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Supracostal Puncture versus Subcostal Puncture in Percutaneous Nephrolithotomy

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ABSTRACT

Background: In order to reach the posterior upper-pole calyx of the kidney, which is the farthest back part of the kidney, a supracostal puncture is recommended for staghorn calculus management.

Objective: To compare safety, operative time and efficacy of supracostal puncture versus subcostal puncture in percutaneous nephrolithotomy (PCNL).

Patients and methods: Urology clinics at Zagazig University were the site for this prospective randomized comparison research. Fifty patients with an indication for percutaneous nephrolithotomy were enlisted and randomly assigned to one of two groups; in Group A, PCNL was performed through supracostal puncture. Patients in Group B had subcostal puncture for PCNL.

Results: Hospital stay was 1.84±0.64 and 1.44±0.48 in supracostal and subcostal groups respectively without significant difference between groups. In supracostal puncture 36.0% had complication as (2 cases 8.0% had hydrothorax , 4 cases 16.0% parenchymal bleeding two of them need transfusion and 2 cases 8.0% had transient fever) and 1 case 4.0% had transient increase in serum creatinine regard subcostal puncture 28.0% had complication as (3 cases 12.0% had parenchymal bleeding just one of them needed transfusion) 3 cases 12.0% had transient fever) and 1 case 4.0% had transient increase in serum creatinine with no significant difference between groups. Supra group was 72 % stone free while subgroup was 64%.

Conclusion: When treating staghorn renal calculi, the success rate was marginally higher in the supracostal puncture group compared to the subcostal puncture group with nearly similar complication rates in both groups.

Keywords: Supracostal Puncture, Subcostal Puncture, Percutaneous Nephrolithotomy.

INTRODUCTION

Management of staghorn and large renal stones is problematic as it is hard to eradicate the stone in single minimal invasive procedure because of the distribution of the stones in the pelvicalyceal system and if residual remains the risk of stone regrowth will be very high with subsequent affection of renal function hence, it is crucial to get rid of the stone entirely **[(1)]**.

An expert committee from the American Urological Association issued guidelines for the treatment of nephrolithiasis. For big and staghorn kidney stones, percutaneous nephrolithotomy is the therapy of choice **[(2)]**. Overall stone burden, stone location and distribution, and collecting system anatomy all influence the treatment plan for renal stones. The key to a smooth removal is the precise insertion of a percutaneous tract that allows for easy stone manipulation **[(3)]**.

Shock-wave lithotripsy as a monotherapy is difficult way to reach the stone free rate in staghorn and large renal stone (54%) **[(4)]**.

When performing percutaneous nephrolithotomy, gaining access to the upper caliceal infundibulum through a subcostal puncture can be challenging, and the resulting angulation and torquing of the kidney during nephroscopy and stone fragmentation can induce trauma, hemorrhage, and stone fragmentation **[(5)]**.

Since it is positioned more conveniently and closer to the body's midline, the upper pole of the kidney is more commonly accessed than the lower pole. By creating a straight path along the kidney's long axis, the upper-pole method guarantees access to the majority of the collecting system and makes it simpler to manipulate the rigid nephroscope and other rigid devices **[(6)]**. Therefore, supracostal puncture is perhaps the greatest method for gaining access to the upper pole posterior calyx, where staghorn and big, complicated renal stones are most likely to be located **[(7)]**.

Although pneumothorax, hydrothorax, and lung damage (1-10%) can result after a supracostal puncture, this injury can now be handled with minimal morbidity thanks to advances in surgical technique and understanding of pleural and diaphragmatic architecture **[(8)]**.

This study objective was to compare, safety, efficacy, as well as operative time of supracostal puncture versus subcostal puncture in percutaneous nephrolithotomy (PCNL).

PATIENTS AND METHODS

Urology clinics at Zagazig University were the site for this prospective randomized comparison research, from April 2014 to December 2017. Fifty patients (men, women) with an indication for percutaneous nephrolithotomy from patients attending our Urology Outpatient Clinic were included and randomly assigned to one of two research groups.

