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RENAL DISTRACTION DURING PERCUTANEOUS RENAL CALYCEAL ACCESS FOR PRONE & SUPINE PCNL USING A URETERIC BALLOON CATHETER (UBC) – RESULTS, COMPLICATIONS & LITERATURE REVIEW

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ABSTRACT

Special access techniques during percutaneous nephrolithotomy (PCNL) are indicated for challenging stones. Various techniques have been described to inferiorly displace the kidney to facilitate optimal percutaneous access whilst minimizing thoracic complications associated with the supracostal approach.

We describe our institution's technique of using a ureteric balloon catheter to inferiorly distract and immobilize the kidney (UBC Technique) to achieve the optimal calyceal access infracostally during PCNL. This permits effective and safe access in a single puncture whilst additionally stabilizing the renal unit during respiration and reducing the skin-to-calyceal distance by mobilizing the desired calyx in line with the axis of the puncture needle. We reviewed the literature regarding alternative inferior renal displacement techniques permitting infracostal approaches.

From May 2012 to October 2017 150 PCNLs were performed in our institution. Out of these, the UBC technique was used in 18 cases during both prone and supine PCNLs. In all cases, the UBC technique was used successfully to access the most desirable calyx. No complications associated with renal distraction were reported. Post operatively, 1 patient required a blood transfusion, 1 patient had a pyrexia of >38 degrees resulting in a longer admission and 1 patient developed sepsis requiring HDU admission for monitoring only. 15 out the 18 patients had complete stone clearance from their PCNL.

The UBC technique provides a safe alternative to the supracostal approach in percutaneous renal surgery. It is less traumatic than alternative infracostal access techniques and has a very short learning curve.

Keywords: *UBC technique, renal distraction, infracostal access, PCNL*

Percutaneous nephrolithotomy (PCNL) for treating renal stones was first described in the 1970s. Since then percutaneous nephrolithotomy has evolved to become a widely accepted method of managing complex or large renal calculi. Optimal percutaneous access into the renal collecting system is crucial to the success of PCNL and achieving stone free status. Certain clinical situations require the use of special access techniques e.g. challenging upper calyceal stones, stones within a calyceal diverticulum or stones behind infundibular stenosis.[1] In these cases, access has traditionally been achieved through a supracostal approach as it provides direct access to most of the intrarenal collecting system. However, given the close anatomic relation of the upper pole of the kidney to the diaphragm and pleura this technique is associated with a significant risk of pleural and intrathoracic iatrogenic injuries, with rates reported between 3.1–12.5% in the literature.[2–10] The risks of these complications is particularly higher when the puncture is made above the 11th rib compared to punctures above the 12th rib.[2,4] Additionally, the supracostal approach is associated with a significant risk of respiration–related pain.[11]

There have been various alternative techniques devised to replace the supracostal approach and avoid its potential intra-thoracic complications. These techniques simulate the vertical motion of the kidney during respiration. One study reports that the maximum displacement of upper pole of the kidney can reach 39 mm from an end-expiratory to an end-inspiratory position and 43mm for the inferior pole.[2,12] This displacement could be utilized for infracostal access.

AIM

To describe our institution's technique and outcomes of using a Ureteric Balloon Catheter (UBC technique) to provide inferior renal distraction with a review of the literature regarding inferior renal displacement techniques permitting infracostal approaches.

PATIENTS AND METHODS

We carried out a retrospective search of our Institutions PCNL Data base from May 2012 to October 2017. The search resulted 150 cases done in that 5-year period. All patients who required renal distraction via the UBC technique during supine and prone PCNL were included in the study group. Patient demographics, stone characteristics, calyces accessed during PCNL and complications related to renal distraction and PCNL were all recorded.

URETERIC BALLOON CATHETER TECHNIQUE

This was first carried out in our institution in 2012 (SN - senior author). The UBC technique is suitable for either prone or supine PCNLs where the ideal puncture for access to the collecting system is likely to be supracostal. Under cystoscopic guidance, a 0.035inch Sensor™ PTFE-Nitinol Guidewire [Boston Scientific] with Hydrophilic floppy tip is passed into the collecting system. If the patient is in prone position, a flexible cystoscope is used to minimize transfers and reduce operating time. A plain film is taken to demonstrate the stone (Figure 1). Once the cystoscope is removed, a ureteric balloon catheter (Occluder ™, Boston Scientific) is then railroaded over the Sensor™ guidewire into the renal pelvis or desired calyx.

A retrograde pyelogram is then performed to outline the pelvicalyceal system to help delineate a suitable position for the inflation of the balloon (Figure 2). The ureteric catheter balloon is then inflated with contrast mixed with water (2 cc) to confirm its position (Figure 3).

