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Original Research Article

Supracostal Puncture in PCNL: Our Experience

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Abstract: Percutaneous nephrolithotomy has become the cornerstone and one of several procedures developed over the past decades. The planning, patient selection and an effective perioperative protocol are crucial for the outcome of PCNL. Although many standardized techniques established for the management of renal and upper ureteric calculus, supracostal approach is widely used and accepted. The objective is to evaluate and compare supracostal and lower calyceal approach for percutaneous nephrolithotomy (S-PCNL) in renal calculus disease, through a retrospective approach. The retrospective study was conducted by the Dept. of Urology, Mahatma Gandhi Medical College and Hospital, Jaipur. We reviewed the medical records of 600 patients who underwent PCNL by a supracostal access for renal calculus disease from March 2010 to June 2016. Patients with stones of various sizes and characteristics in the kidney and upper ureter were included in the study. Patients were studies for safety of the supracostal approach and its associated complications, including postoperative hospital stay, operative time and success rate. There were 600 patients with renal calculus disease. Among them 396 (69.2%) were males and 204 (30.8%) females. Calculus were noted in the upper calyx in 187 (33.4%), 113 (18.6%) in the middle calyx, 107 (17.4%) in the renal pelvis, 56 (7.2%) in the lower calyx and 137 (23.4%) in the upper ureter. Mean age of the patients was 40. Estimated time of procedures was 60 – 90mins in 162 patients, 90 – 140mins in 336 patients and more than 140 minutes in 102 patients. Hemothorax developed in 1 patient and was managed by chest drain insertion. The present study being retrospective has revealed that supra costal access for management of renal calculus disease is a positive step towards the on-going development and refinement of an already standardized procedure. It carries the risk of injury to the pleura and lungs, which are relatively low and can be managed if the procedure is performed under careful guidance.
Keywords: complication, nephrolithiasis, percutaneous nephrolithotomy, pneumothorax s-pcnl

INTRODUCTION

Percutaneous endourology is based on accessing the kidney and upper urinary tract by needle or a guidewire access, giving the surgeon a straightforward route to the kidney either for drainage or for facilitation of antegrade intrarenal or ureteral endoscopic procedures and allowing for a bloodless procedure.

The first nephrostomy was performed in the year 1865 by Dr. Thomas Hiller, but none followed his examples until 1955 when Goodwin and associates reported performing 16 nephrostomies [1], followed by Fernstrom and Johansson in 1976 who were the first to perform the procedure to extract a calculus through a percutaneous tract [2].

Percutaneous access has been indicated in procedures like Nephrostomy catheter drainage, Antegrade ureteral stenting, Treatment of ureteral strictures, Percutaneous endopyelotomy, Percutaneous endopyeloplasty, Percutaneous nephrolithotomy, Miniature percutaneous nephrolithotomy (Mini-Perc), Tubeless percutaneous nephrolithotomy, Perfusion chemolysis to dissolve and clear certain renal stones and Endoscopic resection and treatment of upper urinary tract urothelial tumors.

Percutaneous nephrolithotomy (PCNL) is the preferred treatment for large (>2 cm) renal or staghorn renal stones [3] and access into the collecting system is safest when using a direct puncture through the overlying renal parenchyma into the fornix of the intended calyx, to avoid major blood vessels [4]. Direct entry into an infundibulum risks injury to one of the interlobar vessels or segmental branches of the renal artery, resulting in significant haemorrhage [4]. Inadvertent puncture of an anterior calyx results in more parenchyma being traversed, increasing the risk of bleeding, and makes it more difficult to access the renal pelvis or other portions of the collecting system. The urologist's selection of the optimum tract based on the intrarenal anatomy and the ability to make secondary tracts as required [5], permit more effective stone removal.

The superior calyceal approach is considered ideal for approaching the renal system when managing staghorn stones, complex upper and lower calyceal calculi, proximal ureteric calculi, and calculi associated with primary pelvi–ureteric junction obstruction [6-8].

PATIENTS AND METHODS

We reviewed the medical records of 600 patients', median age of 40 years, admitted to the department of urology for the treatment of renal calculus disease from March 2010 to June 2016 in Mahatma Gandhi Medical College and Hospital, Jaipur.

