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ORIGINAL ARTICLE

90° Puncture Technique in Prone Percutaneous Nephrolithotomy in Pediatric Age Group

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is the gold standard treatment for renal stones ≥2cm, and it could be an option in some patients with renal stones less than centimeters. We aimed to evaluate the safety and practicability of the 90° puncture technique in prone percutaneous nephrolithotomy in pediatric age group. **Methods:** This prospective cohort study was conducted at urology department Zagazig University Hospital on 18 cases less than 18 years old with renal stones >2cm. imaging study, non-contrast spiral computer tomography (NCSCT), was performed on all patients. Postoperative assessment is measured by recording the rate of success of the modified biplanar 90° puncture technique, the length of hospital stay and any postoperative complications. **Results:** Kidney stones are found in the renal pelvis in 38.9%, lower calyx in 27.8%, middle calyx in 22.2% and the upper calyx in 11.1% of children. The kidney stone ranged in size from 21 to 31mm, with a mean size of 26.1±2.9 mm. Of the mini-PCNLs, 25 were left-sided (71.4%) and 10 were right-sided (28.6%). The stone density ranged from 923 to 1340 with a mean of around (1056±126). 6 patients (33.3%) experienced problems; 2 patients (11.1%) experienced bleeding; 2 patients experienced fever and 2 patients had infection. When managing kidney stones between two and three centimeters in size. **Conclusion:** In the pediatric age range, the modified biplanar 90° puncture approach showed to be a safe and effective method with fewer problems for the therapy of kidney stones measuring 2-3cm. **Keywords:** Percutaneous nephrolithotomy, Pediatric urolithiasis, Pediatric, Renal stones.

INTRODUCTION

In clinical practice, pediatric urolithiasis is a significant kidney disease that is encountered. The reported incidences of urolithiasis have shown significant regional variation. Furthermore, an increasing amount of data indicates that pediatric urolithiasis is becoming more common overall [1]. The preferred course of treatment for kidney stones larger than 2 centimeters is percutaneous nephrolithotomy (PCNL), which may also be an option for certain patients with smaller stones. In the pediatric age category, the same indication is likewise recommended. (Recommendation of AUA/EAU) [2].

These days, there are several different ways to puncture PCNL, and the majority of these are often guided by computerized tomography (CT), ultrasonography (US), and fluoroscopy. Throughout the world, urologists most frequently do percutaneous punctures utilizing fluoroscopy, which uses a variety of monoplanar or biplanar fluoroscopic procedures[3-5].

Compared to monoplanar procedures, biplanar techniques yield more accurate information on the direction and depth of the collecting system. The triangulation and "bull's eye" techniques are the most often used biplanar approaches that have been documented in the literature (Both made and reported for prone PCNL) [3-5] and Dr. Paul Escovar's "0-90° technique," a less well-known biplanar technique [6].

In order to prevent post-puncture bleeding, a precise puncture is essential. Additionally, there is a lower chance of bleeding and infection the fewer punctures that are attempted. Therefore, more accurate calculation of the puncture location may result in lower rates of complications [7]. The

purpose of this research was to assess the feasibility and safety of the Biplanar 90° puncture technique for prone percutaneous nephrolithotomy in the pediatric age group.

METHODS

This prospective randomized study was conducted at urology department Zagazig University, during the period from March 2023 till September 2023. After protocol approval by our local ethics committee (IRB #10551-7-3-2023), Eighteen patients with renal stones >2 cm and GUYs Score Grade (1, 2) scheduled for PCNL were included in the research. Informed consent was signed by all enrolled parents before surgery after the benefits and risks (including bleeding, infection, and associated organ injury) of the procedure have been explained. The study's protocol complied with the Helsinki Declaration, which is the World Medical Association's code of ethics for research on humans.

