Original Article

Outcome of Supracostal Access of Percutaneous Nephrolithotomy in Pediatric Population - A Single Centre Experience

Supracostal Access of PCNL in Pediatric

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ABSTRACT

Objective: Despite lower complication rates reported in adults, the supracostal approach remains underutilized globally. This study aims to assess the safety and efficacy of this approach in pediatric patients.

Study Design: Retrospective, Observational study

Place and Duration of Study: This study was conducted at the Department of Urology, The Kidney Centre, Post Graduate Training Institute, Karachi, Pakistan between January 1st 2023 till March 31st 2024.

Methods: Patients under 17 years old who underwent PCNL via supracostal puncture were included, while those above 17 years old, underwent multiple procedures simultaneously, or those with any renal anomalies were excluded. All PCNL procedures were conducted with the patient in a prone position. Puncture was carried out using an 18-gauge LP needle under fluoroscopic guidance. Data, including post-operative morbidity, stone-free rates, operative time, stone burden, and hospital stay, were analyzed using SPSS v21.

Results: The total number of patients included in the study was 211. The Median age of the patients was 6 years. The median stone size was 1.5 (1.3-1.9) cm. Mild haematuria was observed in 8 patients (3.8%), while only 1 patient had moderate haematuria (0.5%). The mean difference between the pre and postoperative haemoglobin was 0.6g/dl. Pleural effusion was observed in five patients (2.4%). The mean postoperative hospital stay was 3.8 ± 0.4 days.

Conclusion: Supracostal PCNL is a safe and effective approach for complex renal stones in a paediatric population.

Key Words: Percutaneous Nephrolithotomy, Urolithiasis, Supracostal.

Citation of article: Fareed W, Khan SA, Sheikh OK, Siddique SH, Zafar Z, El Khalid S. Outcome of Supracostal Access of Percutaneous Nephrolithotomy in Pediatric Population - A Single Centre Experience. Med Forum 2024;35(12):76-80. doi:10.60110/medforum.351216.

INTRODUCTION

Urolithiasis constituting 10-45% of cases ranks among the top urological diseases in both adults and children [1]. The stone composition in children is identical to that in adults where mostly 75–80% of stones composed predominantly of calcium oxalate [2]. Diagnosing stone disease in children is challenging due to frequent atypical presentations; only 50% experience pain, and stones are incidentally found in 17% of cases while most children with renal stones commonly exhibit feeding and growth issues [3].

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Received: April, 2024
Reviewed: May-June, 2024
Accepted: October, 2024

Technological advancements have shifted the management of renal stones in children from open surgery to a minimally invasive approach [4]. Percutaneous Nephrolithotomy (PCNL) is a well-established, safe, and effective procedure for managing large stone burdens in both children and adults [5]. Miniaturization of instruments have enabled PCNL to be performed with a thinner nephroscope. Variants such as mini-PCNL (15-24 Fr), Ultra mini PCNL (11-15 Fr), and micro-PCNL (<11 Fr) help to reduce blood loss and improve the maneuverability of the nephroscope in smaller kidneys [6].

PCNL can be performed with two types of access; supracostal and subcostal. Reduces stress on the renal parenchyma with greater flexibility are the top most features of Supracostal access whereas subcostal access is used to avoid complications like pneumothorax, hydrothorax, and lung injury.

Most studies on the safety of the supracostal approach are based on adult populations indicating fewer complications[7], but there is a scarcity of data on paediatric PCNL worldwide.

In the current study, our moto is to evaluate the efficacy and safety of the supracostal approach in a pediatric population in terms of post-operative complication, stone-free rates, operative time and hospital stay.

METHODS

Ethical approval was taken from The Kidney Centre Ethical Review Committee (TKC-ERC). The protocol submission reference No. 67-URO-062018 has been given by TKC-ERC. Patient consent has been taken prior to the study.The study was carried out in line with the Helsinki Declaration and STROBE guidelines. Those patients who were below 17 years of age and underwent PCNL from a supracostal puncture from January 1st 2023 till March 31st 2024 were included while those above 17 years of age or those who had multiple procedures at the same time or had any renal anomaly were excluded from the study. A consultant of paediatric urologist performed all the PCNLs.

