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Original article

Comparison Between Ultrasound Guide Mini-Percutaneous Nephrolithotomy & Conventional Method in Complex Renal Stones Regarding Stone Free Rate and the Need for Auxiliary Operations

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Abstract:

Background: Percutaneous nephrolithotomy (PCNL) is one of the most common and effective methods used for removal of large renal stones. PCNL traditionally utilizes fluoroscopy for visualizing the renal stone, creating access, dilating the working tract, and ensuring stone clearance. Percutaneous Nephrolithotomy (PCNL) access to the kidney is performed, mostly under X-Ray fluoroscopy. Providing only two- dimensional image, sometimes includes multiple puncture trials and exposes the patient, personnel and surgeons to ionizing radiation. The same access can be achieved under ultrasound (US) guidance, the aim of the study is to compare Efficacy, accuracy, complications & outcome of ultrasound guided percutaneous nephrolithotomy (US-PCNL) with X-ray guided percutaneous nephrolithotomy (XG-PCNL). **Patients and Methods:** This comparative study was carried out on forty patients performing radiology (ultrasound / fluoroscopy) guided percutaneous nephrolithotomy admitted in urology department or attending emergency. They were divided as follows: Patient group (C-PCNL): twenty patients performing fluoroscopy guided mini-percutaneous nephrolithotomy. Patient group (US-PCNL): twenty patients performing US guided mini-percutaneous nephrolithotomy. All patients with complex calyceal, pelvic, and upper ureteral stones with stone burden of ≥ 20 mm were included (grade II -IV Guys stone score) were included in the study. **Results:** A current study showed that there was statistically significant difference between C-PCNL and US-PCNL regarding stone free rate. (45.0%) in C-PCNL and (60.0%) in US-PCNL which suggest a better stone free rate in US-PCNL. **Conclusion:** The use of US-PCNL to guide access puncture during PCNL eliminates the risk of inadvertent organ injuries. US-PCNL had better stone free Rate than CPCNL.

Keywords: Percutaneous nephrolithotomy, Guys stone score, ultrasound , stone free rate.

Introduction:

Percutaneous nephrolithotomy (PCNL) is one of the most common and effective methods used for removal of large renal stones. PCNL traditionally utilizes fluoroscopy for visualizing the renal stone, creating access, dilating the working tract, and ensuring stone clearance. It was claimed that the ideal puncture should develop a straight tract through a papilla of the targeted calyx into the renal pelvis (1).

- Guy's stone score 1 (GSS1): a solitary stone in the mid/and or lower pole or in the renal pelvis with a normal anatomy and simple collecting system
- Guy's stone score 2 (GSS2): a solitary stone in the upper pole; multiple stones in patients with simple anatomy; or a solitary stone in a patient with abnormal anatomy
- Guy's stone score 3 (GSS3): multiple stones in a patient with abnormal anatomy or in a calyceal diverticulum or partial staghorn calculus
- Guy's stone score 4 (GSS4): a complete staghorn calculus or any stone in a patient with spinal bifida or a spinal injury, calculus in patients with clinical neurological alternations (spinal cord injury, myelomeningocele) (2).

Percutaneous Nephrolithotomy (PCNL) access to the kidney is performed, mostly under X-Ray fluoroscopy. Providing only two- dimensional image, sometimes includes multiple puncture trials and exposes the patient, personnel and surgeons to ionizing radiation. The same access can be achieved under ultrasound (US) guidance, without radiation exposure and with similar success rate in expert hands (3).

Patients and methods:

This comparative study was carried out on forty patients performing radiology (ultrasound / fluoroscopy) guided percutaneous nephrolithotomy admitted in urology department or attending emergency department of Benha university hospitals during the period between January 2022 and March 2023. They were divided as following:

- **Patient group (C-PCNL**): twenty patients performing fluoroscopy guided mini-percutaneous nephrolithotomy.
- **Patient group (US-PCNL**): twenty patients performing US guided mini-percutaneous nephrolithotomy.

