RETROGRADE AIR INJECTION FOR IDENTIFYING PRECISELY POSTERIOR CALYX: A VERY USEFUL TOOL WHILE PERFORMING MINI-PERCUTANEOUS NEPHROLITHOTOMY

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ABSTRACT

Objective: To evaluate the significance of retrograde air injection for identifying posterior calyx in patients undergoing mini-percutaneous nephrolithotomy.
Study Design: Prospective, quasi-experimental study.
Place and Duration of Study: Armed Forces Institute of Urology, Rawalpindi, from Dec 2016 to Dec 2017.
Methodology: We prospectively studied 281 patients, who were undergoing mini-percutaneous nephrolithotomy by single surgeon, fulfilling inclusion criteria. Morbidly obese, hepatitis B or C positive and pregnant women were excluded. After the insertion of ureteric stent in lithotomy position, puncture was carried out in prone position, 3-5 cc of air was injected, in 137 patients among total of 281, when the anatomy of calyces was not clear after retrograde contrast injection with continuous fluoroscopy. The collected data included demographics (age, gender) and success/failure rate with and without air instillation (two groups).
Result: Among 281 individuals selected, there was a mean age of 39.48 years in both gender with maximum patients in their 4th decade. A total of 209 were males (74.4%) and 72 were females (25.6%). In non-randomized two groups, one group (n=141, 50.2%) was injected with air for identifying posterior calyx which resulted in successful puncture in 137 patients with failure in 4 patients, similarly in the group which received no air instillation (n=140, 49.8%) failure to localize posterior calyx was seen in 17 patients, which was found to be statistically significant (*p*-value=0.003)
Conclusion: Air injection is an easy and a very useful tool for urologists in identifying posterior calyx with statistically significant success.

Keywords: Kidney calice, Insufflation, Nephrolithiasis, Percutaneous Nephrolithotomy, Prone postion

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INTRODUCTION

Percutaneous Nephrolithotomy (PCNL) was first described by Fernström and Johansson in 1976[1]. In recent years, further technological modifications have led to the miniaturization of instruments, with much smaller access sheaths becoming available[2]. Treating the kidney stones in paediatric patients was one of the reasons for the advancement in percutaneous nephrolithotomy techniques[3].

In Pakistan, this revolutionary technique, Mini-PCNL, was slow in gaining popularity among the urologists, and only few of the institutes performing it regularly[4]. In this technique, the puncture-step remains the most challenging task for the operating surgeons, as treatment outcomes are highly dependent on the accuracy of needle puncture in the desired calix[5]. The ideal renal access is the one that allows an optimal working angle for complete stone removal while minimizing the risk of bleeding. An inaccurate needle puncture can cause even grave complications such as injuring vessels of kidney and contiguous organs, difficulty in handling surgical instruments and eventually, prejudice the overall surgical procedure and patient's outcome[6]. A perfect initial access is the secret to successful percutaneous removal of stones[7].

In many institutes, the kidney is accessed by an interventional radiologist in the radiology

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Received: 09 Apr 2018; revised received: 09 Apr 2018; accepted: 10 Apr 2018

department, making PCNL to be a staged procedure. However, The Urologist's ability to access the kidney in the operating room can transform PCNL to be carried out as a single-stage procedure, which inturn can minimize the transfer of patient to the radiology suit to place the tract after retrograde ureteric catheter insertion in the operating room, and then returning back to the operating room for the final step of stone-removal. In addition to the providing comfort to the patient, urologist's selection of the optimum tract based on the intrarenal anatomy and the ability to make secondary tracts as required can permit more effective stone removal. Watterson *et al*. also found that access-related complications were fewer and stone-free rates improved when the urologists made the percutaneous access[8].

The precise identification of the posterior calyx can be difficult and to overcome this problem it has been suggested that a trainee has to perform about 24 PCNL-procedures to obtain a good proficiency, similarly to become a competent in the same procedure he has to perform 60 cases, and excellence can be obtained at >100 cases[9].

It is a common observation that 'the posterior calyx' appears less dense than 'anterior calyx' in the prone position after retrograde pyelography[10]. To further ensure its exact location, air can be injected into system for making it more obvious[11]. This simple step of injecting air and its accuracy in the identification of the posterior calyx is neither studied well in our population nor internationally, thus necessitating its need for a prospective study to know its usefulness as a reliable technique.