Patients were randomly assigned to one of two therapy groups: **Group A** included 25 patients, PCNL was done by supracostal puncture, and **Group B** included 25 patients, PCNL was done by subcostal puncture.

Inclusion criteria: Patients fit for surgery and has

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staghorn stone (renal pelvis stone with at least extension to one calyx).

Exclusion criteria: Patients with only lower calyceal stones, congenital renal anomalies, patients with abnormal coagulation profile, extremely obese patients, and active pulmonary or pleural illness patients.

All patients were subjected to complete urological evaluation with special emphasis on:

- A full history especially history of stone disease.
- General, abdominal and genital examination.
- Laboratory investigations included complete blood picture (CBC), urine analysis and culture, bleeding profile, liver function tests (LFT), random blood sugar, and kidney function tests (KFT).
- Radiological study includes: plain film on kidney, ureter and bladder (KUB), renal ultrasound, intravenous urography (IVU) or non-contrast spiral computed tomography (NCCT) **(Figure 1)**.

Figure (1): NCCT showing left staghorn stone

Operative technique:
Preoperative broad-spectrum antibiotics were administered two hours preoperatively.

Anesthesia: For both groups, general anesthesia was performed.

Positioning: For both groups fixation of ureteric stent in the lithotomy position to delineate the pelvicalyceal system, after that the prone posture was used for all patients, and pressure points were assessed and cushioned. Supportive pillows under the chest and the symphysis allowed for maximum airflow.

Puncture:
In Group A: Supracostal puncture was always performed in the region between the 11th and 12th ribs. The incision made just above the medial edge of the 12th rib, right above the scapular crease **(Figure 2)**. As the needle moved forward, it did so in the centre of the intercostal space, away from the intercostal nerve and the intercostal arteries. Puncturing the skin and subcutaneous tissue during complete expiration prevents damage to the lung or pleura, whereas puncturing the renal parenchyma during deep inspiration fully displaces the kidney downwards, facilitating access to the upper pole posterior calyx **(Figure 3)**.

Figure (2): Site of supracostal puncture.

Figure (3): Needle puncture and advancement through intercostal space between the 11th and 12th ribs

In group B: The posterior axillary line, roughly halfway between the 12th rib and the iliac crest, is where all subcostal punctures are made (approximately 1 cm inferior and medial to tip of last rib).

Technical aspect (in both groups):
Using a ureteral catheter, the pelvicalyceal system was opacified and dilated under fluoroscopic supervision, allowing for renal access **(Figure 4).** After puncture was done advancement of guide wire into pelvicalyceal system for tract dilation was performed **(Figure 5).** To do this, Alken-style coaxial dilators were inserted into the nasal passages. A 30F Amplatz sheath was placed after gradual telescopic dilatation, and a 26F nephroscope was inserted through it (**Figure 6).** Irrigation with a solution of 1.5% glycine was performed at a height of 40–50 cm above the operation table. Various types of forceps and graspers were used to extract the stones. We used a pneumatic intracorporeal lithotriptor to break up the larger stones, and then a grasper was used to recover the pieces. At the conclusion of the surgery, a nephrostomy catheter was placed using fluoroscopy for guidance. A silk suture was used to close the nephrostomy as in **Figure 7**, and a dressing was placed on the wound. Ureteral catheter was replaced by JJ stent.

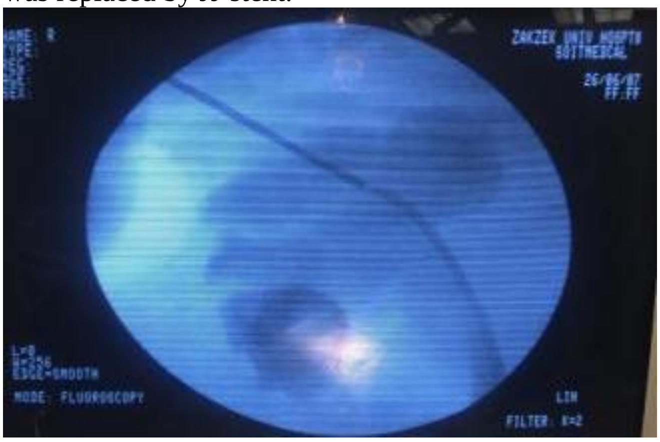

Figure (4): The ureteral catheter is used to obfuscate and dilate the pelvicalyceal system