Inclusion criteria:

All patients with complex calyceal, pelvic, and upper ureteral stones with stone burden of ≥ 20 mm were included (**grade II -IV Guys stone score)** (3)**.**

Exclusion criteria:

- Any Patients refuse to do the procedure.
- Patient with grade I guy's stone score.
- Patient with severe skeletal deformity
- Patient with active UTI unless treated.
- Any Patients have absolute contraindication for the procedure such as: severe hyperkalaemia.
- Patients with uncorrected coagulopathy.

Ethical Consideration:

Ethical permission for the study was obtained from the patients who were fully informed about all study procedures and their consent was obtained prior to the patient enrolment in the study. This study was approved by the ethical committee of the faculty of Medicine, Banha University Hospitals. Study in {MS. 25.1.2021}

Methods:

Before procedure for all patients, patients were subjected to history taking to fulfil needed data:

1. Full history taking:

Including personal history, present complaint, urological symptoms, history of present illness, any history of chronic disease or previous surgical intervention.

2. Clinical examination:

➢ *General examination:*

• Vital signs: pulse, blood pressure, respiratory rate and body temperature.

➢ *Local examination:*

• Full examination of abdomen.

3. Laboratory investigations:

• Complete blood count.

• Blood Urea Nitrogen (BUN).

• Serum creatinine.

• Urine analysis ±culture & sensitivity test.

• Random blood glucose.

• Serum electrolytes (sodium, potassium, calcium, phosphorus).

• Coagulation profile (PT, PTT, PC, INR).

• Liver function test.

4.Radio diagnostic imaging:

• Routine pelvi-abdominal ultrasound.

• CTUT

• Kidney-ureter-bladder plain x-ray film.

Technique

Before the procedure, computed tomography of the urinary tract is done to delineate renal anatomy, stone size, location & density, presence of hydronephrosis or other ureteric or urinary bladder stones (figure 1). Modern PCNL is a complicated staged procedure where each step is technically demanding and should be completed with precision. The main steps are positioning of the patient, renal access either through fluoroscopy guided access (figure 2) or ultrasound guided access (figure 3), safe tract dilatation, intra-corporeal lithotripsy, fragments evacuation and upper system drainage**.**

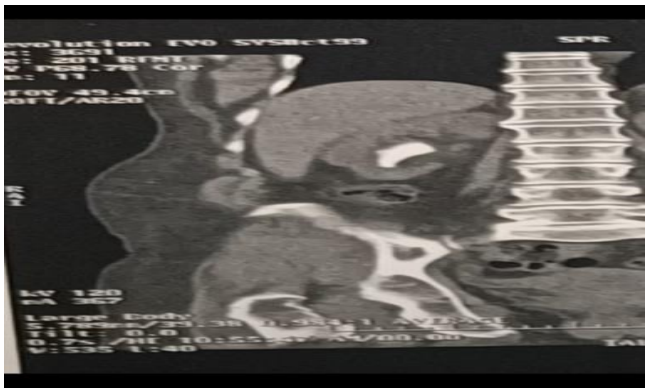

Figure (1): Preoperative CTUT coronal image revealed right partial staghorn stone & right minimal hydronephrosis.

