

# PCNL in Inspiration – Our Experience

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## ABSTRACT

**Introduction:** Percutaneous Nephrolithotomy (PCNL) has been done in full expiration since its introduction. However, it increases the chances of supracostal punctures and thoracic complications. We studied the efficacy and safety of performing the procedure in full inspiration.

**Material and Methods:** This prospective study included all adult patients with renal calculi undergoing PCNL in our institute. Patients with co-morbidities, or in whom the desired calyx was infracostal on expiration were excluded. During surgery, the patients were placed in prone position and the desired calyx was identified and marked with relation to 12<sup>th</sup> rib on inspiration and expiration. The procedure was done in full inspiration and the desired calyx was punctured either by Bull's eye or oblique technique.

**Results:** Out of the 512 patients included in the study, infracostal puncture was possible in 450, while supracostal puncture was needed in 62 patients. Mean pain score on visual analogue scale for the infracostal group on the first and second post operative day was  $6.31 \pm 1.17$  and  $2.78 \pm 1.00$  respectively as compared to  $8.35 \pm 0.93$  and  $3.58 \pm 0.97$  for those needing supracostal puncture. 121 patients (23.63%) had complications (mostly grade 1 and 2), of which, 94 (77.7%) were in infracostal group and 27 (22.3%) in the supracostal group.

**Conclusion:** PCNL in deep inspiration is both safe and effective, with significantly less postoperative thoracic morbidity and less pain.

**Keywords:** Supracostal, Infracostal, Calyx

## INTRODUCTION

Percutaneous Nephrolithotomy (PCNL) is the procedure of choice for complex and large renal calculi.<sup>1</sup> PCNL has been done in full expiration since its introduction. However, PCNL in expiration is associated with 37.3% to 52.29% supracostal punctures and 3.31% to 4.92 thoracic complications.<sup>2,3</sup> A supracostal nephrostomy is associated with more pain and discomfort as compared to infracostal tube.<sup>4,5,6</sup> Because of these, infracostal access is preferred during PCNL. It is a known fact that kidneys descend with inspiration. We intended to clinically imply this fact by puncturing the desired calyx in full inspiration, thus avoiding pleural injury.

## MATERIAL AND METHODS

This prospective study was conducted in our institute from July 2015 to December 2016 after taking clearance from our institutional ethics committee. This study was performed in accordance with the guidelines laid down by the Declaration of Helsinki.

All the adult patients (>18 years) with renal calculi undergoing PCNL in our department were included in this

study. Exclusion criteria for this study were history of renal surgery on the affected side, comorbidities like hypertension, diabetes mellitus, renal insufficiency, liver dysfunction, coagulopathy, spinal deformity, anomalies of the PCS, radiolucent calculi, hepatomegaly or splenomegaly. Patients in whom the desired calyx was infracostal on expiration were also excluded from this study.

Pre operative work up of the patients included complete blood counts, bleeding profile, renal function tests, urine culture and NCCT of KUB region with CT Urography or IVU (Intra Venous Urography). All the patients were given pre operative intravenous antibiotics which were continued post operatively. Demographic, clinical and surgical details were collected.

PCNL was done in prone position and the desired calyx was identified.<sup>7</sup> Desired calyx was defined as the calyx which provides the shortest route to the PCS (Pelvicalyceal system) with minimal renal injury and opportunity for complete clearance of stones. Its location in relation to the rib on inspiration and expiration was marked and the extent of descent of desired calyx on full inspiration was also noted. Data of the patients were noted in excel sheet along with other details. Peri and post operative complications were graded according to Modified Clavien grading system.<sup>8</sup>

## SURGICAL TECHNIQUE

Under epidural anaesthesia, an ureteric catheter was placed in the desired ureter retrogradely. Then the patient was put in prone position and air pyelogram was made by instilling air into the PCS through preplaced ureteric catheter.

After selecting the proper calyx for puncture, its relation with the 12<sup>th</sup> rib in inspiration and expiration was noted. Descent of the calyx on full inspiration was noted. If the desired calyx became infracostal on full inspiration, then the puncture was made by Bull's eye technique using 18 G diamond tip puncture needle. After entering the calyx, guide wire was passed into the PCS. The tract was dilated using Alken's dilator and Amplatz sheath was placed over it. 24

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Fr Wolf nephroscope was used to visualise and retrieve the calculi. Whenever needed, pneumatic lithotripter or Ho: YAG LASER was used to fragment the calculi.

