on the first postoperative day to detect complications such as pneumothorax or hydrothorax. Monitoring also encompassed vital signs, urine output for gross hematuria, and baseline tests like complete blood counts, urea, creatinine, and serum electrolytes. Persistent urinary leakage for more than 7 days post-removal of the Percutaneous Nephrostomy (PCN) tube was categorized as a nephrocutaneous fistula. Postoperative fever persisting above 38°C for 3 days warranted re-admission or intravenous antibiotics. Stone clearance was defined as the absence of radiopaque shadows on X-ray Kidney, Ureter Bladder (KUB) on the first postoperative day. Asymptomatic residual stone fragments less than 5mm in diameter were deemed clinically insignificant, while symptomatic significant residual fragments necessitated secondary procedures.

Complications were graded according to the

Table 1: Modified Clavien system

Grade 1	4
Grade II	18
Grade III	None
Grade III-a	None
Grade III-b	1
Grade III-c	None
Grade IV	None
Grade IV-a	1
Grade IV-b	None
Grade V	None

Table 2 Demography and clinical variables of patients

Variables	Median,IQR/n(%)
Age of patient	24,37
size of stone	2.6, 1.5
serum creatinine	0.8, 0.5
Gender	
male/female	63(61.2)/40(38.8)
number of stones	
single stone	57(55.3)
2-3 stones	19(15.4)
multiple 4 or > 4	11(10.7)
Staghorn	16(15.5)
side of stones	
Right	54(52.4)
left	49(47.6)
site of stones	
pelvis	54(52.4)
pelvis and one pole	28(27.2)
lower pole	5(4.9)
staghorn	16(15.5)
Comorbid	
Hypertention	9(8.7)
DM + HTN	2(1.9)
urine c/s positive	19(18.4)

Table3 Operative parameters of the study

Variables	n(%)
Nephroscope size	
27 fr	61(59.2)
15 fr	42(40.8)
Amplantz sheet size	
30 fr	61(59.2)
24 fr	42(40.8)
Tube size	
22 fr	61(59.2)
14 fr	39(37.9)
tubeless	3(2.9)
Residual stone	23 (22.3)
Ancillary procedures	24 (23.3)
procedures required	
Dj insertion	4 (3.9)
ESWL	18 (17.5)
urs	2 (1.9)
Time of PCN Removal	
24 hour	75 (72.8)
23-48	25 (24.3)
tubeless	3 (2.9)
Time uretric removed	
24 hour	27 (26.2)
24-48	76 (73.8)

Table 4 Post operative complications of patients

Post operative	
Complications	n (%)
hematuria + fever	2 (1.9)
hematuria + leakage	1 (1)
hematuria	5 (4.9)
leakage	2 (1.9
fever	5 (4.9
hydrothorax	1 (1)
Total no of patients	
with complications	16 (15.5)

Clavien grading system, and data analysis utilized IBM SPSS software version 21. Continuous variables were reported as median with Interquartile range, while categorical data were presented as numbers with percentages. The normality of data was assessed using the Shapiro-Wilk test.

RESULTS:

Within our study cohort comprising 103 patients, 63 (61.2%) were male, with a median age of 24 years. Pre-operative mean serum creatinine levels ranged from 0.2 mg/dl to 3.2 mg/dl, with a mean of 0.9 mg/dl. The mean size of the largest stone dimension was 2.8 cm, ranging from 0.8 cm to 6 cm. Detailed demographic and clinical characteristics of the patients are summarized in Table 1.

Operative outcomes, as presented in Table 3, indicate that 23 patients (22.3%) had residual stones post-procedure, with 24 patients (23.3%) requiring ancillary procedures. Percutaneous nephrostomy (PCN) removal occurred within 24 hours in 75 patients (72.8%), while 3 patients (2.9%) underwent a tubeless procedure.

Among the study participants, only 16 patients (15.5%) experienced complications. Hematuria was reported in 5 patients (4.9%), while hydrothorax occurred in only 1 patient (1%). This particular case involved a 6-year-old boy with a staghorn stone in the right kidney, managed by tubeless PCNL. Due to decreased oxygen saturation and difficulty recovering from anesthesia, the patient was promptly transferred to the ICU for conservative management, as detailed in Table 4.

None of the patients required blood transfusion, and there were no reported cases of nephrocutaneous fistula development.

