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Original Research Article

A Retrospectively Assessment of the Efficacy and Safety of Supracostal Access for Mini Percutaneous Nephrolithotomy in Pediatric Patients

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Abstract

Aim: The aim of the present study was to evaluate the efficacy and safety of supracostal percutaneous nephrolithotomy (PCNL) through the 11th intercostal space and compare it with subcostal PCNL in children with renal calculi.

Methods: We retrospectively reviewed the electronic medical records of 100 children (65 boys and 35 girls) who underwent PCNL procedures at our center for treatment of renal calculi for the period of one year

Results: The patients who underwent standard PCNL or combined supracostal and subcostal PCNL, 100 patients were analyzed. Of these, 35 and 65 had a supracostal and subcostal access respectively. Stone size and location of stone were comparable in both the groups. Most of the children had stone larger than 2 cm as an indication for PCNL. The preoperative characteristics of the patients, urinary tracts and stones were comparable for both treatment groups. Supracostal tracts were used for treatment of staghorn stones, upper calix stones, mid calix stones and upper ureteral stones causing calculous anuria. There were no major complications (eg intrathoracic complications, adjacent organ injury or bleeding requiring selective angiographic embolization, urgent renal exploration, nephrectomy) following any of the procedures.

Conclusion: In conclusion, percutaneous nephrolithotomy for treating renal stones in children provides a high degree of safety and efficacy whether a supracostal or subcostal approach is used.

Keywords: Supracostal Percutaneous Approach, Nephrolithotomy, Pediatric Patients.

Introduction

Percutaneous nephrolithotomy (PCNL) is one of the preferred treatment options for renal and upper ureteric calculi in children. [1] The incidence of pediatric urolithiasis has increased in the recent years and with technological advancements in PCNL such as mini/ ultramini PCNL, those complex calculi are now being managed via percutaneous approach which were earlier treated only with laparoscopic or open renal surgery. [2]

There are two types of access to the pelvicalyceal system in PCNL, namely supracostal and subcostal. Pediatric PCNL, like the adult counterpart, is performed via subcostal access in majority of the cases. [3] While the supracostal access has obvious advantages compared to subcostal access for staghorn calculi, complex lower calyceal calculi and the upper ureteric calculi, its use has been selective due to the risk of complications, particularly hydrothorax. [4] This resulted in underutilization of supracostal access for PCNL in children even in stones where it may score above subcostal access. Most of the literature on supracostal PCNL still comes from the adult series. Recent reports on supracostal PCNL in adults, particularly tubeless PCNL, have shown that the incidence of complications compared to the subcostal PCNL is lower than reported historically and this has led to renewed interest in supracostal PCNL in children. [5,6]

Over the last two decades, surgical management of pediatric urolithiasis has evolved significantly. Since the advent of extracorporeal shockwave lithotripsy (SWL) in the 1980s, it is currently the modality of choice for managing most upper urinary tract stones.4SWL limitations are: The functional long-term effects on developing kidneys and adjacent structures have not yet been determined, ineffective for large stone burden, and there is a need for multiple sessions under anesthesia.5 Since Woodside and associates [7] reported the first pediatric percutaneous nephrolithotomy (PCNL) in 1985, there have been

many technologic improvements, instruments miniaturization, and mounting endourologic experience. In the present era, PCNL is a well-established minimally invasive technique for management of pediatric nephrolithiasis with better stone clearance and faster recovery compared with SWL or open surgery. The disadvantages of PCNL in children are potential renal damage, radiation exposure, and the risks of major complications, including sepsis and bleeding. [8]

Pediatric urolithiasis carries the risk of lifelong recurrence with an overall 5-year recurrence rate of 55%, [9,10] because it may be associated with anatomic anomalies or metabolic disorders. Previous open stone surgery results in perirenal scarring and distortion of the pelvicaliceal (PCS) anatomy. These changes may affect the outcomes of subsequent PCNL procedures. [11]

The aim of the present study was to evaluate the efficacy and safety of supracostal percutaneous nephrolithotomy (PCNL) through the 11th intercostal space and compare it with subcostal PCNL in children with renal calculi.