MATERIAL AND METHODS

After approval for this study by local ethical committee, a prospective study over a 12-month-period from December 2016 to December 2017, of all consecutive patients who underwent mini PCNL by single surgeon was commenced at Armed Forces Institute of Urology, Rawalpindi Pakistan.

Inclusion criteria included, patients having kidney stones confirmed by CT Kidney ureters bladder or Intravenous Pyelogram, exclusion criteria included patients with hepatitis B or C, pregnant patients or patients who were declared unfit after pre-anesthesia assessment, which mostly included morbidly obese persons, or those who had previous allergy to iodinated contrast materials.

This study encompassed only those cases, which were operated by a single surgeon at our institute, in which total 281 patients were enrolled for this study, data was recorded for the name, gender, age, date of surgery, side of surgery, position for surgery, puncture attempts, needle used for puncture, number of air instillations, anatomy of calyces (simple or complex), access (upper, lower or simultaneous upper and lower pole) and success or failure in localizing posterior calyx after instillation of the air (3-5cc in boluses.)

Each patient in the study was operated under general anesthesia, in the lithotomy position. A 3-6 F ureteric stent was passed, both URS (Richard Wolf) and in some cases, cystoscope with 30-degree lens (Olympus) was used for stent placement. Confirmation of stent-position was obtained by flurosocope (Toshiba X-Ray Image Intensifier, Model Number E5830SD-P4A) and diluted diatrizoate (urografin) was used to delineate collecting system, all images were saved automatically in fluoroscope, and then patient's position was changed to prone.

Statistical analysis was performed by using PASW statistics 18, in which chi-square test was applied for the cross tabulation of both groups (with and without air instillation).

RESULTS

During this prospective, quasi-experimental study spanning over a period of 12-month-duration, a total of 281 patients were studied fulfilling the inclusion & exclusion criteria. They underwent mini-PCNL by the same surgeon at Armed Forces institute of Urology from December 2016 to December 2017.

There was a mean age of 39.48 years in both gender with maximum patients in their 4th decade (figure), whereas among 281 patients, 209 were males (74.4%) whereas 72 were females (25.6%).

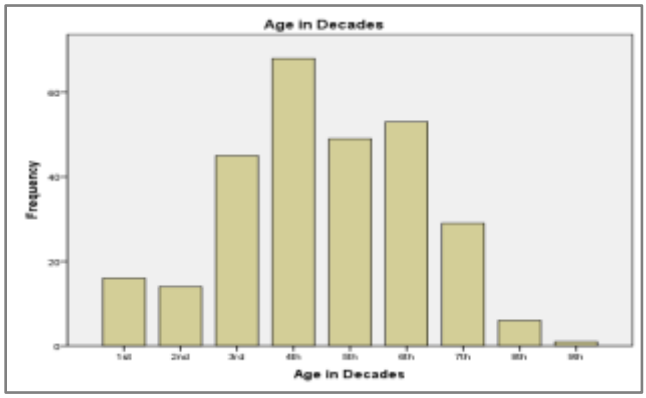

Figure: Age distribution in decades.

In the non-randomized two groups, one group (n=141, 50.2%) was injected with air for identifying posterior calyx which resulted in successful puncture in 137 and failure in 4 patients, similarly in the group which received no air instillation (n=140, 49.8%) failure to localize posterior calyx was seen in 17 patients, leading to a statistically-significant difference. (chi square: *p*-value=0.003) (table).

Table: cross tabulation of "Groups with and without air injection" with "success rate" in puncture for posterior calyx.

Groups	Result		Total	*p*-value
	Successful	Failure		
With air instillation	137	4	141	0.003
Without air instillation	123	17	140	
Total	260	21	281	

DISCUSSION

The normal anatomical location of both kidneys is in the retroperitoneum, although a significant portion of each kidney is actually supracostal; the lower pole is nearly always subcostal. The longitudinal axis of each kidney is oblique and dorsally inclined, making the upper pole calyces more medial and posterior than the inferior pole[12]. Similarly, the posterior calyces of the kidneys are at a 30° oblique angle to the vertical plane when the patient is prone.[10] The posterior calyceal approach of lower pole in prone position with a limitation due to the maintaince of the angle is considered as the safest approach[13], with minimal injury to the renal parenchyma as well as infundibular or other vessel injuries, which may have catastrophic consequences.

At our institute, Patients who are selceted for mini-PCNL, have to undergo through various investigations including Plain CT Kidney ureter bladder (KUB) with 3D reconstruction. We prefer CT Scan KUB 'non-contrast with 3-D reconstruction' as a standard before PCNL because of the reason that it gives more information about length of the tract, access and information about the surrounding structures like retrorenal-colon and spleen.