Preoperative patients had complete workups, which included urine analysis and culture, serum creatinine, and complete blood pictures. Patients were diagnosed as having renal stones based on two radiographic investigations including x-ray, ultrasound, or CT KUB. All patients were administered with prophylactic antibiotic (2nd generation cephalosporin or any alternate drug) 30 min before induction. All procedures were done with general anaesthesia. Patients underwent retrograde pyelogram (RGP) and a 5-fr ureteric catheter was placed along with Foley's catheter. The decision on the puncture site was made based on the findings of RGP. All PCNLs were performed in the prone position. The puncture was performed by an LP needle of 18 gauge via fluoroscopic guidance. After a successful puncture, the guidewire was passed and the track was dilated by single step technique with a metallic dilator. Amplatz 15/16Fr was inserted and a 12fr nephroscope was used. Stones were fragmented with a pneumatic lithotripter and removed by whirlpool effect or grasping by forceps. All the patients have had DJ stent inserted and nephrostomy was placed if indicated.

A Foleys catheter was removed on the first postoperative and patients were discharged on the second postoperative on average based on the situation of the patient. Patients had their haemoglobin and creatinine evaluated postoperatively. The patient also had CXR to exclude chest complications and X-ray KUB to assess stone clearance. Patients had their DJ stent removed around 1 month after the procedure.

A descriptive analysis was performed using frequencies and percentages for the qualitative variables and mean and standard deviation for the continuous variables. The analysis was stratified by group according to preoperative and postoperative haemoglobin loss. Data normality was assessed using the Kolmogorov-Smirnov test and data tends to be skewed. Therefore, we assessed the differences in means and used the non-parametric Wilcoxson Signed-Rank test. Information regarding the following variables was taken into account including post-operative morbidity; stone-free rates, operative time, stone burden, and hospital stay were analysed via SPSS v21.

RESULTS

The total number of patients included in the study was 211. The median age of the patients was 6 years (IQR 3-10 years) with the male predominance 148 (67.8%). Most of the patients belong to Sindhi ethnic group 87 (41.2%). Mild hematuria was observed in eight patients (3.8%), while only one patient had moderate hematuria (0.5%). Most of the patients had unilateral stones (75.4%) mainly on the right side. The median pre and postoperative hemoglobin levels were 11.5(10.3-12.1) and 10.9(9.8-11.6) g/dl. The mean difference between the pre and postoperative hemoglobin was not significant, (p-value= 0.3090). The postoperative transfusion rate was 1.9% out of 211 samples; those who got transfusion have preoperative hemoglobin of < 10g/dl. The median pre and postoperative creatinine levels were same 0.35(0.27-0.48) g/dl. The median stone size was 1.5 (1.3-1.9) cm. The median Hounsfield units (HU) were 930 (647- 1250). Fifty-two patients have multiple stones (24.6%). The majority had a single puncture (99%) while two had a double puncture (0.9%). Pleural effusion was observed in five patients (2.4%) of which two of them required chest tube Insertion (0.9%) and the rest were treated conservatively. The mean postoperative hospital stay was 3.8 ±0.4 days.

Table No.1: Demographics and preoperative data of study participants

Variables		Patients (n=211)	
		N	%
Age	Median	6 years (3-10)	
Sex	Males	143	67.8
	Females	68	32.2
Ethnicity	Urdu Speaking	38	18.0
	Sindhi	87	41.2
	Baloch	55	26.1
	Pathan	22	10.4
	Punjabi	6	2.8
	Afghani	2	0.9
	Others	1	0.5
History of previous surgery	Yes	18	8.5

	No	193	91.5
Side involved	Right	108	51.2
	Left	71	33.2
	Middle	32	15.2
Stone size (cm)	Median	1.5 (1.3-1.9)	
Number of stones	Single	159	75.4
	Multiple	52	24.6
Hemoglobin g/dl	Median, IQR	11.5 (10.3-12.1)	
Serum Creatinine mg/dl	Median, IQR	0.35 (0.26-0.49)	

Table No.2: Postoperative data of the study participants

Variables		**Patients (n=211)**	
		N	**%**
Hemoglobin g/dl	Median	10.9 (9.8-11.6)	
Serum Creatinine mg/dl	Median	0.35 (0.27-0.48)	
Hematuria	No	202	95.7
	Mild	8	3.8
	Moderate	1	0.5
Hospital stay	Mean	3.8±0.4 days	
Number of punctures	Single	209	99.1
	Double	02	0.9
Pleural effusion	Yes	05	2.4
	No	206	97.6
Chest tube insertion		02	0.9
Conservative management		03	1.4

Table No.3: Difference in pre & post-operative hemoglobin (g/dl) among study population

