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Efficacy and safety of the supracostal percutaneous nephrolithotomy and the need of postoperative chest X-RAY after supracostal access: Retrospective single center experience

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Abstract
The aim of this study was to evaluate the safety and efficacy of the supracostal access for percutaneous nephrolithotomy (PCNL) and need for postoperative chest X-ray. Between July 2017 to June 2019, 450 patients underwent PCNL, of whom 157 (35%) had supracostal access. All procedures were performed in a single sitting under general anesthesia. The data were analysed for indications, stone clearance rates and the complications associated with supracostal puncture. The indications for a supracostal access were staghorn stones (50%), pelvis stones (10%), calyceal stones in high-lying kidney (16%) and upper ureter/ureteric stones (16%). All tracts were made in the 11th intercostal space. Single tract access was used in 124 cases (79%), but 33 (21%) required a second tract. Additional punctures were required mainly for staghorn stones. Overall, 96.34% of the patients were rendered stone free or had clinically insignificant residual stones with PCNL monotherapy. Significant bleeding requiring blood transfusion occurred in 8 (5.26%) patients. 10 patients developed chest pain and 1.2% developed hydrothorax which were managed conservatively. Except those patients who had complication, all other patient recovered uneventfully. Postoperative hospital stay ranged from 2 to 9 days. In conclusion, supracostal access gives high clearance rate with acceptable complications and should not be avoided for fear of chest complications. Also no routine follow up chest X ray is required.

Keywords: Supracostal, PCNL, Staghorn

1. Introduction
Since its introduction in 1976, PCNL has become the treatment of choice for large renal pelvic and caliceal calculi, staghorn calculi and some upper ureteric stones [1]. PCNL starts with the achievement of the optimal access of the renal PCS through the desired calyx. Generally, a subcostal approach is preferred to avoid potential damage to the lung, pleura and other visceral organs. This route many a times fails to provide optimal PCS access for staghorn, large upper caliceal stone with narrow infundibulum and complex renal stones and impacted upper ureteric calculi and high lying kidney. In these complex situations, supracostal (particularly upper polar) route provides the most direct access, greater visibility and less trauma to the pelvicaliceal system (PCS) [2,3].
Supracostal route is often under used because of the concerns about safety and intrathoracic complications like pneumothorax, hydrothorax and lung injury; hydrothorax being reported in 6-32% of the procedures [4,5] . Usually the upper pole of the kidney is more posterior and medial, so it provides direct access to the long axis of the kidney and thus thereby facilitating access to lower pole and upper ureter. We present our experience with safety and efficacy of supracostal route for PCNL of staghorn and complex renal calculi and upper ureteric calculi and the need of the routine postoperative chest X – ray for the detection of intrathoracic complications.

2. Material and Methods
450 PCNLs were done between July 2016 and June 2019 and 157 patients had supracostal access, comprising 35% of the procedures. Routine pre-operative investigations were done. Radiologic evaluation routinely included an non contrast CT scan; ultrasonogram and split renal function measurement by DTPA were performed wherever indicated. Preoperative antibiotics were administered according to urine C/S. Ureteric catheter was placed and under C –arm fluoroscopic guidance, air/contrast pyelogram was made. Appropriate calyx was selected and punctured with angular puncture technique and 'J' tip guide wire was placed in PCS or down into the ureter whenever possible. The puncture was made in the lateral half of 11th intercostal space (ISC) to avoid pleural/lung injury and immediately above the upper border of the 12th rib to avoid intercostal vessels injury as depicted in Fig 1. Tract was dilated by Alken telescopic metal dilators, (24-30 Fr) and Amplatz sheath placed. Stone was fragmented with Pneumatic Lithoclast and removed. 20 Fr nephrostomy tube &/or DJ stent was placed at the end of procedure if required. Chest auscultation, SPO2 monitoring done in the recovery room. CXR was done postoperatively on POD 1. On post-operative day 1 X-ray KUB was done to assess complete clearance. On suspicion of chest complication, a thoracic surgeon was consulted, and intercostal chest tube drainage was done if indicated. Complete clearance was considered as no radiological evidence of residual stone disease. Asymptomatic residual, nonobstructing, nonstruvite stone fragments less than 5 mm in diameter were considered clinically insignificant residual fragments. Significant residual calculi were managed by ESWL. The data were analysed for the indications for supracostal access sites, clearance rates and postoperative complications.