Materials and Methods

We retrospectively reviewed the electronic medical records of 100 children (65 boys and 35 girls) who underwent PCNL procedures at our center for treatment of renal calculi department of Urology for the period of 1 year at AIIMS, Patna, Bihar, India.

Preoperative laboratory evaluation included serum creatinine, urine culture and complete blood count. Urinary tract infection was present in 18% of the patients and was preoperatively treated with pathogen specific antibiotics. Noncontrast computerized tomography was the primary radiological evaluation for most of the patients, except those who had undergone excretory urography elsewhere. In addition, antegrade pyelography via a percutaneous nephrostomy tube was performed in patients who presented with calculous anuria.

Technique

Using general anesthesia and with the patient in the prone position the skin was punctured at the posterior axillary line. The percutaneous renal access was established under multidirectional C-arm fluoroscopic guidance through the posterolateral plane of the kidney after fixation of a ureteral catheter, and PCNL was completed in the same session. In the 6 patients with calculous anuria the procedure was staged and started by ultrasound guided insertion of a percutaneous nephrostomy tube to drain the obstructed kidney, followed by PCNL after maximum decrease in serum creatinine. The pelvicaliceal system was punctured at the lower posterior calix in patients with renal pelvis or lower caliceal stones. Middle or upper calix punctures were used when stones were present within or branched into these calices, and in patients with ureteral stones.

The supracostal tract was confirmed to be away from the pleural sac by turning the C-arm into the lateral position to visualize the relationship between the tract and the lower edge of the pleura. Supracostal skin puncture was performed over the lateral portion of the last rib during steady quiet breathing, and then the desired calix was entered during inspiration.

Dilation of the tract was performed using coaxial telescopic dilators. A 22Fr Amplatz sheath and an 18Fr pediatric nephroscope were used for 33 procedures. In older children the tract was di- lated up to 30Fr, which allowed the use of adult instru-ments. Ultrasonic, pneumatic or holmium:YAG laser litho- tripsies were used for stone fragmentation in 41 procedures (68%), whereas forceps were used for extraction of the intact stones in 19 (32%). At the end of the procedure a nephros-tomy tube (16Fr or 22Fr) was placed. Then intraoperative fluoroscopy of the chest was done in supracostal cases to exclude intrapleural fluid.

Stone-free status was evaluated on postoperative day 1 with noncontrast computerized tomography, which was also helpful in detecting intrapleural fluid. Therefore, a chest x-ray was not done. At 48 hours postoperatively antegrade pyelography was performed in patients with suspected intraoperative injury of the renal pelvis, when peripelvic fat was observed during nephroscopy and to exclude extravasation of the contrast material before removal of the nephrostomy tube.

Results

Table 1: Clinical presentations of 50 patients

Presentation	Subcostal N	Supracostal N
Abdominal pain	25	14
Recurrent UTI	15	10
Hematuria	20	5
Calculous anuria	15	4
Total pts	65	35

The patients who underwent standard PCNL or combined supracostal and subcostal PCNL, 100 patients were analyzed. Of these, 35 and 65 had a supracostal and subcostal access respectively. Stone size and location of stone were comparable in both the groups.

Table 2: Indications for PCNL

Indications for PCNL	Subcostal N	Supracostal N
Stone larger than 2 cm	30	10
Multiple stones	23	10
Staghorn stone	4	5
Failed SWL	5	5
Calculous anuria	3	5
Total pts	65	35

Most of the children had stone larger than 2 cm as an indication for PCNL.

Table 3: Preoperative characteristics of both treatment groups

Variables	Subcoastal N=65	Supracostal N=35	P Value
Preoperative UTI:			
No	55	28	0.832
Yes	10	7	
No. kidney morphology:			0.812
Normal	10	5	
Hydronephrosis	15	10	
Pyelonephritis	40	20	
No. stone side:			0.220
Rt	30	20	
Lt	35	15	
No. burden (%):			0.254
Single	32	14	
Multiple	25	16	
Staghorn	8	5	
No. recurrence (%):			0.515
De novo	50	25	
Recurrent	15	10	
Age (yrs): Mean ± SD	7.3 ± 4.6	7 ± 3.7	0.973
Range	0.75–14	1–14	

The preoperative characteristics of the patients, urinary tracts and stones were comparable for both treatment groups. Supracostal tracts were used for treatment of staghorn stones, upper calix stones, mid calix stones and upper ureteral stones causing calculous anuria.