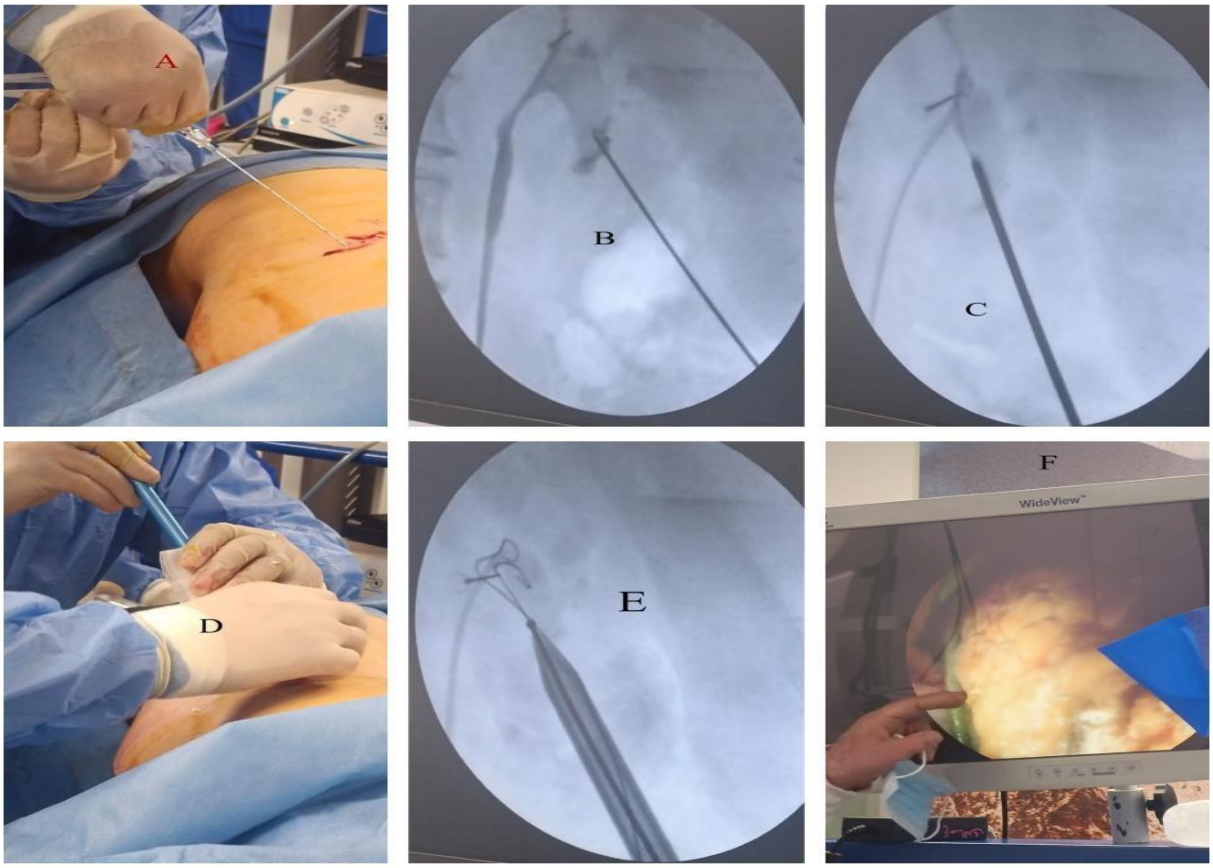

Figure (2): Intraoperative images, image (A & B) shows during needle puncture to the lower calyx in prone position under fluoroscopy, image (C) during application of guide wire, image (D & E) shows dilatation of the tract, image (F) shows the stone seen by the nephroscope.

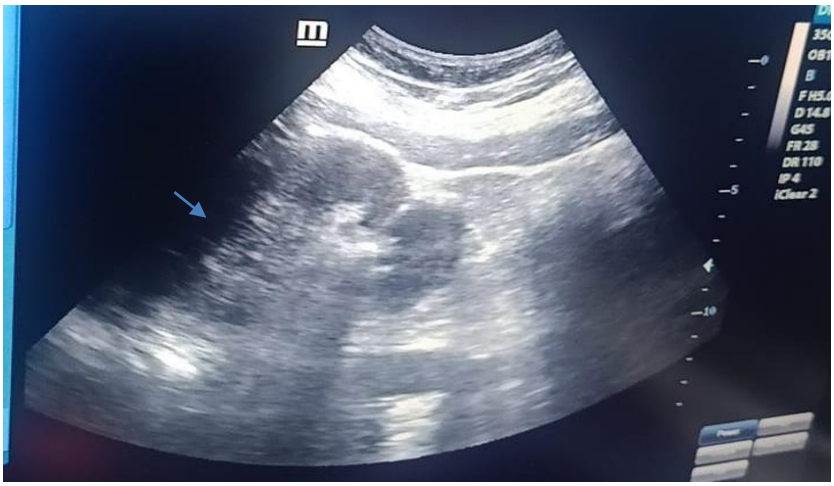

Figure (3): Ultrasound LS view of the left kidney during puncture of the target calyx by needle in prone position (blue arrow).