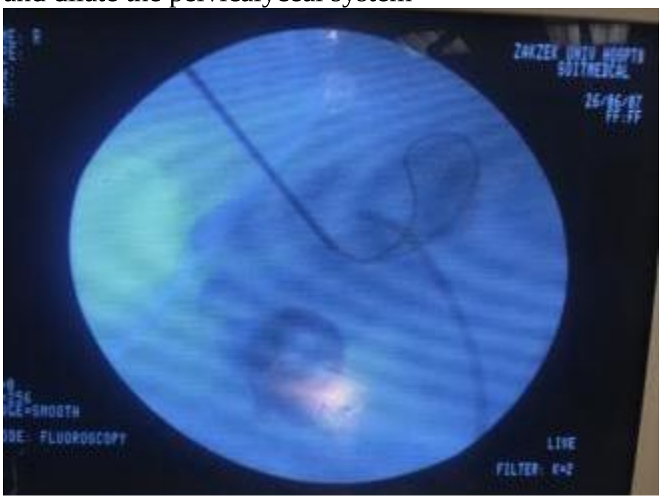

Figure (5): Advancement of guide wire into pelvicalyceal system

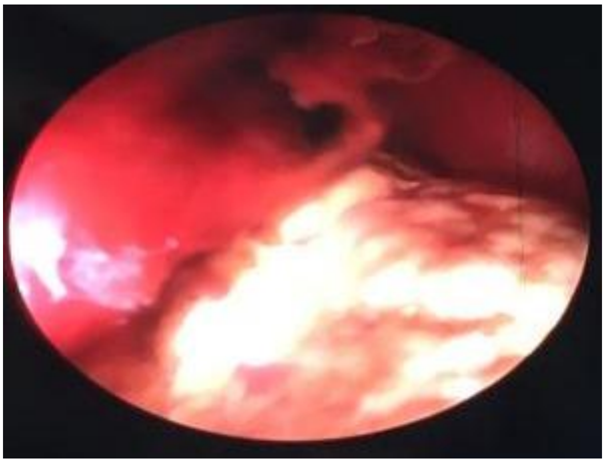

Figure (6): Introduction of a 26 F nephroscope.

Figure (7): A nephrostomy catheter.

Postoperatively: CBC, chest X-ray, KUB, spiral CT, pelviabdominal ultrasound, were done to all patients.

Follow up: Done at 1 week, 2 weeks and 1 month with assessment of complications, post ESWL imaging, renal functions assessment.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

In order to analyze the data acquired, Statistical Package for the Social Sciences version 20 was used to execute it on a computer (SPSS). The quantitative data were presented in the form of the mean and standard deviation. The qualitative data were presented as frequency and percentage. The student's t test (T) was used to assess the data while dealing with quantitative independent variables. Pearson Chi-square test was used to assess qualitatively independent data. The significance of a P value of 0.05 or less was determined.

RESULTS

No significant difference between the 2 groups was found regarding either gender or age (Table 1).

Table (1): Demographics of studied groups

			Supra Group	Sub-group	t/ X^2	P
Age			50.36 ±9.78	47.52± 8.57	1.091	0.281
Sex	Female	N	9	8		
		%	36.0%	32.0%		
	Male	N	16	17	0.09	0.76
		%	64.0%	68.0%		
Total		N	25	25		
		%	100.0%	100.0%		

Data are presented as mean±standard deviation or as frequency and percentage.

There was no significant difference as regard stone burden between both groups (Table 2).

Table (2): Comparison of stone burden between studied groups

			Group		X^2	P
			Supra Group	Sub-group		
Stone burden	Complete stag	N	10	11		
		%	40.0%	44.0%		
	Partial stag	N	15	14	0.08	0.77
		%	60.0%	56.0%		
Total		N	25	25		
		%	100.0%	100.0%		

There was no significant difference as regard laterality (Table 3).