Inclusion criteria were patient's diagnosis with renal pelvis stone > 20mm, patient less than 18 years old, males and females, and patients with negative urine culture. Exclusion criteria was coexisting renal anomalies (UPJ obstruction, ectopic kidney), patient with ureteral stricture, patient with bleeding disorder, patients with coagulopathies, patients with skeletal deformities, recurrent cases, cases of morbid obesity than 40 kg/m^2 in children, single kidney, and patients with active UTI

Pre-operative: Every patient underwent a thorough history taking procedure with particular emphasis on urological history. Physical and clinical examination. Urine analysis and urine culture & sensitivity (Patients receiving appropriate antibiotic treatment for positive urine cultures preoperatively). Complete blood count (CBC). Coagulation profile (I.N.R, PT, and PTT). Blood urea and serum creatinine are tests for kidney function. Test for liver function. Radiological evaluation Kidney-ureters-bladder (KUB), Pelvi-abdominal U/S. Non contrast spiral Computer tomography (NCSCT) for Measuring stone size, site, distribution and HU. Pelvicalyceal anatomy. Relation of the kidney to the surround organs.

Operative technique:

Patients was given prophylactic intravenous antibiotics (cefoperazone 50-100mg/kg) were administered 2 hours pre-operative. General anesthesia was carried out. Place the patient in the lithotomy posture. Use a pediatric cystoscope to do the cystoscopy and locate the ureteral orifice and a 0.025 inch guide wire was introduced; the wire was progressed to the pelvicalyceal system level with fluoroscopic supervision, 5F or 6F open-ended After the guide wire was taken out, the ureteral catheter was advanced over it leaving the ureteral catheter in place, a retrograde ureteropyelography was done, and ureteral catheter was fixed with tape to an appropriate Foley catheter size.

Surgical technique (figure 1):

1st step, identifying the calyx to puncture: The calyx to be punctured is chosen with the C-arm at 0 degrees (anteroposterior projection), and the needle is moved from the head to the toes. A visible landmark is placed over the patient's skin at this chosen position (Verified by fluoroscopic control) when the needle is at the tip of the papillae; we named this point A. The entire needle track (Line A), which was the actual trajectory during the puncture, may be followed by the landmark marked on the skin. 2nd step then entry point along this line in the safety zone is determined: (between the last rib superiorly, paravertebral line medially and posterior axillary line laterally). The puncture needle was introduced under C arm guidance just near to the desired calyx. 3rd step, identifying the depth of the calyx: To provide a full lateral view of the kidney, the C-arm must be rotated 90 degrees around the patient's location beneath the surgical table. Knowing which calyces are anterior or posterior was made possible. Using the vertebral column as a reference point and seeing the spinous process as posterior and the vertebral column body as anterior is a useful approach for this. The needle was moved in anterior or posterior direction to face the desired calyx. 4th step, the C arm: rotate again in zero position and the needle advanced to reach the desired calyx. This technique allowed that always the puncture site in the safety area.

Postoperative follow up:

Every patient was watched for thirty to sixty minutes in the recovery area. All patients had postoperative CBCs performed 24 hours later, and when the HB level was < 8 gms. /dl according to British Hematological Society or for hemodynamic instability. The patients' nephrostomy tube was clamped on the first postoperative day and withdrawn on the second if there was no need for a second examination and there was no sign of a fever or urinoma. Urine

analysis, urine culture and sensitivity in patient with fever and expected suffering of infection. KUB done in the 2nd day following surgery for assessment of the remaining pieces and placement of double-J stent. Non contrast spiral Computer tomography (NCSCT) for measuring of residual fragment figure 2.

If there are no visible shards or leftover fragments with a maximum diameter of less than 4 mm, the patient is deemed stone-free. Post-operative antibiotics (cefoperazone 50-100mg/kg) were routinely continued postoperatively twice daily for 5days. Follow up patients for any Complications such as hematuria, fever, infection, urinary leakage, renal colic, and symptoms of peritonitis and management of this complication.