Despite all such preoperative investigations and liberal use of image intensifer in oblique and lateral views peroperatively, locating the precise position of anterior or posterior calyx can be tricky and can often result in the accidental puncture of the anterior calyces. Due to the Renal rotation during development, the posterior calyces are are usually oriented with their long axis pointing towards the Brodel's line, hence puncture of posterior calyx will traverse this relatively avascular zone, but in case of anterior-calyceal puncture, there is an increased risk of bleeding as more parenchyma is traversed to reach the calyx and also because of the reason that it wont traverse through the Brodel's line[14].

Similar to the investigations which help in the access of calyces, other preparations for PCNL patients include, urine culture & sensitivity, any urinary tract infection found is treated

with oral antibiotics as per culture sensitivity. In cases where culture shows mixed organisms with no sensitivity then fosfomycin or nitrofurantoin are used because of their excellent sensitivity for the organisms causing urinary tract diseases in our population. We did not include any patient of hepatitis B or hepatitis C in this study, as we have not yet started performing mini-PCNL on them.

Likewise, all patients undergoing PCNL are regularly assessed before surgery in pre-anaesthesia department; morbid obesity is one of the frequent reason to abandon the mini-PCNL procedure in our patients as it is performed in the prone position. This position can precipitate cardio respiratory compromise due to abdominal compression[15]. For such patients we perform PCNL in the supine position. However, the scope of this study was limited to only prone-positined mini-PCNL patients.

All patients understudy were passed ureteric catheter 3-6 F after induction of general anaesthesia and delivery of broad-spectrum antibiotics. Nonetheless, in the lithotomy position, positon of ureteric catheter is also confirmed by single shot fluoroscopy, in which a diluted urografin is injected and single shot is taken, all the images of fluoroscopy including plain image containing Kidney stone are automatically saved for each patient in biplanar Toshiba with rotating C-Arm fluoroscope (Toshiba X-Ray Image Intensifier, Model Number E5830SD-P4A).

The image intensifier is also sterile-draped and generally, it is placed on the side of operating kidney (to lessen the confusion because of the change of 'kidney to be operated' in supine and prone positions.) Foot pedal for fluoroscopy is placed along the surgeon, for the puncture; initially we use a spinal needle (18G), whose tip is aligned with the desired-entry calyx. The Bull eye technique is performed in malrotated or Horseshoe kidneys; in rest, we perform triangulation technique. Retrograde pyelography is performed with the C-arm at 0-degree angle to delineate the intrarenal collecting system and exact location of the stone(s). The configuration of calyces may be different at upper or lower poles. The calyces in the lower pole may be compound as they may increase to three in number, which can confuse between the anterior and posterior. Furthermore, in the lower pole other issues can be due to the presence of one or more lower pole anatomical variations, an increased infundibular (IF) length and a decreased IF width and angle[16].

The posterior calyx can be correctly identified, as it will appears less dense relative to the anterior calycx after a retrograde contrast administration. To further localized, In this study we injected 3-5 cc of room air into the PCS (Pelvicalyceal system) system via a retrograde ureteric catheter with continuous fluoroscopy for 3-5 seconds, air was seen clearly emerging upward in the PCS, thus delineating the posterior calyx only as the anterior calyx was already filled with the contrast due to the effect of gravity, this led to a remarkable and a clear identification of the posterior calyx. The remaining procedure including tract-dilatation and intracorporeal lithotripsy was an easy and a straightforward business to deal with. The patients in whom even with this technique we failed to access the posterior calyx, either the procedure was continued from the anterior calyx or a second puncture was carried out as a routine.

In literature we were able to find few case reports of complications relating to air injection during PCNL, for example, air embolism in which Parikh *et al*.[17] used 40 ml of intermittent boluses of air in multiple punctures. Usha[18] also reported such complications, which can be managed well if detected earlier during the surgery. However, we did not experience such complications in our patients understudy. Our internet-search (PubMed, Google scholar) found many trials on PCNL, for example, better postioning of the patient (Supine/ Prone) and Imaging modality (fluoroscope/ Ultrasound/ with or without pyelography), but we were unable to find any trials with which we can compare out study.

CONCLUSION

Air injection is an easy and very useful tool for urologist in identifying posterior calyx with a statistically significant success.

CONFLICTOFINTEREST

This study has no conflict of interest to be declared by any author.

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