



## Outcome of PCNL by Supracostal Approach for Staghorn Stone in Comparison with Infracostal Approach

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### Abstract

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**Introduction:** Percutaneous nephrolithotomy (PCNL) is the treatment of choice for staghorn stones, large renal stones and some upper ureteric stones. The subcostal approach in staghorn stones has the problem of angulation and torque on the kidney but a supracostal approach provides direct access and thereby facilitates better stone clearance. The purpose of this study was to compare stone clearance rate and also to observe the complications between supracostal and infracostal access routes in managing staghorn calculi.

**Materials and Methods:** The present quasi-experimental study was conducted in the Department of Urology, of the three hospitals in Dhaka. A total of 68 subjects (32 in Supracostal group and 36 in Infracostal group) with staghorn stone who were treated by PCNL were the study subjects. Data were collected by interview of the patients, clinical examination and laboratory investigations using the research instrument. Data were processed and analysed using software SPSS version 11.5. The outcome measures were stone clearance, success rate, duration of hospital stay and complications encountered by the patients of either group.

**Results:** The findings of the study showed that there was no significant difference between the groups in terms of age, sex and body mass index. The groups were also similar in terms of side of kidney involved and incidence of multiple stones. As outcome was considered, stone-free and success rate, it was higher in the supracostal group compared to that in the infracostal group, while the rate of complications was higher in the infracostal group than that in the supracostal group. Some patients in both the groups required additional maneuver to augment stone clearance but not statistically significant. The additional maneuvers were extracorporeal shock wave lithotripsy (ESWL), ureteroscopy with intracorporeal lithotripsy and PCNL.

**Keywords:** PCNL,  
Supracostal, Infracostal,  
Staghorn

**Conclusions:** The study concludes that outcome of percutaneous nephrolithotomy for staghorn stone clearance is better in supracostal than infracostal approach and the rate of complications was higher in infracostal approach with higher duration of hospital stay.

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### **Introduction :**

Percutaneous nephrolithotomy (PCNL) is the treatment of choice for staghorn stones, large renal stones and some upper ureteric stones. Initially it was introduced by Fernstrom and Johansson in 1976<sup>1</sup>. Successful removal of stone requires the accurate placement of a percutaneous tract that provides direct access for stone manipulation. A subcostal tract through the posterior middle or the inferior calyx may provide optimal access for stones in the renal pelvis and those in the middle or the inferior calyx. But it has the problem of angulation and torque on the kidney, which may cause trauma and bleeding and difficult to clear the residue in the superior calyx. However, in most staghorn, upper ureteral 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<sup>2</sup>. Optimal access for the staghorn, large upper calyceal and complex renal stone is through the upper pole posterior calyx, which at times is best accomplished by supracostal puncture<sup>3</sup>. However, supracostal puncture is a concern because of its potential pleural complications such as pneumothorax, hydrothorax and lung injury<sup>4</sup>, hydrothorax reported in 6–32% of the procedures<sup>5,6</sup>. Access through the superior calyx provides a straight tract along the long axis of the kidney, which favours easier manipulation of the rigid scopes and forceps. The major complications of supracostal access are related to the potential for injury to the pleura and lung. Therefore, a thorough knowledge of the anatomical relationships of the diaphragm, pleura and lung is important to avoid this risk<sup>7</sup>. All punctures that pass above the 12th rib pierce the diaphragm. Injury to the parietal pleura can be avoided by staying above the lateral half of the 12th rib. The purpose of the this study was to compare stone clearance rate of staghorn calculi by supracostal approaches with those via infracostal access routes. In addition, we observed the complications for supracostal versus infracostal access routes for staghorn stone .

### **Methods:**

Patients with staghorn stone, admitted in Dhaka medical college hospital , Japan Bangladesh Friendship Hospital and Comfort hospital in Dhaka from January 2012 to December 2012 were enrolled in this study. This prospective quasi-experimental study was conducted by random sampling. Sample size was 68. All the patients who were eligible included in the study and were divided into two groups on the basis of personal judgment of the surgeon. Of them 32 were included in

supracostal group and the remaining 36 in infracostal group. Patients with staghorn calculi and stone in high lying kidneys were included in the study. Patients with pelvic kidney, horse-shoe kidney, morbid obesity, stone in caliceal diverticula, bleeding disorder, pyelonephritis were excluded.

Variables studied were the demographic characteristics, access to stone, complications, auxiliary treatment required and surgical outcome (stone free rate, success rate, length of hospital stay) of the patients were also recorded.