Table (3): Laterality distribution between studied groups

			Group		X^2	P
			Supra Group	Sub-group		
Laterality	LT	N	12	15		
		%	48.0%	60.0%		
	RT	N	13	10	0.72	0.39
		%	52.0%	40.0%		
Total		N	25	25		
		%	100.0%	100.0%		

No significant difference among groups was found regarding operation time. As regard to hospital stay, no significant difference among groups was found (Table 4).

Table (4): Comparison of operation duration and hospital stay between studied groups

	Supra Group	Subgroup	t	P
Operation time in minutes	106.20±22.40	103.16±20.56	0.500	0.619
Hospital stay in days	1.84±0.34	1.44±0.31	1.559	0.126

Data are presented as mean±standard deviation

The percentage of successful individuals was almost the same across the two groups, at around 65% (Table 5).

Table (5): Comparison of stone free among groups

			Group		X^2	P
			Supra Group	Subgroup		
Stone free	No	N	7	9	0.37	0.54
		%	28.0%	36.0%		
	Yes	N	18	16		
		%	72.0%	64.0%		
Total		N	25	25		
		%	100.0%	100.0%		

Regarding ancillary procedures, no significant difference among groups was found (Table 6).

Table (6): Comparison of ancillary procedure distribution between studied groups

			Group		X^2	P
			Supra Group	Subgroup		
Ancillary procedure	No	N	18	16	3.31	0.65
		%	72.0%	64.0%		
	2 look PNL	N	2	4		
		%	8.0%	16.0%		
	2 look PNL then ESWL	N	1	0		
		%	4.0%	0.0%		
	ESWL	N	4	5		
		%	16.0%	20.0%		
Total		N	25	25		
		%	100.0%	100.0%		

Regarding complications, no significant difference was found between groups (Table 7).

Table (7): Comparison of complications among groups

			Group		X^2	P
			Supra Group	Subgroup		
Complications	No	N	16	18	2.65	0.75
		%	64.0%	72.0%		
	Hydrothorax	N	2	0		
		%	8.0%	0.0%		
	Parenchymal bleeding	N	2	2		
		%	8.0%	8.0%		
	Parenchymal bleeding needed blood transfusion	N	2	1		
		%	8.0%	4.0%		
	Transient fever	N	2	3		
		%	8.0%	12.0%		
	Transient increase in serum creatinine	N	1	1		
		%	4.0%	4.0%		
Total		N	25	25		
		%	100.0%	100.0%		

DISCUSSION

Diverse adjustments to the conventional PCNL method have been made to ensure sufficient stone removal. Supracostal and multitract approaches were first described by **Desai *et al.*** [9]**.**

Subcostal puncture allows access to the targeted calyx in the vast majority of individuals. However, a supracostal technique targeting direct access to the stone and thorough removal may be necessary when dealing with patients who have staghorn stones [9]**.** Our research aimed to compare the effectiveness and safety of sub- and supracostal punctures to determine which was more appropriate for clinical use.

Satisfactory stone-free rates (SFRs), fewer access punctures in PCNL, and less renal tissue trauma due to minimal intrarenal manipulation and angulations can be achieved using a supracostal approach in patients with staghorn renal calculi; however, this approach is associated with a higher risk of thoracic complications such as pneumothorax and hydrothorax. However, the high SFR and improved access to many calyces advocate for the adoption of the supracostal technique despite the significant risk of complications [10].

In our study, 72% of patients in the supracostal group experienced success, 2 cases (8.0%) had 2nd look PNL, one case (4.0%) needed 2nd look PNL then ESWL and 4 cases (16.0%) needed ESWL, whereas it was 64% in subcostal group patients, however in **Singh *et al.*** [11] success rate was 83.72% (36 out of 43 patients) in supracostal group and 80.39% (41 out of 51) in subcostal group. Seven (16.28%) patients in the supracostal group and ten (19.61%) patients in the subcostal group required a secondary surgery, This difference may be attributed to our learning curve and familiarity with supracostal access that is still growing.