Group	Median (IQR)	Wilcoxson (z) test	P-value
Pre-operative Hb g/dl	11.5 (10.3-12.1)	-	0.30
Post-operative Hb g/dl	10.9 (9.8-11.6)	1.018	9

Significant p-value is considered as <0.05

DISCUSSION

With the advancement in imaging technology, the incidence of the renal stone disease has also risen[8]. Over the past few decades, Urolithiasis in children has become more common worldwide [9]. Calcium oxalate stones are the most frequent type in children, comprising 45% to 65% of cases. Struvite (magnesium ammonium phosphate) stones represent 3% to 30%, with higher occurrence in Europe and developing nations compared to North America. Cysteine and uric acid stones together make up just 5% to 10% of cases in children [10]. Medications and dietary changes can lower the risk of stone recurrence after removal [11].

Pediatric stone disease management prioritizes clearing stones and preserving kidney function. Various treatments are commonly employed for renal calculi such as shock wave lithotripsy, percutaneous nephrolithotomy, open surgery, and laparoscopy. While open surgery was once standard, percutaneous nephrolithotomy, facilitated by nephroscopes and minimally invasive methods, is now the preferred treatment for renal stone disease [12]. There are three approaches to performing PCNL for renal stones: lower pole, middle pole and upper pole access. Lower Pole access is traditionally considered the safest for accessing the renal collecting system, associated with lower risks of bleeding and thoracic complications such as hydrothorax or pneumothorax. However, it may not achieve complete stone clearance in cases involving complex or staghorn renal stones, as well as proximal ureteral stones. Recent studies have shown a relatively good safety profile for upper pole approach to PCNL compared to lower pole access[13]. Most research on upper pole punctures is based on studies involving adults, resulting in a scarcity of pediatric-specific data. Our study focuses on all upper pole approach PCNL procedures performed in pediatric patients at the kidney center.

We found our complication rates to be similar to contemporary results obtained in various studies. In terms of blood loss, our mean hemoglobin drop was 0.6 gm/dl, similar to that observed by a researcher (HB Drop 0.9gms/dl +/- 0.3) in their subgroup of patients who underwent Supracostal puncture for PCNLs. Similarly, only 2.4% of our patients developed hydrothorax which is again similar to the figure found by a researcher although that number rose to 7.3% in

patients who underwent supra 11 puncture[14]. That gives credence to the belief that the higher the puncture is, the greater the chance of developing pulmonary complications.

Another study involving patients aged 07 to 76 years, 14.4% experienced early or delayed chest complications (13 out of 90), with a higher incidence observed on the right side (20.8%, 11 out of 53) compared to the left side (5.4%, 2 out of 37) [15]. Our findings indicate a lower occurrence of pleural effusion, affecting only 2.4% of patients (5 cases), with chest tube insertion necessary in only 0.9% (2 cases).

Another important consideration is the postoperative transfusion rates, as highlighted in studies by Goyal et al., where it was 7.6% in supracostal PCNL [16], and by Purkait et al., where it reached 19.6% [17]. In contrast, our study reported a much lower rate of 1.9% requiring postoperative transfusions. This significant difference can be attributed to Purkait et al.'s inclusion of bilateral PCNLs in their series and the use of adult-size conventional PCNL instruments in both studies, whereas our study utilized miniature instruments.

In the study conducted by Omer et al., the mean operative time was 63.8 ± 13.2 minutes, and the mean length of stay was 4.3 ± 2.2 days [18]. In contrast, our study showed better outcomes in terms of hospital stay, with a mean of 3.8 ± 0.4 days. This is particularly significant because prolonged hospital stays can significantly increase costs, which is a crucial concern in developing countries where financial considerations are paramount.

However, this study is limited by its lack of comparison with subcostal PCNL and stone-free rates post-PCNL. Future studies should be conducted to compare these approaches and establish their safety and efficacy. Nevertheless, based on our findings, it can be confidently concluded that the Supracostal technique, especially when performed with miniature instruments in pediatric populations at high-volume centers with experienced surgeons, is as safe and effective as the subcostal approach.

CONCLUSION

The Supracostal approach of PCNL is safe and effective with minimal complications for complex renal stones in a Paediatric population.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Wajahat Fareed, Shariq Anis Khan, Osama Kalim Sheikh
Drafting or Revising Critically:	Shakeel Haseeb Uddin Siddique, Zeeshan Zafar, Salman El Khalid
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

Conflict of Interest: The study has no conflict of interest to declare by any author.

Source of Funding: None

Ethical Approval: No. 143-URO-042022
Dated 23.04.2022

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