Statistical analysis

The collected data was revised, coded, tabulated and introduced to a PC using

Statistical package for Social Science **(**IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). Data were presented and suitable analysis was done according to the type of data obtained for each parameter. Mean, Standard deviation (± SD) for parametric numerical data, while Median and range for non-parametric numerical data. Frequency and percentage of non-numerical data Student T Test was used to assess the statistical significance of the difference between two study group means. Chi-Square test was used to examine the relationship between two qualitative variables.

P > 0.05: Non-significant (NS) P < 0.05: Significant (S)

Results:

There was statistically significant difference between C-PCNL and US-PCNL regarding puncture attempts as shown in (table 1).

There was statistically significant difference between C-PCNL and US-PCNL regarding Stone Free Rate as shown in (table 2, figure 4 & figure 5).

There was statistically significant increase among C-PCNL than US-PCNL regarding Need for auxiliary operation as shown in (table 3).

Table (1): Comparison between C-PCNL and US-PCNL regarding puncture attempts.

		C-PCNL (No.=20)	US-PCNL (No.=20)	Mann-Whitney U	P. value
Puncture attempts	**Median**	6 (1-8)	5 (1-7)	133.000	0.04

C-PCNL: conventional percutaneous nephrolithotomy
US-PCNL: US guided percutaneous nephrolithotomy

Table (2): Comparison between C-PCNL and US-PCNL regarding Stone Free Rate.

			C-PCNL (No.=20)	US-PCNL (No.=20)	X^2	P. value
Stone Free Rate	**Free**	No.	9	12	6.883	**.032**
		%	45.0%	60.0%		
	non-significant	No.	2	6		
		%	10.0%	30.0%		
	significant	No.	9	2		
		%	**45.0%**	**10.0%**		

C-PCNL: conventional percutaneous nephrolithotomy **US-PCNL:** US guided percutaneous nephrolithotomy

Figure (4): KUB x-ray film after ultrasound guided mini-percutaneous nephrolithotomy revealed left DJ in position & no residual stones.

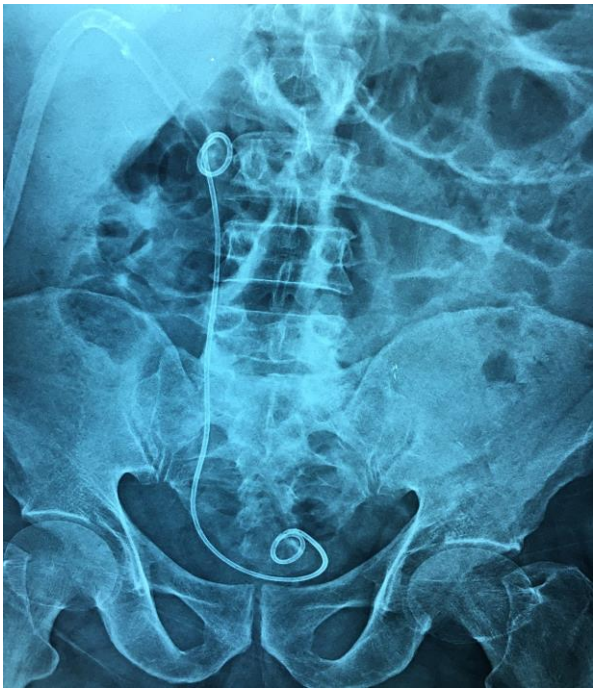

Figure (5): KUB x-ray film after fluoroscopy guided mini-percutaneous nephrolithotomy revealed right tiny gravels & DJ in position.

Table (3): Comparison between C-PCNL and US-PCNL regarding Need for auxiliary operation.