Using a supracostal technique, which allows for better manipulations of the nephroscope inside the pelvicalyceal system, we were able to get access to several calyces with more ease. Unlike the angulation and torque needed when establishing a tract using a subcostal approach. The anatomical position of the kidney above the iliopsoas muscle and the straight tract of the upper infundibulum along the long axis of the kidney are likely to blame for this variation.

Different studies report a range of 3%-11% for the occurrence of thoracic complications following supracostal punctures. Hydrothorax was seen on postoperative chest X-ray in just 2 of 25 patients (8%) who received supracostal puncture in our research. One had no clinical symptoms and was treated conservatively without intercostal drainage installation, whereas the other developed dyspnea and required chest tube placement. PCNL was found on the left side of both individuals. Since the right kidney is situated lower than the left, access to its top pole is simplified in comparison to the left kidney [12].

The risk factors for a pleural complication after percutaneous nephrolithotomy were described by **Sharma and colleagues** [8] in a study of 332 cases. About 3% occurrence rate of pleural complications was found (10 patients). Predictive indicators for pleural complications include a low body mass index, an average patient age below 27 years, and a technique of access above the costa. Longer distance between the upper pole and the diaphragm, as well as increased posterolateral perirenal fat at the level of the renal hilum, are proposed as mechanisms by which obesity may provide protection against pleural complications.

We think that puncturing the skin and subcutaneous tissue during expiration and choosing the 11th intercostal gap laterally to the mid scapular line provide for an effective supracostal puncture Alternatively, the minimal risk of thoracic complications is achieved by puncturing the renal parenchyma during inspiration (to ensure proper renal descent).

There was no correlation between puncture style and blood loss, regardless of statistical analysis. We observed that the preoperative Hb of all three patients requiring blood transfusions in our research was low, and that their postoperative Hb decreased below 8 g percent. When comparing the quantity of blood loss between patients, however, the supra puncture group experienced higher bleeding than the subcostal puncture group. Puncturing the upper calyx can cause this, as can applying too much force during intrarenal operations, resulting in a rupture of the upper infundibulum [11].

Sampaio and colleagues [13] reported that two-thirds of kidneys pierced at the upper pole infundibulum had an interlobar vascular injury, while only 13% of kidneys punctured at the lower pole infundibulum had an arterial injury.

Blood transfusion rates as high as 17.5 percent were reported by **Michel and colleagues** [14]**.** Intercostal artery bleeding has been hypothesised to contribute to the excessive blood loss observed after supracostal punctures. Transfusion rates ranged from less than 1 to 5 percent, while **Jain *et al.*** [15] found that bleeding was a significant event in 5.7% and a mild problem in 10.3% of patients. Less than 0.5% of individuals have life-threatening bleeding from an arteriovenous fistulae or pseudoaneurysm needing immediate embolization. The majority of bleeding is venous, and a nephrostomy tube may be placed to stop the bleeding effectively in most cases. It is beneficial to tamponade any persistent bleeding by clamping the nephrostomy tube for 10 minutes.

The operative time in our study was 106.20±22.40 minutes for supracostal puncture and 103.16±20.56 minutes for subcostal puncture which was comparable to other studies in literature. **Jain *et al.*** [15] reported the operative time was 92±37 min for supracostal puncture. **Singh *et al.*** [11] reported operative time (min) 71.70±8.53 and 73.02±8.86, which was less time than in our study this may be due to better surgeon experience. We noticed that operative time increase with higher stone burden and also affected by distribution of stone within pelvicalyceal system and affect overall complication rate

Hospital stay in our study was 1.84±0.64 for supracostal puncture and 1.44±0.48 for subcostal puncture. Patients with pleural injury has longer duration of hospital stay.

CONCLUSION

Supracostal puncture was associated with a somewhat higher success rate than subcostal puncture for the treatment of staghorn renal calculi. Even in the supracostal puncture group, where chest issues are more common, most of the time the problems can be handled with conservative treatment. Both punctures had a similar risk, but the supracostal one was more successful. Due to its viability in treating complex/large staghorn calculi, we advocate for its unreserved use.

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Author contribution: Authors contributed equally in the study.

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