Studies have confirmed that the superior pole of the kidney can move vertically up to 39 mm (43 mm lower pole) during respiration.[12] Under fluoroscopic guidance the primary surgeon provides gentle manual traction on the ureteric catheter in a caudal direction. Fluoroscopy confirms the new position of the kidney (Figure 4). Whilst the assistant surgeon maintains gentle traction, the desired calyx is punctured by the primary surgeon using an 18 G/20 cm long Percutaneous Access Needle (Boston Scientific). The needle is advanced under fluoroscopic guidance, in the same trajectory as the orientation of the C-arm (Figure 5). The tract is dilated with a Nephromax™ balloon single step dilator (Boston Scientific) over an Amplatz super stiff ™ guide wire. The traction is released once the Amplatz sheath is in the collecting system and stone clearance can begin.

FIG. 1 Plain film on table showing the stone in the upper pole of left kidney.

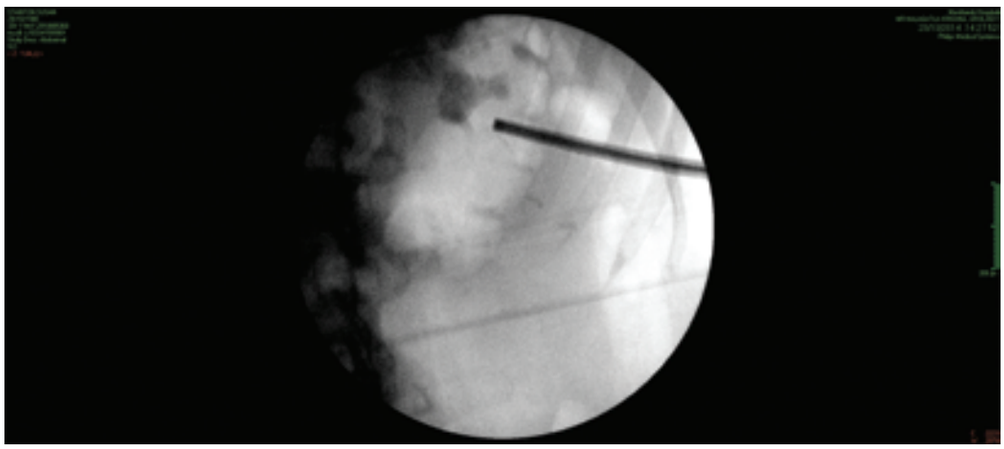


FIG. 2 UBC is placed and retrograde pyelogram is performed prior to balloon inflation. Stone is visible in upper pole moiety.

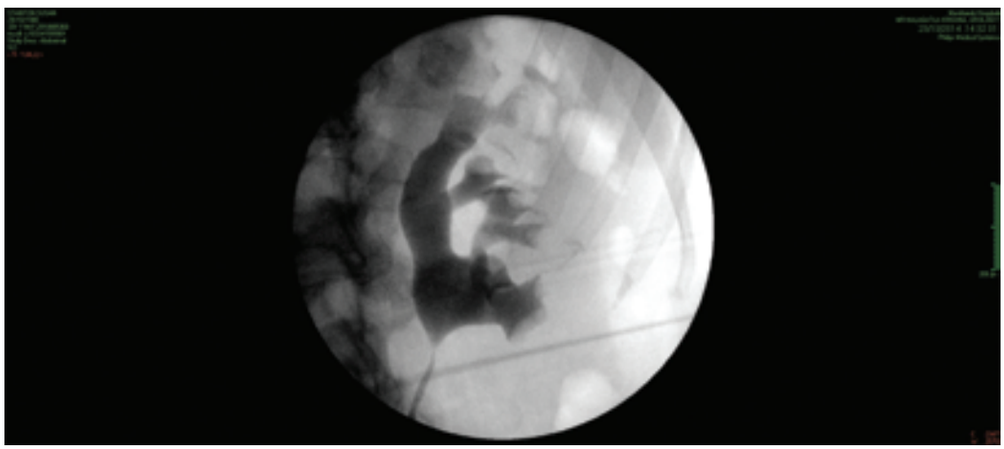


FIG. 3 UBC is then inflated at PUJ with contrast mixed with water (2 cc) to confirm its position.