			C-PCNL (No.=20)	US-PCNL (No.=20)	X^2	P. value
Need for auxiliary operation	**no**	No.	14	20	7.059	**.029**
		%	70.0%	100.0%		
	Yes	No.	2	0		
	C-PCNL	%	10.0%	.0%		
	yes (ESWL)	No.	4	0		
		%	**20.0%**	**.0%**		

C-PCNL: conventional percutaneous nephrolithotomy
US-PCNL: US guided percutaneous nephrolithotomy

Discussion:

Percutaneous nephrolithotomy (PCNL) is a common method for treatment of kidney stones. All of the steps in PCNL should be performed with proper image guidance. The imageless PCNL should never be applied because it is dangerous to vital structures (4)**.** Nowadays, PCNL is considered a generally safe management option with a low incidence of complications and is the method of choice for treatment of renal stone (5).

According to the study conducted to find the complications and success rate of percutaneous nephrolithotomy in renal stone using Guy's score, it was reported that the most common site

of stone was in the pelvis followed by lower calyx. Forty-six patients (40.3%) had Guy's stone score 1, 43 (37.71%) had a score of II, 15 (13.6%) had a score of III and 10 (8.77%) had a score of IV (6).

In a study done in 2015 (7) on 122 patients who underwent PCNL, 75.5% of the patients were GS 1, 21.6% GS 2 and 2.9% 0GS 3. In their study, 10% of GS 1, 4% of GS 2 and 66% of GS 3 patients had residual stone. Eighteen patients experienced some form of complications out of which 3 patients needed surgical intervention with Modified Clavien score of III.

The current study showed that, there was statistically significant difference increase among C-PCNL than US-PCNL regarding puncture attempts.

On contrary, it was revealed that the number of attempts for successful PCS punctures and the access time were significantly higher in S-US-PCNL compared with the corresponding values in either P-US-PCNL or C-PCNL (1). It is likely that the reasons for this significant difference may be attributed to the fact that in P-US-PCNL procedure the needle trajectory is accurately determined by the sonoline on the screen.

US-guided mini-PCNL has many advantages such as an ongoing monitoring of the surrounding tissues and vessels during the procedure, better understanding for increasing accuracy in access to the stone, the staff 's less exposure to radiation, and also no need for contrast injection (8, 9)

The current study showed that, the percentage of Target Calyx was statistically significant lower among C-PCNL than US-PCNL, (80.0%) in C-PCNL and (100.0%) in US-PCNL.

This came in agreement with the study done in 2016 (10) where it was reported that, the success rate in achieving access in their study was 100% in both groups.

The present study showed that, there was statistically significant difference between C-PCNL and US-PCNL regarding stone free rate. (45.0%) in C-PCNL and (60.0%) in US-PCNL.

Some studies showed that the stone-free rate in percutaneous nephrolithotomy with ultrasonography guidance varied from 66.6 to 94.7% (8 , 11). Other studies showed that primary stone-free rate and total stone-free rate with ultrasound-guided percutaneous nephrolithotomy were 45.7 – 69.6% and 82.6 – 96.5%, respectively (12 ,13)

that reported (10) the stone-free rate was 88.46% and 72%, without any significant statistical difference in groups A and B, respectively (p=0.16).

On contrary (14) some researchers reported a statistically insignificant difference in the stone free rate with

USGA-PCNL (49.1%) compared to FGA-PCNL (36.9%) (p=0.159).

It was shown (1) that the primary Stone Free Rate was comparable between the three arms of the study. These rates were raised after additional auxiliary procedure. Indeed, some authors claimed that primary SFR range from 55% to 100% which increased after additional procedures with a trivial non-statistically significant difference between fluoroscopy and US arms (10 ,15).

This study revealed that, there was statistically significant increase among C-PCNL than US-PCNL regarding Need for auxiliary operation.

Conclusion:

Based on the results of the current study it can be concluded that: The use of US-PCNL to guide access puncture during PCNL eliminates the risk of inadvertent organ injuries & exposure to ionizing radiation. US-PCNL had less intraoperative puncture attempts. US-PCNL had better stone free Rate & less need for auxiliary operation compared to C-PCNL. Both techniques had similar postoperative complications.