STATISTICAL ANALYSIS

All of the data was collected, tabulated, and statistically analyzed using IBM SPSS Statistics for Windows. IBM Corp., Armonk, NY, Version 23.0. Number & (percentage) was used to convey qualitative data, and mean ± SD & (range) was used to describe quantitative data. t: pupil's A test was applied between two normally distributed groups. The percentage of categorical variables was compared using the Fisher exact test or the Chi-square test, as applicable. A test always had two sides. P-value < 0.05 was considered statistically significant and p-value ≥ 0.05 was considered statistically insignificant

RESULTS

The study: Modified Biplanar 90° puncture technique in Prone Percutaneous Nephrolithotomy was applied for 18 children,11 of them (61.1%) were males and 7(38.9%) females. Mean age of all patients was 9.17±3.47 years, ranged from 3-15 years (table 1).

Kidney Stones, located in left middle, left lower calyx, left renal pelvis in 16.7% 16.7%,22.2%of children respectively, regarding stone site in right kidney distributed as upper, middle calyx, lower calyx, renal pelvis in 11.1%, 5.6%, 11.1% and 16.7% respectively. Mean size of kidney stone was 26.1±2.9 (mm) ranged from 21-31(mm). The mean of stone density was1056±126.1 and ranged from (923-1340) (table 2).

Planned puncture site was anterior to posterior axillary line so the site was modified again posterior to posterior axillary line table 3. The procedure takes two to three hours to complete.

Modified Biplanar 90° puncture technique was effective in 83.3% of patients and residual stones ≥ 4 mm with-out clinical symptoms in 16.7% of patients (table 4).

Six patients (33.3%) suffered complications; two patients had bleeding; two patients had a fever; and two patients had an infection (table 5).The bleeding managed by blood transfusion of 300ml.

Table (1): Demographic characters in studied group

Variables	The studied group (18)	
	n.(18)	%
Gender		
Males	11	61.1%
Females	7	38.9%
Age (years):		
mean ± SD	9.17±3.47	
(Range)	(3-15)	
Age group		
≤6 years	5	27.8%
>6 years	13	72.2%

Table (2): Characters of kidney stones

Variables	The studied group (18)	
	n.(18)	%
Site of stone		
LT-middle calyx	3	16.7
LT- lower calyx	3	16.7
LT- renal pelvis	4	22.2
RT-upper calyx	2	11.1
RT- middle calyx	1	5.6
RT- lower calyx	2	11.1
RT- renal pelvis	3	16.7
Size of stone(mm) mean ± SD (Range)	 26.1±2.9 (21-31)	
Density of stone mean ± SD (Range)	 1056±126.1 (923-1340)	

Table (3): Site and preplanned puncture

Variables	The studied group (18)	
	n.(18)	%
Inside	13	72.2
Outside	5	27.8

Table (4): Rate of success of Modified Biplanar (0-90) Puncture Technique

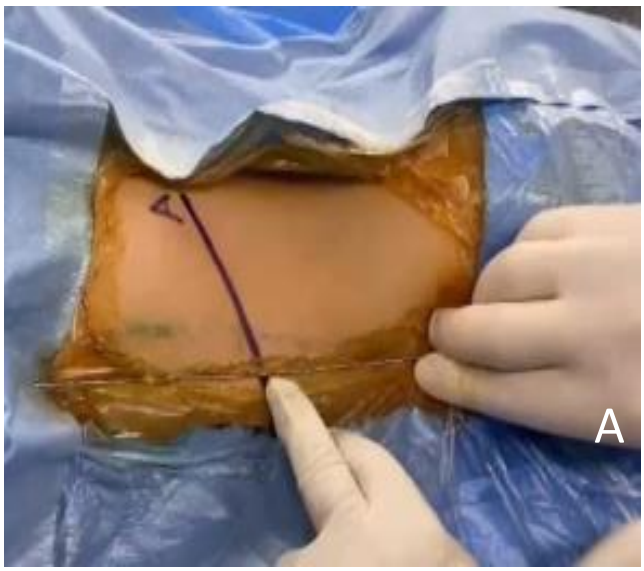
Success		n.	%
Success 15(83.3%)	**No residual stones**	12	66.7
	residual stones < 4 mm with-out clinical symptoms	3	16.7
Failed 3(16.7%)	**Residual stones≥4 mm**	3	16.7

Table (5): Frequency of complications

	n.	%
Complications **Yes** **No**	 6 12	 33.3 66.7
Bleeding	2	11.1
Fever and Infection	4	22.2

