Inferior Distraction of the Kidney to Aid Upper Pole and Supracostal Punctures During Supine Percutaneous Renal Access

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the treatment of choice for large or complex renal calculi. Percutaneous renal access is also often used for management of ureteropelvic junction obstruction (UPJO), proximal ureteral strictures, and renal collecting system tumors. To achieve the optimal result, it is important to gain intra-renal access through an appropriate calyx. In cases with upper pole stones, impacted upper ureteral calculi, staghorn calculi, and UPJO, supracostal access, and in others, upper pole access may be needed to achieve the best result. However, the supracostal approach and specifically upper pole access are often avoided, and a subcostal approach is used to reduce the risk of intrathoracic complications.[1,2]

Better knowledge of pleural and diaphragmatic anatomy and further development in surgical techniques have reduced the risk of intrathoracic complications,[3] but published series report rates of intrathoracic complications varying between 3.1% and 12.5% in those undergoing supracostal percutaneous access. These series further report that the rate of intrathoracic complications is significantly higher when the puncture is supra-11th rib compared to a supra-12th Puncture.[1-8] There is also a significantly increased incidence of respiration-related pain in those having a supracostal access (32%) versus those having subcostal access (5%).[9]

The supra-12th approach is transthoracic, but extrapleural, whilst the supra-11th rib access is both transthoracic and transpleural.[8] Pulmonary complications may arise after supracostal puncture due to the anatomic relationship of the upper pole of the kidney with the diaphragm and the pleura.

The right kidney is usually lower than the left kidney and the posterior surface of the right kidney is crossed by the 12th rib, whereas the left kidney is usually crossed by the 11th and the 12th ribs. The upper pole of the kidney is usually medial and posteriorly placed compared to the lower pole, which is lateral and more anterior. The pleura reflects at the level of the 10th rib in the mid-axillary line and the posterior reflection of the pleura extends inferiorly to the 12th rib at the level of L1 vertebra. The lung is located at the 10th thoracic vertebral level posteriorly with the lowermost part lying above the 11th rib at the 10th intercostal space,[10] and may move caudally as much as 2 vertebral bodies during inspiration whilst in the prone position.[11] During full expiration, around 80% of the upper pole lies above the 12th rib and at the end of expiration, when using a supracostal approach, the pleura may be traversed on the right in about 29% of cases and on the left in 14% of cases.[12] The diaphragm arises from the tip of the 10th to 12th ribs posteriorly and as high as the 7th rib anteriorly.[5] It appears clear from the above anatomic description that supracostal punctures will usually traverse the diaphragm, and many of these punctures will also pierce the pleura.

Endourologists have employed a variety of techniques to reduce the incidence of complications during supracostal puncture. Some suggest to keep the puncture site as medial as possible, close to the lateral border of the erector spinae muscle, with a maximum lateral angulation not more than 30 to 35 degrees to avoid injury to the spleen, liver, and colon.[13] Others recommend that the puncture should ideally be over the lateral half of the rib,[14] avoiding the lower rib margin in order not to puncture the intercostals vessels. With the patient in full expiration, the surgeon should traverse the retroperitoneum and diaphragm with the needle to prevent any potential injury to the lung, whilst the needle is passed into the renal collecting system through the parenchyma during full inspiration to enable full downward displacement of the kidney.[15] The Amplatz sheath should be placed well in to the collecting system and a well-draining nephrostomy tube should be placed in the end to minimize the leakage of urine into the pleural space.[16]

Some go further and advocate a subcostal entry even for the upper pole calculi.[17] However, this often very oblique course has its own potential complications and limitations. The acute entry angle makes the use of rigid instruments to access the renal pelvis very difficult as well as increasing the risk of trauma during manipulation of the rigid instruments. The risk of injuring the peri-infundibular vessels would also be increased in this position.

One important point to consider during supracostal puncture is the kidney movement during respiration. The kidneys tend to move in a tilted sagittal and coronal plane.[18] One study shows that the maximum vertical motion of the superior pole from its end-expiratory to its end-inspiratory position can be almost 40 mm.[18]

From the prior discussion, it would appear that access above the 12th rib is relatively safe, but access above the 11th rib should be avoided if possible due to increased risk of complications.[2] Some have stated that supra-10th rib puncture should always be avoided.[2] Even those who say that supracostal renal punctures are effective and safe, with low and acceptable complications, state that these should be attempted in selected cases and with caution.[14,19,20]

With these thoughts in mind, we have started using a technique to inferiorly distract the kidney prior to a potentially high supracostal percutaneous puncture in order to reduce the risk of pleural and chest complications. This "inferior distraction" of the kidney lowers the percutaneous access point, and is a valuable technique useful in all supracostal, but especially upper pole punctures.

CASE REPORT

We report a technique used to inferiorly distract the kidney safely during upper pole punctures for complex endourological procedures, such as percutaneous nephrolithotomy, in order to lower the entry point into the kidney. This has the potential to reduce intrathoracic complications during supracostal renal access whilst allowing the surgeon to place an ideal access into the calyx. We have carried out this technique in our last 10 upper pole punctures without any increased morbidity whilst lowering the percutaneous puncture site by an average of 3.2 cm.

TECHNIQUE

This technique is suitable during supine PCNL, including any modified supine position where simultaneous retrograde and anterograde access is possible, especially for complex upper pole calculi, where a lower pole puncture alone would not be enough to achieve clearance (Figure 1), or in high-lying kidneys and in those where direct access to the UPJ is required

Figure 1. An initial retrogradely placed guidewire in the collecting system to help carry out filling of the kidney prior to the anterograde lower pole puncture. An access needle is marking the upper pole calculus.