3. Results

157 patients in the age group of 23-55 years (mean 39 years) underwent supracostal PCNL through 11th ICS during study period. 113 (72%) were males and 44 (28%) were females. Location of stones were as follows

- Staghorn calculus – 80 (50%)
- Renal pelvic stone – 16 (10%)
- Upper ureteric calculus- 25 (16%)
- Pelvic + caliceal stones – 22 (15%)
- Upper ureteric + caliceal stones – 12 (08%)
- Upper caliceal / diverticular stones – 02 (01%)

Single tract access was sufficient in 124 (79%) cases while 33 (21%) needed an additional access tract. Complete clearance was achieved in 152 (96.34%) patients with PCNL monotherapy. In 70.6% superior calyceal puncture was chosen while middle calyceal and lower calyceal puncture was done in 23 % and 6.35% respectively (Table 1). Our analysis revealed better stone clearance rate by PCNL alone with those noted by Kekre *et al*. (79.5%) [6] and Golijanin *et al*. (87%) [7]. 5 patients required ECSWL due to clinically significant residual calculus. Of staghorns (50%), 77 (96.72%) patients were completely cleared. Three staghorn patients underwent second look because of bleeding and completely cleared off stones. Significant bleeding requiring blood transfusion occurred in 8 (5.26%) patients. 10 patients complained chest pain and difficulty in breathing postoperatively. 2 of these 10 (1.2% of total patients) developed hydrothorax detectable on CXR and all were managed conservatively without any need of ICD (fig 2). Also, no visceral injury was encountered in our series. One patient developed perforation of pelvic which was managed by prolonged nephrostomy tube upto 7 days.

4. Discussion

The success of PCNL depends directly on obtaining optimal access to the PCS. Supracostal (above 12th rib) route is the best access for at least 4 subsets of the patients:

1) staghorn calculi

2) impacted upper ureteric stones that can't be flushed or pushed back up into the kidney.

3) large upper - pole caliceal calculi with narrow infundibulum and upper polar caliceal diverticular stones.

4) high lying kidney.

Supracostal upper polar access provides straight and nearly parallel tract to the long axis of kidney with resultant superb visualization of all calices, pelvis and upper ureter, great maneuverability and significantly decreased torque, angulation and trauma and bleeding. A straight tract also favoues easier manipulations of rigid nephroscope and forceps, thus minimizes the excess bleeding [8]. With supracostal upper polar access one is directly above the stone making the procedure very easy. With upper pole calyx one can access all the calices but with middle posterior calyx it is very difficult to approach middle anterior and lower posterior calices (fig 3). For safe supracostal puncture, anatomical relations of kidney to pleura and lung are very important. Diaphragm is attached to inferior border of L1 vertebra and the anterior surfaces of upper lumbar vertebral bodies. The lateral half of 12th rib is inferolateral to the pleural limit because parietal pleura reflects to the 10th rib level in the mid-axillary line and crosses, usually, the 12th rib obliquely at its midpoint. Visceral pleura never descends to the level of the midpoint of the 12th rib except with forced ventilation (fig.4). Cephalad renal movement occurs in upto 80% patients when moved from supine to prone position [9]. Supracostal access is often is the best one in these cases. We have achieved the complete clearance rate of 96.34% which is comparable to previous series (Table 2). One of the most important complications of supracostal puncture is hydrothorax which has been attributed due to accidental entry into the pleura and failure to seal the tract with the sheath or inadequate drainage of kidney afterward [10]. Overall, the occurrence of hydrothorax (1.2%) in our analysis is comparable to previous series (Table 3) and also the recovery was uneventful by conservative measures. It has long been recommended by many authors that postoperative CXR after supracostal puncture is necessary to rule out intrathoracic complications. In the present series we experienced that postop CXR can be safely avoided if there are no signs intraoperatively (difficulty in ventilation or breathing, fall in SPO2, decreased air entry) and patient is asymptomatic postoperatively as all of our patients who developed hydrothorax were symptomatic**.** Additional studies, by Picus *et al*., Kekre *et al*., Ogan *et al* and Bjurlin MA *et al* are in favor of our finding (Table 3). Other complications like lung injury has not been reported in any of the series like ours. Injury to other visceral organs like liver and spleen may occur with more cephalad puncture and thus we avoided puncture above 11th rib.

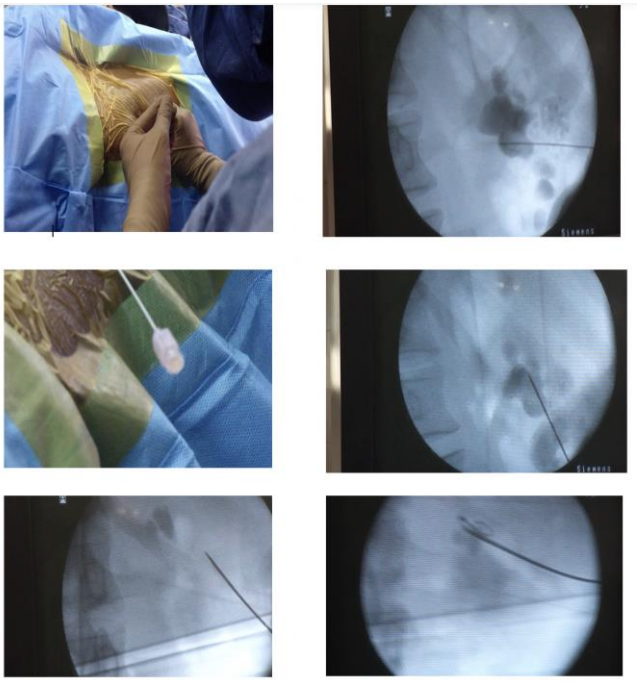

Fig 1: figure showing various stages of supracostal puncture.