Table 4: Postoperative events and outcomes of both treatment groups

Variables	Subcoastal N=65	Supracostal N=35	P Value
Mean ± SD Range	4.6 ± 2.5 2–12	4.9 ± 2.4 2–10	0.664
Complications			
None	56	29	1.0
Bleeding/hematuria	3	2	
Fever	3	2	
Leakage	3	2	
Auxiliary procedures:			
No	56	30	0.634
Yes	9	5	
Results at discharge:			
Stone-free	57	29	0.743
Insignificant residual	4	3	
Residual for SWL	4	3	
Results at 3 mos:			
Stone-free	60	32	0.763
Insignificant residual	5	3	

There were no major complications (eg intrathoracic complications, adjacent organ injury or bleeding requiring selective angiographic embolization, urgent renal exploration, nephrectomy) following any of the procedures.

Discussion

The first series of PCNLs in pediatric patients was reported by Woodside et al in 1985. [8] Since then, PCNL has become an established technique for treatment of pediatric nephrolithiasis. The indications include large or complex stone burden, obstructed kidney, hard stones (eg cystine) and residual stones after failed SWL. [12] Concerns regarding PCNL in children have included the use of large instruments in relation to small kidney size, the risk of major complications and the long-term sequelae of renal punctures. [13] These concerns have gradually dissipated due to the continuous advancement of instruments such as small nephroscopes and intracorporeal lithotripsy devices, facilitating the introduction of mini-percutaneous techniques. [14]

The patients who underwent standard PCNL or combined supracostal and subcostal PCNL, 100 patients were analyzed. Of these, 35 and 65 had a supracostal and subcostal access respectively. Stone size and location of stone were comparable in both the groups. Most of the children had stone larger than 2 cm as an indication for PCNL. The success rate of supracostal PCNL in children has been evaluated by few authors, but mostly in combination with subcostal access rather than in isolation. Oner et al [15] reviewed 77 children who underwent single upper pole access vs. single other pole access. Supracostal access was required in 8 out of 10 patients with upper pole access against 3 out of 67 patients with other pole access. Stone clearance was 100% in the former against 82% in the latter. Kumar et al [16] reported their experience of PCNL in 12 children with staghorn calculi. In the majority of renal calculi access to the desired calix is possible by a subcostal puncture. However, in staghorn and complex upper pole calculi the subcostal approach fails to provide optimal access. In these cases a supracostal approach provides direct access, and thereby facilitates better stone clearance. [17] Usually, the upper pole of the kidney is more posterior and more medial than the lower pole, so access via a superoposterior calix is more direct to the long axis of the kidney. This approach additionally facilitates access to a lower calix and the upper ureter. [18]

The preoperative characteristics of the patients, urinary tracts and stones were comparable for both treatment groups. Supracostal tracts were used for treatment of staghorn stones, upper calix stones, mid calix stones and upper ureteral stones causing calculous anuria. There were no major complications (eg intrathoracic complications, adjacent organ injury or bleeding requiring selective angiographic embolization, urgent renal exploration, nephrectomy) following any of the procedures. Certain measures should be taken while performing supracostal puncture in PCNL to reduce the incidence of chest complications in adults and children. First, the supra 11th rib is better avoided because of the higher incidence of pleural and pulmonary violation and injury to adjacent organs such as the liver and spleen. [19] In addition, the supracostal skin puncture should be done over the lateral portion of the rib, and the puncture should be made during steady, quiet breathing or breath holding in expiration. The benefit of this approach can be explained by the fact that the upper pole of each kidney lies anterior to the 11th and 12th ribs. During expiration the lower limit of the parietal pleura crosses these ribs obliquely, such that the lateral portions of these ribs are inferior and lateral to the lowest limit of the pleura. [20]

Conclusion

In conclusion, percutaneous nephrolithotomy for treating renal stones in children provides a high degree of safety and efficacy whether a supracostal or subcostal approach is used.

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