Figure 2. A retrograde study confirming an upper pole stone. Note the long and relatively narrow upper pole calyceal neck.

Figure 3. Note the lower pole inferior distraction wire introduced anterogradely. Comparing the position of the upper pole stone in relation to the adjacent vertebral bodies with Figure 2 (both images in full inspiration with the C-arm of the image intensifier in the same position) clearly shows the inferior distraction of the kidney.

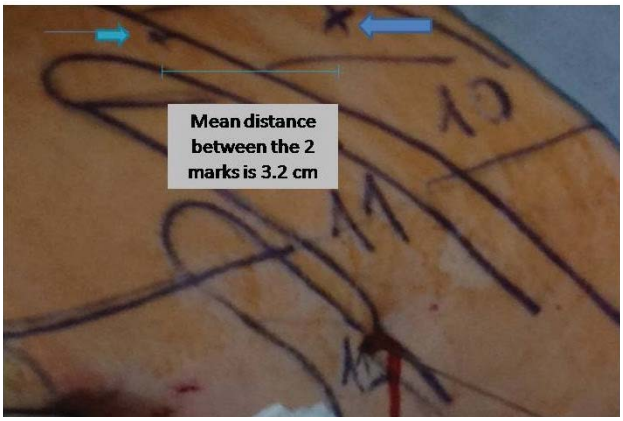

Figure 4. The long thick arrow point shows the location of the upper pole stone in inspiration before the inferior distraction wire is placed. The short thin arrow shows the location of the stone in inspiration after the inferior distraction wire is placed.

and where the ideal puncture is likely to be supra-10th rib or supra-11th rib. Once retrograde filling of the collecting system has been carried out (Figure 2), we introduce a hydrophilic guidewire via a suitable lower pole calyx into the collecting system and manipulate it down the ureter (Figure 3) and into the bladder, where it can be grasped with forceps introduced via a cystoscope and externalized via the urethra leaving a

through-and-through wire. Each end of this wire is then put under tension by gentle caudal traction either by an assistant or by fixing the wire under gentle traction onto the drapes at both ends using standard mosquito clips (we would like to stress the importance of gentle traction) and this serves two purposes. Firstly, it stops the respiratory-related movement of the kidney, which makes the puncture technically easier and safer in a lower position than would otherwise be possible. As has been mentioned in some studies, respiratory-related kidney movement may be up to 40 mm. Secondly, it enables further caudal distraction of the kidney, which also helps lower the ideal puncture site and therefore, reduces the risk of pleural injury as has been alluded to in the literature earlier. With this inferior renal distraction wire in place and under gentle tension, a further percutaneous puncture into the ideal calyx is carried out and the procedure is performed as standard.

RESULTS

We have carried out this technique safely and without any increased morbidity for our last 10 upper pole punctures with the percutaneous puncture site being on average 3.2 cm lower (in full inspiration) after the inferior distraction wire has been placed and put under gentle tension (Figure 4). This downward displacement of the kidney is evident when one compares the placement of the upper pole stone (marked with access needle) in relation to the vertebrae in Figures 3 and 4.

In 6 cases, a potential supra-10th rib puncture was made into a supra-11th puncture and in 4, a supra-11th puncture turned in to a supra-12th puncture. In all cases, the upper pole puncture was made in the line of the calyx and hence, access into the renal pelvis subsequently was straightforward with relatively easy manipulation of the instruments, which is more difficult if an oblique entry is made into the calyx.

There was no incidence of pneumothorax or other thoracic complications. Clearance of stones was achieved in all 10 cases after successful upper pole punctures.

DISCUSSION

The literature is clear in stating that supracostal percutaneous renal punctures carry a higher risk of pulmonary and intra-thoracic complications.[15] This risk appears to progressively increase with higher punctures positions. The evidence suggests that supra-11th rib punctures carry a higher risk than supra-12th punctures.[1-8] Some state that supra-10th rib punctures should be avoided altogether.[2]

Some investigators have used lung inflation to achieve inferior renal distraction in order to more safely carry out upper pole puncture.[21] In one series, the superior calyx was accessible in the complete supine position using this technique.[21] However, the puncture site was subcostal meaning that the tract is likely to be angled, which means that manipulation of instruments and entry into the renal pelvis and UPJ would be more difficult.

When a supracostal puncture is deemed necessary, any technique that would help achieve an ideal access in the line of the desired calyx, especially for high-lying upper pole stones, whilst lowering the access site, would be potentially very useful. Our technique of placing a "through-and-through" lower pole wire under gentle caudal traction at both ends helps lower the entry point into the kidney (mean of 3.2 cm in our cases) and hence, has the potential to reduce intra-thoracic complications whilst still potentially allowing the surgeon to try and place an ideal access into the required calyx.

We have found this a safe and effective technique with no increased morbidity and we would like to highlight its use during supracostal punctures to lower the access point. It is particularly useful for upper pole punctures where supra-11th or even supra-10th access may otherwise often be needed to achieve good or ideal access. Not only it lowers the kidney and hence makes the access potentially safer, it also stops the kidney moving during respiration and hence, makes the puncture easier as this would normally require coordination with the anesthetist for controlling breathing.

CONFLICT OF INTEREST

None declared.

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