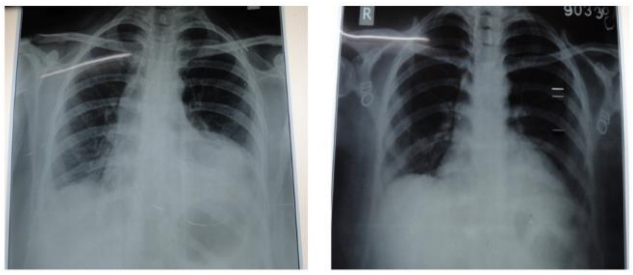

Fig 2: Chest X-ray showing hydrothorax which after conservative management shows clear lung fields.

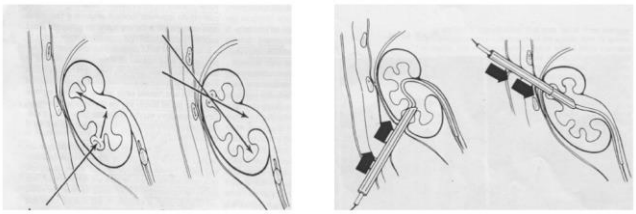

Fig 3: Superior calyceal puncture make access and manuverability through pelvis and calyx easy and torque free.

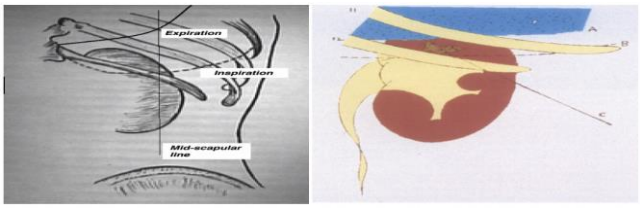

Fig 4: movement of pleura during forced ventilation

Table 1: Calyceal site of puncture for Supracoastal punctures

Site of puncture	Number (%)
Superior calyx	110 (70.6%)
Middle calyx	36 (23.02%)
Lower calyx	11 (6.35%)

Table 2: Comparison of clearance rate, ECSWL and transfusion rate from various authors.

Investigators	Overall clearance %	ECSWL %	Staghorn clearance %	Transfusion rate %
Shah *et al*, 2006	96.5	3.4	NR	5
Lang *et al* 2009	88.35	NR	83	4
Gupta *et al*, 2002	95.78	3.8	84	9.6
Golijamin *et al*, 1998	67.8	30.4	NR	19.2
Shaban *et al*, 2008	88.9	11.11	72.72	3.3
Bahar *et al*, 2011	89.4	10.6	77.42	6.5
Netto *et al*, 2005	96.75	3.25	NR	12.5
Lojanapiwat *et al*, 2006	92.9	3.5	NR	2.4
Sukumar *et al*, 2008	89.09	10	NR	1.8
Raza *et al*, 2007	83	12	87	6.06
Hossain *et al*, 2011	82.14	14.3	78	NR
Present study	96.34	0.03	96.72	5.26

Table 3: Camparison of complications rate from different author series

Investigators	Patients (n)	HTX-PTX rate (%)	Thoracostomy rate (%)	Routine post-op CXR
Bjurlin *et al*,2012	46	4.3	4.3	Yes
Lang *et al*, 2009	103	1.0	NR	NR
Ogan *et al*,2003	60	NR	11.7	Yes
Munver *et al*, 2001	98	7.1	7.1	NR
Yadav *et al*, 2006	332	3.3	2.1	Yes
Gupta *et al*, 2002	63	5.0	5.0	Yes
Kekre *et al*,2001	102	9.8	9.8	No
Golijanin *et al*, 1998	115	4.3	4.3	NR
Forsyth *et al*, 1987	69	Nil	Nil	NR
Picus *et al*,1986	50	12	8	Yes
Lojanapiwat *et al*,2006	170	15.3	5.3	Yes

Sukumar *et al*, 2008	110	9.1	4.5	Yes
Netto *et al*, 2005	16	6.25	NO	Yes
Shaban *et al*,2008	24	Nil	Nil	Yes
Muzrakchi *et al* 2004	56	Nil	Nil	Yes
Shah *et al*, 2006	144	3.5	3.5	Yes
Stening *et al*, 1998	21	Nil	Nil	Yes
Hossain *et al*, 2011	28	13.5	13.5	Yes
Present study	157	1.2	Nil	Yes

5. Conclusion

Our results show that supracostal access provides safe and effective approach with acceptable morbidity in the hands of expert urologists. It provides optimal access to the PCS with excellent clearance rate and is ideally suited for staghorn, upper ureteric and large upper caliceal calculi.

For safe supracostal puncture

- Puncture in lateral half of the ICS.
- Puncture of skin and diaphragm in full expiration and entry into renal parenchyma in deep inspiration.
- Dilate the tract to minimum size needed.
- Use of Amplatz sheath to minimize the fluid extravasation and maintain low pressure irrigation system.
- High index of clinical suspicion for intrathoracic complications.
- Routine postoperative CXR is not necessary and should be done only if intraoperative signs or postoperative symptoms strongly indicate towards intrathoracic complication(s).

6. Conflict of interests

Author declares no conflicts of interest

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