Table (6): Clavien-dindo classification of surgical complications

Grade	Definition
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications Blood transfusions and total parenteral nutrition are also included
III	Requiring surgical, endoscopic or radiological intervention
IIIa	Intervention not under general anesthesia
IIIb	Intervention under general anesthesia
IV	Life-threatening complication (including CNS complications)* requiring IC/ICU management
IVa	Single organ dysfunction (including dialysis)
IVb	Multiorgan dysfunction
V	Death of a patient



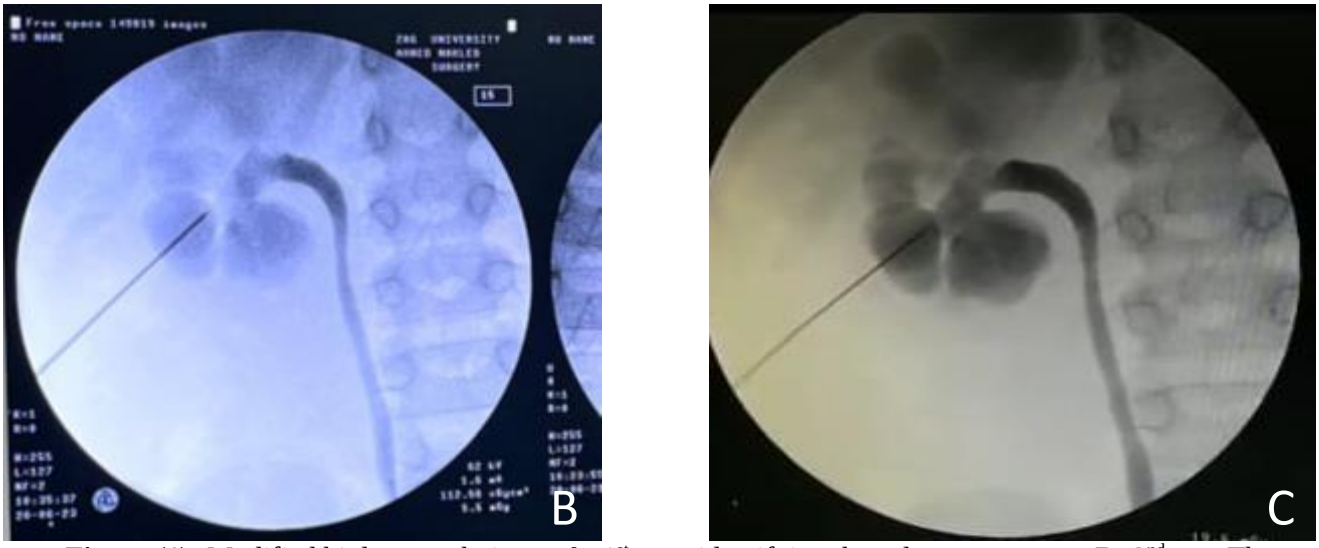


Figure (1): Modified biplanar technique . **A;** 1st step, identifying the calyx to puncture. **B;** 2nd step Then entry point along this line in the safety zone is determined. **C;** 3rd step, identifying the depth of the calyx. **D;** 4th step, The C-arm.

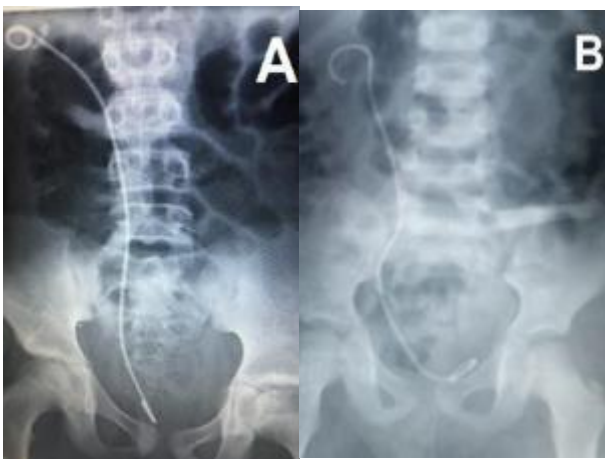


Figure (2): Post-operative KUB x-ray. A: KUB show RT JJ in place and residual stone, B: KUB show RT JJ in place and no residual stone.

