Ultrasonography-Guided Punctures—
with and without Puncture Guide*

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Abstract

The key requisite of any percutaneous nephrolithotomy technique is access to the collecting system. The kidney has a high degree of vascular network and is liable for vascular injury. Therefore, for an ideal puncture, a percutaneous tract would be developed that leads straight from the skin through a papilla and the target calix into the renal pelvis. Percutaneous renal access can be achieved under fluoroscopic control or using an ultrasonography (US)-guided puncture. The shortcomings and side effects of extensive radiation during therapeutic procedures are well known. The choice of method for the type of access depends on training and personal preference. The advantages of US-guided puncture are avoidance of radiation, avoiding adjacent and visceral injury and, most importantly, intrarenal vascular injury. US offers the shortest and straight access to the collecting system with minimal morbidity. US-guided access is of particular importance in the pediatric population and in special situations in which the procedure is performed with the patient in the supine position. I believe US-guided puncture has a significant reduction in complications. The available ultrasound probes come with a puncture attachment and, on US scanning, the puncture pathway is represented by an electronic dotted line on the scanner screen, which facilitates exact placement of the needle. US-guided access is optimal with a needle guide, because the electronic dotted line helps in assessing the depth and plane of the puncture needle. This helps in reaching the desired calix in the most accurate way. US access without a needle guide is useful in bedside procedures, in grossly hydronephrotic systems, and nonavailability of an electronic guide. We think the punctures with this technique are suboptimal. Both methods need a certain degree of training and orientation. The training in US should be structured.

Introduction

The key requisite of any percutaneous nephrolithotomy (PCNL) technique is access to the collecting system. The kidney has a high degree of vascular network and is liable for vascular injury. Therefore, for puncture, the ideal would be to develop a percutaneous tract that leads straight from the skin through a papilla and the target calix into the renal pelvis. This is a basis for any percutaneous procedure.

Percutaneous renal access can be achieved under fluoroscopic control or using an ultrasonography (US)-guided puncture. The shortcomings and side effects of extensive radiation during therapeutic procedures are well known. The choice of method for access depends on training and personal preference.

We prefer to gain percutaneous renal access by using US scanning with a puncture attachment. The advantages of gaining access with US attachments are many. The dotted line on the screen represents the likely pathway for the needle to travel to the target calix. At a few centers, where ultrasound probes are devoid of such attachments, the punctures are likely to be suboptimal.

US-guided punctures with a needle guide

This is the method of choice at our center. We use the 3.5/5 MHz (BK Medical, Herlev, Denmark) probe with a puncture attachment. Once a ureteral catheter is passed across the ureter, the patient is placed in a prone position (Fig. 1), although we have also been performing US-guided punctures with the patient in the supine position. We typically keep one bolster under the lower chest and the other bolster at the level of the iliac crest. We believe that, with the patient in the prone position with bolsters in this position, the bowels and viscera tend to fall, thus minimizing the chance of bowel injury.

To establish access, US scanning commences posterior and proceeds until the posterior axillary line. If scanning is performed in this way, the first calix to be seen will be the posterior calix. The site of needle entry is marked, and puncture is accomplished with the help of an 18-gauge echo tip (Cook

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*A video demonstrating this technique is available on the enclosed CD ROM and online at www.liebertonline.com/end.
Medical, Bloomington, IN) needle. The key point at this crucial step is that there should be minimal respiratory movement and movement of the ultrasound probe.

Scanning the kidney parallel to the 12th rib should correspond to the plane of the pelvis and lower calix. The dotted line on the US screen corresponds to the needle excursion through the puncture guide attachment. This is followed by aligning the dotted line so that it is in a straight line along the skin, renal parenchyma, cup of the calix, infundibulum, and pelvis.

Once the proper direction is confirmed, the needle is pushed through the puncture guide attachment, and one can visualize the excursion of the needle, which will travel along the dotted line to the desired calix. On removal of the stylet, clear fluid indicates proper placement. If one uses a bivalved tip, sharp needle and if there is no tissue resistance, then one will be able to see the excursion along the dotted line—three-dimensional vision. Puncture guide ensures that the needle travels the line that you have chosen, also you can control the depth by measuring the distance on the dotted line.

We have been successfully performing our access with US guidance in PCNLs performed with patients in the supine position and also in the pediatric population.2,3 In a prospective study by Basiri and associates4 wherein they compared US-guided access with fluoroscopic access. They found US access to have comparable results with fluoroscopy. Among the significant advantages, they were able to make a diagnosis of retrorenal colon in one case with US. They further stress the fact that use of US helps to detect residual stones intraoperatively.4

Basiri and colleagues4 describe totally US-guided PCNL, including tract dilatation. We do the initial US-guided puncture and then perform the rest of the procedure, such as dilatation, introducing the Amplatz sheath under fluoroscopy guidance. Our policy in managing staghorn calculi is “multiperc.” US helps us in attaining multiple accesses and guidewires in the desired calix at the outset. This may become difficult as the procedure progresses, because of poor vision or because of extravasation.

Apart from US for the initial access in PCNL, US can also be used for deobstructing the pelvicaliceal system in obstructive anuria and in pregnant patients.

The most serious limitation of US is the learning curve that is associated with it. Apart from recognizing the anatomy and the adjacent viscera, the operator also needs to have a three-dimensional orientation of the renal fossa and the kidney.

The training in US-guided punctures should be structured. The learning curve at our center is shortened by hands-on training on urologic US in the outpatient department during residency training. This is followed by PCNLs in patients with grossly hydronephrotic systems. Later, the trainee graduates to performing PCNLs initially in patients with simple stones and then in patients with large complex calculi.

**US-guided punctures without a needle guide**

Although suboptimal, US-guided punctures without a needle guide can be helpful in situations such as bedside nephrostomies and nonavailability of equipment.

The ultrasound transducers do not possess a puncture guide and an electronic dotted line. The operator places the probe and scans the concerned renal unit. The “probable” path of the needle is marked along with the puncture site, and access is gained; because the puncture is without a puncture guide, the needle may deviate and may not be seen on the screen. Precise puncture may not be possible. Then fluoroscopy is performed with contrast instillation in the collecting system. Puncture is made with some adjustment of the needle with fluoroscopy guidance.

Alternatively, in grossly hydronephrotic kidneys, the ultrasound probe helps in the access in the paraspinal area, followed by opacification of the pelvicaliceal system. Later, under fluoroscopic guidance, a puncture is performed in an appropriate calix. This technique adds to fluoroscopy exposure and defeats the advantage of ultrasound.

The serious limitation of the technique is that, although the ultrasound probe shows the kidney and the calices, it does not show the full depth and plane of the path that the needle traverses; as a result, the chance of visceral injury increases.

**Conclusion**

US-guided access is optimal with a needle guide, because the electronic dotted line helps in assessing the depth and plane of the puncture needle. This helps in reaching the desired calix in the most accurate way. The operator needs to be experienced in the use of US with this technique.
US-guided access without a needle guide is useful in bedside procedures, grossly hydronephrotic systems, and non-availability of an electronic guide. We feel the punctures with this technique are suboptimal.

Both methods require a certain degree of training and orientation. The training in US should be structured.

Disclosure Statement

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References


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Abbreviations Used

PCNL = percutaneous nephrolithotomy
US = ultrasonography