Before proceeding to operative procedure, proper and detail counseling was done with the patients regarding the operative procedure, possible complications and management, care of wounds, care of catheter, postoperative follow up and investigations and Informed written consent was taken from the patients for operation, anesthesia and record data for study purpose.

Prior permission was taken for this study from the Ethical Committee . Data were collected by interview of the patients, clinical examination and laboratory investigations using the research instrument and data were processed and analyzed using software SPSS (Statistical Package for Social Sciences) version 11.5. The test statistics used to analyses the data presented in categorical scale was Chi-square ( $\chi^2$ ) test, for comparison of data on continuous scale, unpaired t-test was done. For all analytical tests, the level of significance was set at 0.05 and  $p < 0.05$  was considered significant.

### **Procedural technique:**

All PCNL procedures were performed by urologists in a single stage under general anesthesia in prone position. Percutaneous access was made at the time of surgery by the operating urologist under fluoroscopic guidance. All the supracostal punctures were made during full expiration to prevent parenchymal injury to the lung, and the needle advanced just above the upper border of the 12<sup>th</sup> rib . The architecture of collecting system was delineated by contrast introduce through the ureteral catheter. For infracostal puncture, puncture site was in the posterior axillary line mid way between the 12<sup>th</sup> rib and the ileal crest .

A bull's-eye technique was used to gain access directly into the center of the papilla of the chosen calyx. Once the pelvicalyceal system was entered a standard 26 French nephroscope was then introduced through the Amplatz sheath and the stone was fragmented with the pneumatic lithotripter and removed by tri and bi radiate forceps. After complete clearance it was confirmed fluoroscopically and endoscopically, a 6 Fr

DJ stent was placed in antegradely. In patients with a supracostal access tract, the integrity of the costophrenic angle was confirmed by chest fluoroscopy. At the end of procedure, a 24 French chest tube was placed as nephrostomy tube. The nephrostomy tube was removed after 24 hours in all patients. The urethral Foley catheter was removed in all patients after 12–24 h, once the urine cleared. All patients had a chest X-ray in supine posture soon after surgery to exclude pneumothorax or fluid collection. Stone clearance was assessed with a plain abdominal X-ray at 1 or 2 days follow-up. Complete clearance was considered as no radiological evidence of residual stone. The procedure was considered successful if the patient was either free of stones or had no obstruction with residual fragments of < 2 mm in the largest dimension on renal ultrasonography and radiography. Patients with larger residual fragments were treated with ESWL before stent removal. After 6 weeks the stent was removed cystoscopically under local anesthesia after doing a plain X-ray KUB.

#### Results :

A total 68 patient ( 32 in supracostal group and 36 in infracostal group ) were the study subject. Among them 47% of the patients in supracostal and 55.6% of the patients in infracostal group were more than 40 years old with a male predominance in either group. There was no significance difference between the groups in terms of age and sex ( $p = 0.673$  and  $p = 0.534$ ). One-quarter (25%) of the patients in supracostal group was overweight and obese compared to 27.8% in infracostal group ( $p = 0.635$ ) (Fig. 5-1).

About two-thirds (59.4%) of patients in supracostal group had stone in the right kidney and 40.6% in left

kidney which in the infracostal group were 63.9% and 36.1% respectively ( $p = 0.702$ ). Patients with multiple stone were considerably more in infracostal group than that in supracostal group (21.9% vs. 25.0%,  $p = 0.987$ ).

In majority (31 out of 32) cases of supracostal group, the location of primary access was upper pole, while in 23 of the 36 cases of infracostal group the location of primary access was lower pole (Table I). The stone free rate was significantly higher in the supracostal group than that in the infracostal group (81.3% vs. 61.1%,  $p = 0.049$ ). The success rate was also considerably higher in the supracostal group than that in the infracostal group (90.6% vs. 75%,  $p = 0.092$ ). The mean length of hospital stay was higher in infracostal group than that in supracostal group ( $5.1 \pm 1.3$  vs.  $4.3 \pm 1.3$  days,  $p = 0.175$ ) (Table II). Tract bleeding, and fever was significantly higher in the infracostal group than that in the supracostal group. Transfusion needed was also considerably higher in the infracostal group than that in the supracostal group. While atelectasis, haemothorax, hydrothorax, UTI were solely found in supracostal group and pelvic perforation, perinephric collection and septic shock found in infracostal group (Table III). During this study period total 7 patients needed extracorporeal shock wave lithotripsy (ESWL), among them two (6.3%) patients in supracostal group and 5 (13.9%) in the infracostal group required (ESWL) ( $p = 0.266$ ). Similarly 1 (3.1%) and 3 (8.3%) patients in the supra and infracostal groups required URS & ICPL ( $p = 0.353$ ). Only 1 (2.1%) patient in the infracostal needed PCNL as opposed to none in the supracostal group ( $p = 0.529$ ) (Table IV).