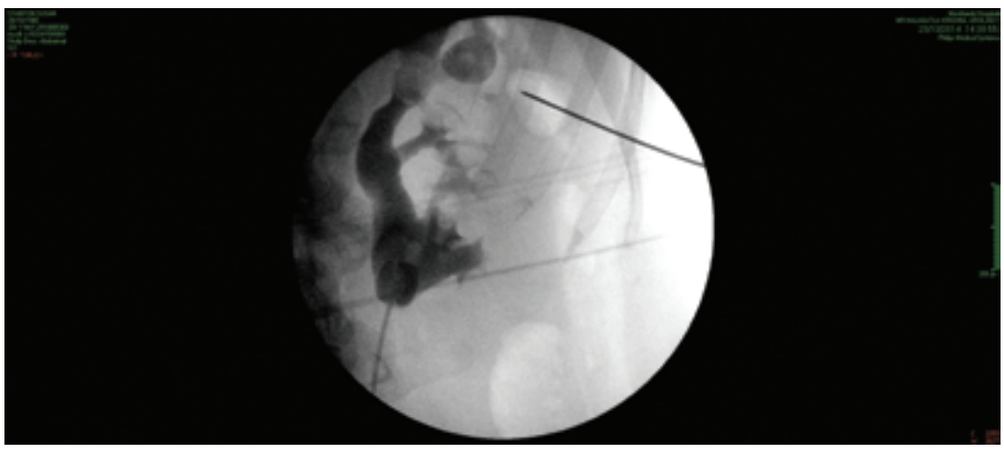


FIG. 4 Gentle traction is applied to the UBC to displace kidney inferiorly.

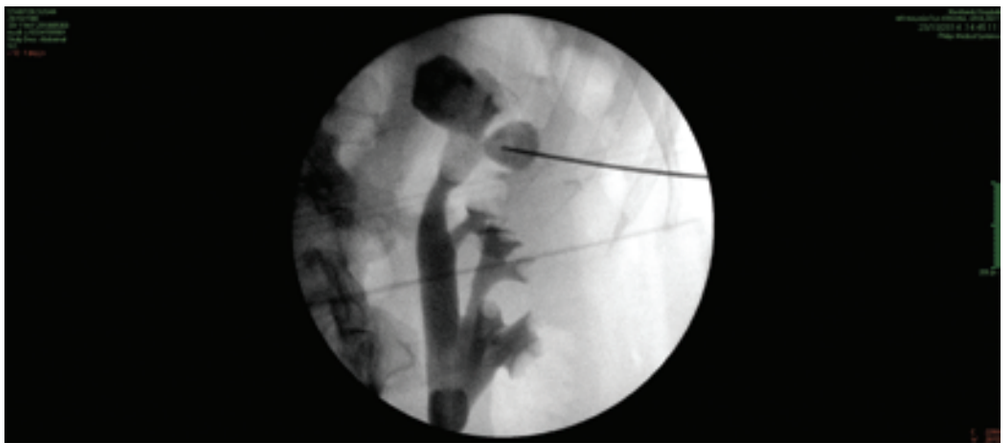
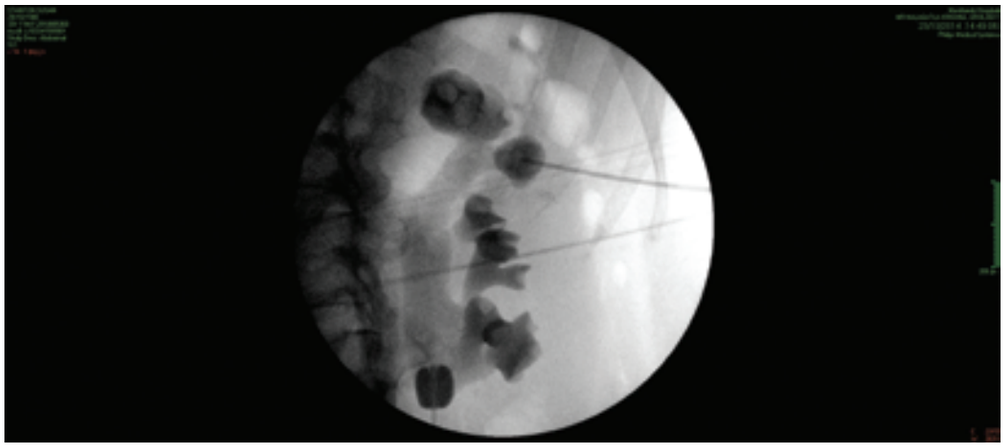


FIG. 5 Needle is successfully inserted infracostally into superior calyx of upper moiety where stone is located.



RESULTS

Out of a total 150 patients who underwent PCNL in the 5-year period, 18 patients (10 male and 8 female) required the use of the UBC technique as part of their PCNL. The mean age was 55 years (range 25–89). Five PCNLs were performed with the patient prone and 13 were performed with the patient supine. In all cases, the UBC technique was used successfully to access the most desirable calyx: 7 upper calyx, 5 middle calyx and 6 lower calyx.