Patients presented to the outpatient clinic with clinical features suggestive of renal calculus disease underwent ultrasonography and X-ray KUB as preliminary diagnostic modalities along with a urine routine. They were considered eligible if stones identified were larger than 7mm in the kidney and upper ureter. Patients were subjected to an Intravenous Pyelogram before scheduling PCNL and those who showed marked hydronephrosis underwent percutaneous drainage i.e. nephrostomy or ureteral stenting and were reviewed after 2 weeks of the procedure with a repeat plain radiograph KUB and ultrasonography and planned for definitive PCNL after resolution. Patients with high Creatinine clearance levels were first hydrated and managed conservatively or by decompression procedures or haemodialysis so PCNL could be scheduled.

Inclusion criteria were patients from the age of 18 to 65 years, who had recurrent pain and who failed expulsion or medical treatment.

Exclusion criteria comprised of patients who had untreated urinary tract infections, bleeding tendency, stricture per urethra and giant stones which may have prevented successful completion of the procedure.

The patients were subjected to a complete pre-operative work up as per protocol i.e. history taking and general physical examination to identify any anatomical disorders or congenital anomalies. Complete blood count, urine analysis, urine for culture and sensitivity, coagulation profiles, electrolyte tests and renal function tests were conducted along with X-Ray KUB, IVP or Non-enhanced CT were performed.

Operative intervention included administration of an antibiotic pre-operatively and the patient sent to the operating room and placed in a supine position for inducing general anaesthesia and ureter catheterization, the patient was then placed in prone position for commencement of PCNL.

Procedure

All the patients after receiving broad spectrum antibiotic coverage were placed in prone position keeping in mind and padding the face, extremity pressure points and chest to support ventilation. The benefits of prone flexible cystoscopy include avoiding a second patient transfer, reducing the likelihood of accidental ureteric catheter dislodgement, and less risk to the airway.

After antiseptic cleansing, adhesive disposable drapes with collecting pockets were used to capture the irrigation fluid. All PCNL's were performed by biplanar fluoroscopy with a rotating C-Arm. Intrarenal anatomy, stone configuration were studied and the desired calyx were punctured and guide wires were navigated through the collecting system and duly fixed and tract dilatation was pursued. After securing renal access, tract dilatation and placing the working sheath, the rigid nephroscope was inserted under direct vision and Nephroscopy performed under videoendoscopic monitoring. Irrigation fluid (0.9% normal saline, warmed to room temperature), was used. Stone fragmentation was performed by pneumatic lithotripter, and fluoroscopy with contrast nephrogram was performed to obtain a stone free status. The puncture was examined for any overt/active bleeding, double J stent was placed and guide wire was removed. Nephrostomy tube sized 22-24 Fr was then placed via the dilated puncture and clamped until the first postoperative day.

Table 1: Stone Status: Location

Stone Location	Patients	Percentage	Puncture Used
Upper Calyx	187	33.4%	Supra costal
Middle Calyx	113	18.6%	
Renal pelvis	107	17.4%	
Lower Calyx	56	7.2%	
Upper ureter	137	23.4%	

All patients were managed in a single stage procedure, Supracostal approach was considered as the choice of puncture through the intercostal space between the 11th and 12th rib. As the needle was guided through the middle of the intercostal space, thus avoiding the intercostal vessels and nerves, on full expiration the puncture was made and further tract dilatation was done.

All cases were managed as inpatients and those who had an uneventful post-operative course were discharged on the third post op day and reviewed for outpatient cystoscopy along with an X-Ray KUB for DJ stent removal after two weeks.

Intraoperative complications like migrating or lost stone, excessive bleeding were monitored and causes of failure of the procedure were duly documented.

Endpoint of study was considered when the patients were reviewed 2 months after the procedure along with a plain radiograph KUB, who had no or insignificant residual stones. Other types of upper tract imaging were not done except when there were complications.

RESULTS

There were 600 patients with renal calculus disease. Among them 396 (69.2%) were males and 204 (30.8%) females. Calculus were noted in the upper calyx in 187 (33.4%), 113 (18.6%) in the middle calyx, 107 (17.4%) in the renal pelvis, 56 (7.2%) in the lower calyx and 137 (23.4%) in the upper ureter. Mean age of the patients was 40 years. The size of the stone in the treated patients was in the range 7-40 mm.