**Table I.** Comparison of access to stone between two groups

Access to stone	Group					
	Supracostal			Infracostal		
	UP	MP	LP	UP	MP	LP
Location of primary access	31	01	00	00	13	23
Location of secondary access	00	3	00	00	05	04

**Table II.** Comparison of surgical outcome between two groups

Surgical outcome	Group		p-value
	Supracostal(n = 32)	Infracostal(n = 36)	
Stone free rate*	26 (81.3)	22 (61.1)	0.049
Success rate*	29 (90.6)	27 (75.0)	0.092
Length of stay#	$4.3 \pm 1.3$	$5.1 \pm 1.3$	0.175

\*  $\chi^2$  Test was employed to analyse the data # Data were analysed using Student's t-test and presented as mean  $\pm$  SD

**Table III:** Comparison of complications between two groups

Complications	Group		p-value
	Supracostal (n = 32)	Infracostal (n = 36)	
Atelectasis	1 (3.1)	00	0.471
Tract bleeding	2 (6.3)	10 (27.8)	0.020
Transfusion needed	6 (18.8)	14 (38.9)	0.069
Haemothorax	1 (3.1)	00	0.471
Hydrothorax	2 (6.3)	00	0.218
Fever	4 (12.5)	13 (36.1)	0.025
UTI	1 (3.1)	00	0.471
Pelvic perforation	00	1 (2.8)	0.342
Perinephric collection	00	5 (13.9)	0.036
Septic shock	00	1(2.8)	0.342

**t- test** was employed to analyses the data

Figures in the parentheses denote corresponding percentage.

**Table IV :** Comparison of auxiliary treatment required between two groups

Auxiliary treatment required	Group		p-value
	Supracostal (n = 32)	Infracostal (n = 36)	
ESWL	2 (6.3)	5 (13.9)	0.266
URS and ICPL	1 (3.1)	3 (8.3)	0.353
PCNL	00	1 (2.8)	0.529

\* **t- test** was employed to analyse the data

### Discussion :

Growing experience with percutaneous renal surgery since its introduction in the late 1970s has resulted in significant evolution of this technique. The idea is to utilize the percutaneous approach in an effective as well as safe manner with acceptable morbidity in various situations. Various approaches for access to the upper pole caliceal system have been tested. Of them supracostal superior calyceal access has been shown to be the most suitable approach for staghorn calculi, calculi in the upper ureter, and complex inferior calyceal calculi. It is a good choice for direct access for most of the intrarenal collecting system and upper ureter<sup>8</sup>.

An upper pole access provides a straight tract along the long axis of the kidney<sup>9</sup>, with excellent exposure of the superior calyceal, renal pelvic, upper ureteral and lower pole calyceal contents<sup>10</sup>. However, the objective of the present study was to make a comparative evaluation of stone clearance rate also the safety and

efficacy of supra- and infra-costal approaches for percutaneous nephrolithotomy for staghorn calculi .

The present study showed that there was no significant difference between the groups in terms of age, sex and body mass index. The group were also similar in terms of side of kidney involved. However, in terms of location of primary access, majority (96.8%) of supracostal group had primary access in the upper pole, while 63.9% of the infracostal group had primary access in the lower pole.

As outcome was considered, stone-free rate that is no radiological evidence of residual stone and success rate that is if the patient was either free of stones or had no obstruction with residual fragments of < 2 mm in the largest dimension on renal ultrasonography and/or radiography was higher in the supracostal group compared to those in the infracostal group (81.3 vs. 61.1% and 90.6% vs. 75% respectively). Considering p-value stone free rate was statistically significant while

the p-value for success rate was p-0.092. The rates of complications were higher in the latter group than those in former group. The average length of hospital stay was on an average 1 day more in infracostal group than that in supracostal group, although the difference was not statistically significant. Some patients in both the groups required additional maneuver to augment stone clearance but not statistically significant. The additional maneuvers were extracorporeal shock wave lithotripsy (ESWL), ureteroscopy and PCNL.