Cases in which the desired calyx was in the 11<sup>th</sup> intercostal space, the puncture was made from the subcostal area and needle was advanced obliquely till the desired calyx was reached, and then it was dipped down into the calyx with C-arm in 30 degree.<sup>9</sup> After this, position of needle tip in the desired calyx was confirmed, keeping the C arm at 0 degree

<b>Total patients</b>	<b>512</b>
Male	342 (66.80%)
Female	170 (33.20%)
Mean Age (Years)	39.55 ± 10.49
Laterality- Right: Left	276 : 236
GSS	
1	297
2	133
3	42
4	40
Mean operative time (Minutes)	53.85 ± 23.83

**Table-1:** Characteristics of the study population

	<b>Infracostal</b>	<b>Supracostal</b>
No of patients	450 (87.90%)	62 (12.10%)
Mean operative time (Minutes)	53.23 ± 23.82	58.35 ± 23.61
<b>Calyx punctured</b>		
Superior	149 (29.10%)	32 (51.61%)
Middle posterior	293 (57.23%)	30 (48.39%)
Inferior	8 (1.56%)	0
<b>Method of puncture</b>		
Bull's eye	152 (33.78%)	25 (40.32%)
Oblique	298 (66.22%)	37 (59.68%)
<b>Post operative pain</b>		
VAS on POD 1	6.31 ± 1.17	8.35 ± 0.93
VAS on POD 2	2.78 ± 1.00	3.58 ± 0.97
Post operative hospital stay (days)	3.36 ± 0.67	3.60 ± 0.95
<b>Complication</b>		
Grade 1	42 (9.33%)	11 (17.74%)
Grade 2	51 (11.33%)	14 (22.58%)
Grade 3a	1 (0.22%)	2 (3.23%)
Grade 3b	0	0
Grade 4	0	0
Grade 5	0	0

**Table-2:** Intra operative and post operative finding when the puncture was done in inspiration

	<b>Below 12<sup>th</sup> rib</b>	<b>At 12<sup>th</sup> rib</b>	<b>In 11<sup>th</sup> ICS</b>	<b>At 11<sup>th</sup> rib</b>	<b>In 10<sup>th</sup> ICS</b>	<b>At 10<sup>th</sup> rib</b>
<b>Upper calyx (181)</b>						
On Expiration	00	36	86	48	9	2
On Inspiration	81	58	31	11	0	0
<b>Middle calyx (323)</b>						
On Expiration	00	189	109	25	0	0
On Inspiration	156	117	49	1	0	0
<b>Lower calyx (8)</b>						
On Expiration	0	8	0	0	0	0
On Inspiration	8	0	0	0	0	0

**Table-3:** Respective location of desired calyx on inspiration and expiration

position and also by aspirating the PCS contents. If the above approach was not found feasible for high lying renal stones, then these manoeuvres were used through the 11<sup>th</sup> intercostal space.

## RESULT

512 patients who meet the study criteria were included in this study. Three hundred and forty two (66.80%) patients were males. Two hundred and seventy six (53.9%) patients were operated for right sided stones. Mean age of the patients was 39.55 ± 10.49 years. Mean operative time was 53.85 ± 23.83 minutes (Table 1).

Infracostal puncture was possible on full inspiration in 450 (87.90%) patients while supracostal puncture was needed in 62 (12.10%), as the desired calyx could not be accessed either by bull's eye or by our oblique method (Table 2 and 3).

The mean decent of the kidneys on deep inspiration was 3.40 ± 0.92 cm. The mean crano-caudal mobility in full inspiration was comparable in males (3.37 ± 0.91 cm) and females (3.44 ± 0.95 cm).

Table 4 shows the advantage of puncture done on inspiration by avoiding significant proportion of supracostal punctures had the puncture been done in expiration. Mean pain score on visual analogue scale for the infracostal group on the first and second post operative day was 6.31 ± 1.17 and 2.78 ± 1.00 respectively as compared to 8.35 ± 0.93 and 3.58 ± 0.97 for those needing supracostal puncture (Table 4).

The desired calyx that was approached was middle posterior in 323 cases (60.71%), superior in 181 cases (34.02%) and inferior in eight cases (1.50%) (Table 3). Guy's Stone Scoring system was 1 in 297 cases (58.01%), 2 in 133 cases (25.98%), 3 in 42 cases (8.20%) and 4 in 40 cases (7.81%). One hundred and twenty one (23.63%) patients had complications of which, 94 (77.7%) were in infracostal group and 27 (22.3%) in the supracostal group. Among those who underwent PCNL via subcostal route, majority had grade 1 (n=42, 44.7%) and 2 (n= 51, 54.2%) complication. Only one patient experienced grade 3a complication and needed a DJ stenting for urinary leak >24 h. In the supracostal group, 11 (40.7%) had grade 1 while 14 (51.8%) had grade 2 complications. Two patients (7.4%) in this group had chest complications (grade 3a) out of which, one had pneumothorax which subsided on itself in 5 days while the other had hydrothorax necessitating a chest tube placement. None of the patients had grade 3b, 4 or 5 complications.