Table 2: Stone Status: Size of stone and success rates

Size of Stone	No. of Patients	Success Rates	Failure Rates
< 1cm	100 (16.6%)	95 (15.8%)	5 (0.8%)
1-2 cms	160 (26.6%)	150 (25.0%)	10 (1.6%)
2-3 cms	296 (49.4%)	259 (43.3%)	37 (6%)
3-4 cms	44 (7.4%)	39 (6.6%)	5 (0.8%)
Total	600	543 (90.5%)	57 (9.5%)

Table 3: Analysis of factors affecting complications after s-PCNL

Factors		Remarks
Operative Duration		
60 – 90 mins	162	32.4%
90 – 140 mins	336	57.2%
140 – 180 mins	102	10.4%
Gender		
Male	396	69.2%
Female	204	30.8%
Ratio		
Obesity		
Yes	232	36.4%
No	368	63.6%
Access		
One	388	64.8%
Two	148	24.4%
Three	64	10.8%
Previous PCNL, Surgery		
Yes	88	7.6%
No	512	92.4%

Table 4: Causes of Failure and accessory procedure done

Causes	Number	Procedure Done	No. of patients
Upward stone migration	32	2nd and 3rd puncture	All
Stone fragment failure	22	2nd and 3rd puncture	All

Table 5: Complications among 600 s-PCNL procedures

	Number	Rate %
Intraoperative		
Transfusion	346	57.6 %
Minor renal parenchymal Injury	14	2.3%
Renal Capsule Rupture	1	0.2%
Significant bleeding	8	1.4%
Renal collecting system Injury	2	0.3%
Adjacents Organ Injury	0	0.0%
Early		
Fever / Urosepsis	20	3.4%
Persistent Haematuria	4	0.6%
Renal colic	2	0.4%
Pleural Effusion	3	0.5%
Hemothorax	1	0.3%

The supracostal puncture and access for PCNL is safe and effective; Access to the calyx was non traumatic and manipulation of the nephroscope through dilated tract was easy and free from major complications. Access was gained with ease to all calyxes and the upper ureter also. There was no solid organ injury and hemothorax was noted in only 1 (0.3%) patients. Pleural effusion developed in 3 patients and was conservatively managed and resolved during follow-up. Minor renal parenchymal injury was noted in 14 (2.3%) patients, capsule rupture and collecting system injury was seen in 2(0.3%) patients, which was managed conservatively. Blood and blood product transfusion was done in 346 (57.6%) patients. We placed double J stents in all patients as per our protocol; there were no complications in follow up patients.

Estimated time of each procedure was 60 – 90mins in 162 patients, 90 – 140mins in 336 patients and more than 140 minutes in 102 patients. Though patients under prolonged general anaesthesia have electrolyte imbalances and paralytic ileus, they were conservatively managed with no further complications.

Access was gained through supracostal puncture in all patients initially, but difficulty in stone extraction, impacted stones and anatomically difficult entities like position of kidney, small renal hilum were reasons for acquiring another puncture site.

Post operatively fever was present in 20 patients, and was managed with appropriate antibiotics after obtaining a urine culture and sensitively report. Persistent haematuria in 4 patients mostly due to insignificant and impacted small calculus were managed conservatively by observance and prolonging use or changing double J stent.

DISCUSSION

The kidneys lie in the retroperitoneum, although a significant portion of each is actually supracostal. The longitudinal axis of each kidney is oblique and dorsally inclined, making the upper pole calyces more medial and posterior than the inferior pole [9]. The posterior calyces of the kidney are at a 30° oblique angle to the vertical plane when the patient is prone. The upper or lower pole calyces are offset by 10° in the cranial or caudal plane, respectively. In many instances the upper-pole puncture is the most appropriate calyx to work in, especially for complete staghorn calculi or when direct access to the PUJ is desired [10, 11].

All supracostal punctures would traverse the diaphragm; Although harmless, this can be a source of intense pain after the procedure [12]. This pain is reduced by either using a smaller nephrostomy tube or by injecting the puncture site with an anaesthetic agent like bupivacaine, but it was not considered as part of our protocol in this study.