In this study all procedures were performed in a single sitting under general anesthesia. Regarding complications there were atelectasis, haemothorax, hydrothorax, UTI, pelvic perforation, perinephric collection, septic shock, tract bleeding, fever and blood transfusion. Access via supracostal route resulting in one patient developed atelectasis (3.1%) on the ipsilateral side, likely related to irritation of the diaphragm which was managed conservatively with follow up x-ray. One patient developed haemothorax (3.1%), secondary to injury of the intercostal artery and made an uneventful recovery after blood transfusion and insertion of a chest drain tube. Hydrothorax (6.3%) developed in two patients which was minimum and required no intervention. In infracostal group pelvic perforation was noted in one patient (2.8%) during surgery but the procedure was continued as there was no bleeding. The patient with perinephric collection five (13.9%) was treated by conservative measure. Patient with sepsis after surgery one (2.8%) developed septicemic shock, recovered well with intravenous antibiotics and supportive measure. All but those who had complications, recovered uneventfully. Postoperative hospital stay was 3 - 5 days.

Similar findings were reported in a study by Hossain in which 122 patients underwent PCNL<sup>11</sup>. Of them 28(23%) had supracostal access. The outcome measures were stone clearance rates and complications. The indications for a supracostal access were staghorn stones (50%), pelvic stones (28.5%), calyceal stones in high-lying kidney (18%) and upper ureter/ureteric stones (3.5%). More than 80% of the patients were rendered stone-free or had clinically insignificant residual stones with PCNL monotherapy, and this increased to 96% with secondary procedures. In patients with staghorn stones, were completely cleared off in 78% patients. Overall complication rate was 28% and included hydrothorax, haemothorax, pelvic perforation, perinephric collection, infection/sepsis.. Postoperative hospital stay was 2 - 9 days.

Access through upper pole allows certain advantages. Entry through the superior posterior calyx allows movements of the rigid nephroscope along the normal axis of the kidney with minimal torque and hence lesser bleeding. While making a superior calyceal tract, care should be taken to puncture through the center of the calyceal papilla and direct puncture into the pelvis and near the infundibular neck must be avoided. Sampaio showed that injury to an interlobar vessel was seen in 67% of kidneys on puncturing the upper-pole infundibulum<sup>12</sup>, while only 13% of kidneys had an arterial injury when puncture was made through the lower-pole infundibulum. Although success rates after PCNL range from 75 - 95%, periprocedural and intraoperative complication rates of up to 83% have been described<sup>13</sup> Major complications are relatively rare and include, but are not limited to, septicemia (0.3%-4.7%)<sup>14</sup>, colonic, spleen, liver (0.2-0.8%)<sup>15</sup> or pleural injuries (0-3.1%)<sup>16</sup>, minor complications are relatively common and include urinary extravasation (7.2%)<sup>17</sup>, transfusions (0.8-17.5%)<sup>18</sup> and fever (21.0-32.1%)<sup>19</sup>.

With the increased interest in the urologic literature on harms and complications, coupled with the inherent biases associated with gross categorization of complications as major or minor, urologists have been turning toward the Clavien classification system to define their procedure-related complications<sup>20</sup>. More recently, Honey and associates in a randomized controlled trials demonstrated the effectiveness of managing larger stone with PCNL<sup>21</sup>, the procedure has become the treatment of choice for large, complex stones and for patients with upper tract anatomic anomalies. Over the past three decades, many refinements in both the techniques and patients positioning have improved the outcomes while decreasing the incidence of adverse events related to PCNL.

Upper calyceal access during percutaneous nephrolithotomy can be the preferred approach for complex stones in the upper pole, renal pelvis or proximal ureter due to its favorable anatomic positioning with regard to the collecting system. Traditionally, a supracostal approach is not advocated due to a higher incidence of intrathoracic complications. However, keeping the anatomy of the upper pole, collecting system and a few technical considerations in mind, upper calyceal access can be performed safely and efficiently<sup>8</sup>. Lojanapiwat & Prasopsuk also held the view that the advantage of upper-pole access for nephrolithotomy is direct access to most of the intrarenal collecting system and upper ureter<sup>22</sup>.

### Limitations:

Like any other scientific study, the present study was not without limitations. The following limitations deserve mention: 1.The sample size was small, 2.Operations were performed by different surgeons and 3.Follow up period was short.

### Conclusion:

The current study demonstrates that percutaneous nephrolithotomy for staghorn stone using supracostal approach is better than infracostal approaches in terms of stone clearance and complications. The stone clearance rate was higher in supracostal approach than that in the infracostal approach, while the complications were higher in the later group than that in the former group. Despite the advantages of supracostal approach, it should be borne in mind that the procedure may cause intrathoracic injury leading to fatal consequence. However, understanding the anatomy of the upper pole and its collecting system and performing the procedure with technically competent urologists, upper calyceal access for staghorn stone clearance using supracostal approach can be safe with high success rate.

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