Approach	Technique	If puncture was on Expiration	On Inspiration
Subcostal	Bull's eye	00	245 (47.85%)
	Oblique	169 (33.01%)	205 (40.04%)
11 <sup>th</sup> intercostal puncture	Bull's eye	247 (48.24%)	09 (1.76%)
	Oblique	85 (16.6%)	53 (10.35%)
10 <sup>th</sup> intercostal puncture	Bull's eye	5 (0.98%)	00
	Oblique	6 (1.17%)	00

**Table-4:** Punctures if done on expiration as compared to when it was done on inspiration

## DISCUSSION

In the modern era, renal stone surgeries are commonly performed via percutaneous approach. Percutaneous approach can be either supracostal or subcostal, the latter being the traditional approach. Later supracostal approach came into picture to provide direct access to the upper pole.<sup>5</sup> Khaled et al studied the safety and efficacy of supracostal access and advocated this technique for dealing with upper calyceal calculi, PUJ, and proximal ureter calculi.<sup>7</sup> Incidence of bleeding was also less using this approach as it allowed manipulation of the nephroscope along the longitudinal axis without any torque.<sup>7</sup> But, the drawback is the increased risk of pleural and lung injury associated with supracostal puncture.<sup>5,7</sup>

The ascend of both the kidneys on changing position from supine to prone is a well known fact.<sup>10</sup> However, this movement in the cranio-caudal direction was smaller (left kidney 16.9+/-6.7 mm and right kidney 16.1+/-7.9 mm) as compared to pancreas and liver (23.7+/-15.9 mm and 24.4+/-16.4 mm respectively).<sup>11</sup> In another study which was done to assess the respiratory induced mobility of the kidney with its implications for stereotactic kidney radiotherapy, the mean (range) cranio-caudal mobility was 0.98 cm (0.25-3.00 cm) for the left kidney and 0.9 cm (0.25-2.05 cm) for the right kidney.<sup>12</sup> So based on this finding, we chose our approach of percutaneous puncture during inspiration. We found a mean decent of 3.40 ± 0.92 cm of the kidneys, which is more than that seen in above studies as the descent was assessed in deep inspiration. Various methods have been described in the past to displace the kidney for PCNL, using either the puncture needle or the amplatz sheath.<sup>13,14</sup>

In our series, we used a novel approach for accessing the desired calyx without any increased risk of intrathoracic complications. The procedure was performed in deep inspiration, which caused decent of both the kidneys and thereby leading to easy and direct access to the desired calyx. By this technique, majority of punctures were subcostal and hence the chances of intrathoracic complications were minimal. Even though supracostal puncture was done in inflation, the chest related complications were minimal as compared to those done by standard technique.<sup>2,3</sup>

In our series, we did not encounter any case of intrathoracic complication while using the subcostal approach. In patients who needed supracostal puncture, only two developed chest complication (2/512, i.e. 0.40%). Various series have reported different rates of intrathoracic complications using standard PCNL technique.<sup>2,3</sup> The Supra twelfth rib

approach is transthoracic but extrapleural while the supra eleventh rib access is both transthoracic and transpleural.<sup>18</sup> Intrathoracic complications range from 3.1% –12.5% in supracostal approaches in various series (for both 10<sup>th</sup> and 11<sup>th</sup> intercostals approaches) but the incidence of thoracic complications ranged from 0 – 100% when 10<sup>th</sup> intercostal approach was used.<sup>5,15-23</sup>

In our series, by puncturing in inspiration, we were able to avoid 10<sup>th</sup> intercostal punctures completely and about 81% of 11<sup>th</sup> intercostal punctures that otherwise would have been needed if the puncture was done in expiration. Thus the chest related complications were prevented. If one is able to combine puncture in inspiration and oblique technique, then 80 to 90% supracostal punctures can be avoided without any significant rise in thoracic complication. To the best of our knowledge this is the first series to report prone PCNL in inspiration

## CONCLUSION

So, to conclude, our novel technique of subcostal access for PCNL in deep inspiration is both safe and effective, with significantly less post operative morbidity and less pain.

## ABBREVIATIONS

PCNL- Percutaneous Nephrolithotomy, PCS - Pelvicalyceal system

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