Bleeding is considered as one of the most commonly occurring complications in previous studies. Sampaio *et al.* [4] reported injury to an interlobar vessel in two thirds of kidneys on puncturing the upperpole infundibulum, while only 13% of kidneys had an arterial injury when accessed through the lowerpole infundibulum. However, when the puncture was through the centre of the calyceal papilla they detected no arterial lesions.

Assessing a stone free status in variable and mostly subjective even though being considered a very important prognostic factor in previous studies, but due to use of several imaging techniques and poor patient follow up it is often missed. Golijanin *et al.* [13] reported a retrospective study of 104 patients who underwent 115 SPCNL to treat 102 complete staghorn calculi, six large semistaghorn calculi, three large upper calyceal stones and four significant volumes of residual stone fragments after ESWL. Additional renal access was required mainly for complete staghorn stones in 23 (20%) patients. ESWL was needed to treat residual stones in 30.4% and a 'secondlook' PCNL in 15.6%. The stone freerate after PCNL was 67.8%, while after PCNL followed by ESWL, secondlook PCNL, or both, the stonefree rate increased to 87%.

As per the above study, the overall complication rate after SPCNL is 10–26%.[12] In our study the overall stone free rate was 90.8% by single stage supracostal percutaneous nephrolithotomy.

Hopper *et al.* [11] used CT with sagittal reconstruction when patients were at both full inspiration and expiration. On expiration the needle path had a 29% chance on the right and a 14% chance on the left of transgressing the pleura, while during forced full inspiration the lung would be in the path of the needle in most patients. During expiration the lower extent of the parietal pleura crosses the 12th rib obliquely, so that the lateral part of the 12th rib lies below and lateral to the lowest limits of the pleura. Injury to the pleura can be avoided by staying above the lateral half of the 12th rib and lateral to the midscapular line. However, even when taking all these precautions, in a small proportion of patients the pleura can still be injured. Access through the pleural space can lead to the accumulation of fluid and cause hydrothorax, requiring the insertion of a chest tube.

In our study, one patient developed hemothorax in the left chest, patient was managed in intensive care with oxygen support at 6 L/hour, blood transfusion, antibiotic and analgesic management. Intercostal drain tube was placed through the 6th rib at the posterior axillary line and about 600ml of blood was drained, Subsequently the patient's general condition was satisfactory to proceed with the scheduled protocol for post-operative PCNL management, the chest tube was removed on post-op day 7 when the air column seized to function and the patient was satisfactorily discharged on the 10th post-operative day and had no complaints during follow-up two weeks later. Gupta *et al.* [8] reported 63 supracostal access procedures, with 14 (22%) sustaining overall complications. Chest complications developed in seven (11%) patients, three with minimal blunting of the costophrenic angle, managed conservatively, while significant hydrothorax and haemothorax occurred in three and one patient, respectively, who were treated with chest drains

Maheshwari, P.N. *et al.* [15] and colleagues studied 428 patients and concluded that the supracostal approach for PCNL was safe and effective; access to the calyx was not traumatic and manoeuvring the nephroscope through this tract was easy and free from complications. It was possible to reach not only the calyx of entry, but also the renal pelvis, upper ureter and the lower calyx whenever indicated. No surrounding organ injury was noted in any of the patients. No patient had any major pleuro-parenchymal trauma requiring surgical intervention. Only three of the 150 patients (2%) developed a pleural effusion; of these, one patient with a recurrent staghorn calculus needed intercostal chest drainage for 48 h and the other two had clinically insignificant pleural effusion, managed conservatively. The pleural effusion resolved during follow–up.

CONCLUSION

Hossian *et al.* [16] and collegues have concluded in their study that Although the morbidity is slightly higher than with a subcostal approach, this may be avoided to some extent by adhering to the basic principles of always puncturing in full expiration, sufficiently laterally to the margin of erector spinae muscle closer to the midscapular line, and always using a working sheath during nephroscopy and a well-draining nephrostomy tube after the procedure. Proper attention to the technique and intraoperative and postoperative monitoring can detect chest complications, and these can easily be managed with intercostal drainage without serious morbidity or death

The present study being retrospective has revealed that supra costal access for management of renal calculus disease is a positive step towards the on-going development and refinement of an already standardized procedure. It avoids solid organ injury at the risk of injury to the pleura and lungs, which are relatively low and can be managed if the procedure is performed under careful guidance, with reasonably well stone free rates.

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