DISCUSSION

The average age of all patients in the current research was 9.17±3.47 years, they 18 children,11 of them (61.1%) were males and 7(38.9%) females, which similar to the study of **Desoky et al. [8]** on 22 children, they were 15 males (68.2%) and 7 females (31.8%) with mean age was 9.5 ± 3.2 years.

Bujons et al [9] who found that in 33 patients who presented with renal calculi, they 27 boys (81.8%) were boys, and six kids (18.2%) had a mean age of 7 years. While, **Gamal et al [10]** in a study included 27 children he found that 21 children (77.7%) were males and 6 boys (23.3%) were females with a mean age of 6.8 years (range 2.5-12 years).

The current study showed that kidney stones, situated in the lower calyx and 38.9% of the renal pelvis in 27.8% of children , middle calyx in 22.2% and 11.1% of children stone located in upper calyx. Mean size of kidney stone was 26.1±2.9 (mm) ranged from 21-31(mm). Of the mini-PCNLs, 25 were left sided and 10 (28.6%) were right sided (71.4%). About mean of stone density was1056±126.1 and ranged from (923-1340).

Bujons et al [9] they discovered that 64% of patients had stones in the lower calyceal group and 50% had stones in the renal pelvis. With a range of 3–13.20 cm2, the average stone size was 4.46 cm2. There were one to twenty stones in all this was different to our study as we include guy's score 1 and 2.

While **Gamal et al [10]** reported that By measuring the longest diameter of each stone or, in the event of numerous stones, the total of the longest diameters of all the stones we were able to determine the mean stone size, which was 32 mm (range 20-7 mm). In 17 instances, the stones had a right side, and in 10 instances, a left side.

The current study showed that modified biplanar 90° puncture technique was success to remove kidney stone without residual in 66.% of patients and residual stones ≤ 4 mm with-out clinical symptoms in 16.7 % of patients and residual stone ≥0.4%mm with or with-out clinical symptoms. Which similar to the study of **Desoky et al [8]** who found that in 83.3% of patients, total stone removal was accomplished.

Desoky et al [8] found that with 20 patients having no stones or remaining fragments smaller than 4 mm, the success rate was 90.9%. A follow-up PCNL was required for one patient (4.5%) due to the appearance of 8 mm radiolucent debris on postoperative computed tomography. Another patient underwent SWL due to a remnant radiopaque piece that was 7 mm dislodged to the upper ureter.

The current study showed that complications occurred in 6 patients (33.3%), bleeding in 2 patients (11.1%) also fever in 2 patients, 2 patients represented with infection.

Desoky et al [8] found that Four patients (18.2%) experienced postoperative fever, which was treated conservatively. While postoperative urinoma affected two patients (9.1%) and was treated with a double-J stent and conservative methods, one patient required blood transfusion.

While **Gamal et al [10]** reported that there was two documented cases of intraoperative complications; the first required 300 ml blood transfusions (3.5%), while the second case (3.5%) resulted in a pelvicalyceal system perforation during tract dilatation, which was managed conservatively. Hypothermia during surgery wasn't observed in any patients. Two occurrences of postoperative fever (7%), which improved after receiving intravenous antibiotics for 72 hours, were the only postoperative problems. Urinary leakage, ureteral blockage, or postoperative bleeding were not observed as postoperative consequences.

This study had some limitations because it was conducted with a small sample size. It is still advisable to conduct similar studies with more participants and long-term follow-up to confirm the role of the modified biplanar (0–90) puncture technique in prone percutaneous nephrolithotomy in a pediatric age group in a large-scale population.

Declaration of interest

The authors report no conflicts of interest. The authors along are responsible for the content and writing of the paper.

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None declared

CONCLUSION

In the paediatric age group, the 90°-puncture technique for prone percutaneous nephrolithotomy has been shown to be safe, efficacious, and less complicated for managing kidney stones measuring 2-3cm.

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