DISCUSSION:

In our investigation, we adopted the Supra 12th rib puncture technique, chosen based on stone location, anatomical considerations, and its perceived advantages in accessing the entire calyceal system of the kidney, including the upper ureter and enabling Endopyelotomy. 7 Percutaneous renal surgery plays a pivotal role in managing various renal and ureteral conditions where alternative treatments are not feasible. 8 This procedure requires a comprehensive understanding of retroperitoneal structures, renal anatomy, including intrarenal vasculature, calyx positions, adjacent solid organs, and pleural anatomy. 9

The majority of stones located in the pelvis and mid or lower calyces are typically accessible via a subcostal puncture. However, for stones situated in the upper ureter, superior calyx, and staghorn stones, an approach through the superior calyx offers distinct advantages.10 Employing a supracostal puncture over the lateral portion of the twelfth rib to access the collecting system can help prevent potential pleural injury. Various techniques for percutaneous access have been described, including bulls-eye and triangulation, with bulls-eye being the preferred method in our study due to its provision of more direct access to the desired calyx.[11]

Our analysis revealed excellent stone clearance rates (77.7%) with PCNL monotherapy, comparable to those reported by Kekre et al. and Golijanin et al. 12 The intricate relationship between kidney anatomy and the adjacent lung, coupled with the proximity of the pleura, can pose challenges. However, a nuanced understanding of pleural and diaphragmatic anatomy, along with refined surgical techniques, can help minimize complications. We aimed to minimize the number of tracts, as earlier studies indicated a rise in complications with multiple tracts. Contrary to some assessments, we found that acceptable clearance can often be achieved with a single tract, although success depends on surgical expertise, anatomy, and stone position.[13]

Thoracic complications represent a major limitation of supra 12th puncture. Anatomically, the supracostal puncture traverses the skin, subcutaneous tissue, latissimus dorsi, intercostal muscles, diaphragm, and enters the kidney through Gerota's fascia and perinephric fat. Posteriorly, the parietal pleura typically obliquely reflect at the midpoint of the 12th rib, and during full expiration, the visceral pleura never reaches the level of the midpoint of the 12th rib. Thus, a supracostal puncture made during full expiration and advanced laterally can avoid the pleural space. 14 Complications encountered in our series were not significant, with only one patient who underwent tubeless PCN developing hydrothorax post-procedure, managed conservatively. This observation underscores the importance of adequate drainage in preventing fluid accumulation

in the pleural space, even in the presence of pleural violation. Although some studies did not find differences in thoracic complications between tubeless supracostal PCNL and standard supracostal PCNL, management options for thoracic complications described in the literature include sealing the tract with the working sheath during the procedure or placing a percutaneous tube after the procedure. 15 Small effusions can be managed conservatively with serial chest X-rays and monitoring of vital signs. A study by B. Lojanapiwat in 2006 reported thoracic complications in 15.3% of patients out of 170, with a stone clearance rate of 82.2%. Another study by Sudhir Sukumar showed thoracic complications in 9.1% of 110 patients, with a slightly higher stone clearance rate of 86.4%, but 8.2% of their patients required a second puncture. 16 In our study, three patients had a percutaneous tract through the lower pole supra 12th, and one had a middle pole supra12th due to the higher position of the kidney. None of our patients required supra 11th puncture, which is associated with a 16-fold greater risk of thoracic complications according to literature. Five patients had stones with a major bulk in the lower pole, approached by supra12th due to their stones extending into the pelvis with an acute infundibulo-pelvic angle. Approaching through the lower pole would risk the stone falling into the proximal ureter and pose difficulty in accessing the upper ureter. 17

Our assessment demonstrated the efficacy of supracostal puncture in removing stones with good clearance rates, even with a single puncture. This represents an important modification of the traditional approach to the kidney. Although chest complications, while significant, did not occur in a significant proportion of our study population, they can be managed easily and often resolve with conservative measures. 18 A chest X-ray should be performed if a patient experiences respiratory difficulties in the postoperative period. This approach is safe, cost-effective, and reduces unnecessary radiation exposure to patients. Morbidity can be reduced to a significant extent by adhering to basic principles such as always puncturing in full expiration, sufficiently laterally, and using a working sheath during the procedure and a well-draining nephrostomy tube post-procedure. With the advent of flexible nephroscopes, retrograde intrarenal surgery, and laser ablation, the need for supracostal punctures may decrease in the future. However, this approach may still be a cost-effective option for stone clearance with minimal morbidity, particularly in developing countries.

The modified Clavien system used in our series is gaining popularity in urological surgery, including PCNL procedures. This grading system has some limitations, and further studies are awaited for the development of an accepted classification system applicable to all urologic procedures.[19, 20]

Limitations of our study include its retrospective nature and data collection from a single tertiary care hospital. Collaborative studies involving multiple hospitals may yield more significant results, further highlighting the pros and cons of supracostal access for PCNL.

CONCLUSION

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RECOMMENDATIONS

Utilizing the supracostal approach provides optimal access for addressing large calyceal and ureteric stones, especially for the intricate task of managing complex staghorn stones. While this method may involve slightly elevated morbidity, adherence to basic principles can help alleviate associated risks. Through careful technique and vigilant intraoperative and postoperative monitoring, potential chest complications can be promptly recognized and managed effectively.

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