None of the following complications associated with renal distraction were reported: injuries to pelvi-ureteric junction (PUJ) causing extravasation, mucosal tears at PUJ, significant haematuria from the site of the ureteric balloon or avulsion of the PUJ. All 18 patients had Ureteric Stents (On or Off Strings) inserted intraoperatively and none required drainage nephrostomies post operatively.

Post operatively, 1 patient required a blood transfusion, 1 patient had a pyrexia of >38 degrees resulting in a longer admission and 1 patient developed sepsis requiring HDU admission for monitoring only. No patients required embolization secondary to bleeding or admission for ITU for inotropic support and no patient suffered any visceral injuries.

Fifteen out the 18 patients had complete stone clearance from their PCNL. This was evaluated post

operatively with plain radiographs to look for residual stones. One patient with staghorn stones required FURS and laser stone fragmentation for residual stones and a second patient with upper pole stones had 2 small residual stones in the mid ureter which subsequently passed the fragments spontaneously without any intervention. The third patient with a complete staghorn stone had a small middle calyceal residual stone post PCNL requiring ESWL.

DISCUSSION

Karlin and Smith first described a renal displacement technique in 1989.[13] Their technique used an Amplatz sheath, which was passed through a central or lower pole calyx. At this point, the urologist would push the Amplatz sheath caudally with the consequent caudal displacement of the kidney below the 12th rib. A second puncture is then safely made into the upper calyx, which is now located in a subcostal position, minimizing the potential risk of pulmonary injuries. This method proved to be successful in 21 of 25 cases, failing only in patients whose kidneys were immobile as a consequence of previous operations. There were no thoracic complications reported.

In 2002 Campbell-Walsh 8th edition of Urology, the author briefly commented that in addition to the Karlin and Smith technique, an occlusion balloon catheter could be used to displace the kidney inferiorly using gentle caudal traction. No technical details are supplied and no study using ureteric balloon catheter is reported by the authors in the literature.[14]

In 2011, Lezrek. et al proposed a needle renal displacement technique using an 18-gauge diamond-tipped needle.[15] The lower or middle calyx is punctured using this needle. A stiff shaft hydrophilic guidewire is then introduced, and the needle's proximal end is progressively advanced in the cephalic direction, under continuous fluoroscopic monitoring displacing the kidney caudally. The kidney is now distracted and immobilized allowing the upper pole calyx to be safely punctured. As with the Karlin and Smith technique, it failed in patients with postsurgical adhesions. Moreover, unsatisfactory renal displacement was reported in cases of significant hydronephrosis.

More recently in 2012, Goyal. et al reported a technique to inferiorly distract the kidney during supine PCNL.[2] This technique involves introducing an antegrade hydrophilic guidewire via a suitable calyx in the collecting system, down the ureter and into the bladder where it is externalized through the urethra. Gentle tension is then applied on either ends of the "through-and-through" wire. This allows caudal distraction of the kidney, stops respiratory related movement and lowers the ideal puncture site by an average 3.2 cm. This technique was carried out on 10 patients undergoing upper pole punctures during PCNL, with stone free rates reported in all 10 cases with no incidence of thoracic complications.

To date, the UBC technique has been used successfully on 18 patients at our institution (5 prone PCNLs and 13 supine PCNLs). All the desired calyces were accessed infracostally. There has been no visceral complications and stone free rates were achieved in 15 out of the 18 (83%) patients. The advantage of the UBC technique over other described renal displacement techniques is that it only a single puncture of the kidney is needed to achieve effective and safe access to the desired calyx. It permits stabilization of the renal unit during respiration and brings the desired calyx in line with the axis of the puncture needle, reducing the skin-to-calyceal distance.

The technique is straightforward to learn. The theoretical risk of shear injury is unlikely with the minimal traction required to displace the kidney. In practice only a displacement of 20–30 mm is required to achieve safe infracostal access, however physiologically the kidneys allow a maximum displacement of 40 mm. There are additional benefits to using the ureteric balloon catheter: it allows contrast to stay within the pelvi-calyceal system for longer and could prevent stone fragments migrating into the ureter during the PCNL. Our UBC technique can be performed in supine or prone positions as per surgeon preference.

CONCLUSION

Our UBC approach is a renal displacement technique that provides a safe alternative to the supracostal approach in percutaneous renal surgery. Compared to other techniques, it is less traumatic, achieves good stone clearance rates via one access route and is a safe versatile adjunct to the armamentarium of the stone

surgeon. It enables access to the desired calyces for the purpose of PCNL and has a very short learning curve.

COMPLIANCE WITH ETHICAL STANDARDS

FUNDING

The authors declared that this study has received no financial support.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

ETHICAL STANDARD

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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