References:

1) El-Shaer, W., Abdel-Lateef, S., Torky, A., & Elshaer, A. Complete ultrasound-guided percutaneous nephrolithotomy in prone and supine positions: a randomized controlled study. Urology 2019, 128, 31-37.
2) Lojanapiwat, B., Rod-Ong, P., Kitirattrakarn, P., & Chongruksut, W. Guy's stone score (GSS) based on intravenous pyelogram (IVP) findings predicting upper pole access percutaneous nephrolithotomy (PCNL) outcomes. Advances in Urology, 2016.
3) Aro*, T., Rai, A., Hoenig, D., Gupta, M., Desai, M., Smith, A., & Okeke, Z. V04-04 ultrasound-guided percutaneous nephrolithotomy, you should do it too. the journal of urology, 203(Supplement 4) 2020, e388-e388.
4) Kalogeropoulou C, Kallidonis P and Liatsikos EN Imaging in percutaneous nephrolithotomy. J Endourol. 2009;23:1571
5) Basiri, A., Ziaee, A. M., Kianian, H. R., Mehrabi, S., Karami, H., & Moghaddam, S. M. H. Ultrasonographic versus fluoroscopic access for percutaneous nephrolithotomy: a randomized clinical trial. Journal of endourology 2008, 22(2), 281-284.
6) Joshi, S., Clapp, W. L., Wang, W., & Khan, S. R. Osteogenic changes in kidneys of hyperoxaluric rats. Biochimica et Biophysica Acta (BBA)-Molecular Basis of Disease 2015, 1852(9), 2000-2012.
7) Kumsar, Ş., Aydemir, H., Halis, F., Köse, O., Gökçe, A., & Adsan, O. Value of preoperative stone scoring systems in predicting the results of percutaneous nephrolithotomy. Central European Journal of Urology2015, 68(3), 353.
8) Hosseini, M. M., Hassanpour, A., Farzan, R., Yousefi, A., & Afrasiabi, M. A. Ultrasonography-guided percutaneous nephrolithotomy. Journal of endourology2009, 23(4), 603-607.
9) Hong, Y., Ye, H., Yang, B., Xiong, L., An, L., Ma, K., et al . Ultrasound-guided minimally invasive percutaneous nephrolithotomy is effective in the management of pediatric upper ureteral and renal stones. Journal of Investigative Surgery2021, 34(10), 1078-1082.
10) Falahatkar, S., Allahkhah, A., Kazemzadeh, M., Enshaei, A., Shakiba, M., & Moghaddas, F. Complete supine PCNL: ultrasound vs. fluoroscopic guided: a randomized clinical trial. International braz j urol2016, 42, 710-716.
11) Basiri, A., Mohammadi Sichani, M., Hosseini, S. R., Moradi Vadjargah, A., Shakhssalim, N., Kashi, A. H., et al . X-ray-free percutaneous nephrolithotomy in supine position with ultrasound guidance. World journal of urology2010, 28, 239-244.
12) Zhou, X., Gao, X., Wen, J., & Xiao, C. Clinical value of minimally invasive percutaneous nephrolithotomy in the supine position under the guidance of real-time ultrasound: report of 92 cases. Urological research2008, 36, 111-114.

13) Karami, H., Rezaei, A., Mohammadhosseini, M., Javanmard, B., Mazloomfard, M., & Lotfi, B. Ultrasonography-guided percutaneous nephrolithotomy in the flank position versus fluoroscopy-guided percutaneous nephrolithotomy in the prone position: a comparative study. Journal of endourology2010, 24(8), 1357-1361.
14) Ng, F. C., Yam, W. L., Lim, T. Y. B., Teo, J. K., Ng, K. K., & Lim, S. K. Ultrasound-guided percutaneous nephrolithotomy: Advantages and limitations. Investigative and clinical urology2017, 58(5), 346-352.
15) Zhu W., Li J., Yuan J., Liu Y., Wan S. P., Liu G., et al. A prospective and randomised trial comparing fluoroscopic, total ultrasonographic, and combined guidance for renal access in mini-percutaneous nephrolithotomy. BJU international2017, 119(4), 612-618.

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