ORIGINAL ARTICLE

ULTRASOUND AS A RELIABLE GUIDANCE SYSTEM FOR PERCUTANEOUS NEPHROSTOMY

Tariq Mahmood, Raza Younus,* Fayyaz Ahmad, Shakoor Memon and Ameer Moavia**

ABSTRACT

Objective: To determine the effectiveness and safety of ultrasound as a reliable guidance system for percutaneous nephrostomy (PCN).
Study Design: Quasi-experimental.
Place and Duration of Study: Jinnah Postgraduate Medical Center, Karachi, Pakistan, from January 1997 to July 2005.
Patients and Methods: One hundred and fifty-three PCN were performed in 140 patients, referred from the Department of Urology and Transplantation, JPMC. Out of 140 patients, 137 had obstructive uropathy (>1 cm dilated pelvicalyceal system) of different etiologies. Three patients with ureteral rupture (non dilated pelvicalyceal system) underwent PCN for urinary diversion in the surgical ICU. The technique involved a pre procedural scan, initial renal puncture, placement of a guide wire, tract dilation and placement of 8-12 F Nephrostomy tube, entirely under ultrasound guidance. The machine used was 'Just vision' or 'Eccocee' with 3.5 MHz variable frequency convex transducer. Effectiveness in terms of successful tube placement and safety in terms of complications were observed.
Results: Out of 153 patients there were 78 males and 62 females. The minimum age of patient was 13 years while maximum age was 68 years, all (100%) patients had successful placement of PCN. Minor complications like transient gross hematuria and small perinephric collection occurred in 13 cases (8.5%) but was dealt with effectively by conservative measures. No major complications like hemorrhage, sepsis or periorgan damage were encountered in any of the patients.
Conclusion: Ultrasound was found to be a rapid, effective, radiation-free, portable and safe imaging modality with minimum rate of complications that could be used as a reliable guidance system for critical interventions like percutaneous nephrostomies without using fluoroscopic units.

KEY WORDS: *Ultrasound guided. Percutaneous nephrostomy. Obstructive uropathy.*

INTRODUCTION

Percutaneous Nephrostomy (PCN) catheter placement was initially described by Goodwin in 1955.[1,2] It is now considered an essential component in the treatment of upper urinary tract obstruction when a retrograde route proves anatomically or technically unattainable.[3-5] PCN shows technically high success rates, short hospital stay and is comparatively more comfortable.[6-8] In some cases, it may increase the opportunity for later reconstructive surgery and decrease likelihood of renal loss.[9-11] Further experience has led to its use in several situations i.e., for placement of permanent drainage and for a variety of interventional uroradiologic and endourologic procedures.[9,12] PCN has established significance due to its low mortality, fewer complications and use of local anesthesia, compared to other procedures.[13-15]

Traditionally, PCN is being performed under the fluoroscopic guidance system. Because of its established, well-taught and practiced role, good visualization of the opacified urinary tract and the catheter therein, other modalities like ultrasound has been greatly underused in this regard. Presently, because of the high cost and non-availability of fluoroscopy, virtually non-existent in remote areas of underdeveloped countries, the decision to perform PCN under ultrasound guidance may no longer be a matter of choice, but rather a matter of necessity. The objective of this study was to determine the effectiveness and safety of ultrasound as a reliable guidance system for percutaneous nephrostomy.

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PATIENTS AND METHODS

History of bleeding diathesis, prothrombin time and platelet count of patients were evaluated before the procedure. All patients had normal or corrected bleeding profiles (with vitamin K, FFP or platelet transfusion).

The entire procedure, i.e, US probe manipulation, initial renal puncture and the subsequent steps were performed by the Radiologist with the help of an assistant to stabilize the probe. During the interventional procedure, Urologist cover was available in all cases.

It was a quasi-experimental study, conducted at the Radiology Department, JPMC, Karachi, from January 1997 to July 2005. All patients with dilated pelvicalyceal system, referred to department for PCN, were included. Three patients requiring transient urinary diversion were also included.

Ultrasound machine 'Just vision' or 'Eccocee' both of Toshiba with 3.5 MHz variable frequency convex transducers were used with 8.0-12 F nephrostomy sets.

Consent was taken after informing the patients about the benefits and risks associated with this intervention, the other alternates and cooperation was sought during the procedure for successful placement of the percutaneous nephrostomy.

Patients were placed in the lateral decubitus position with a pillow beneath the dependant side. A pre-procedural ultrasound scan was done to plan the procedure by locating the lower pole calyx from the posterolateral abdominal wall, choosing the closest approach from the skin while avoiding any viscera.

We preferred and used lumbar region in lateral decubitus position as the site of safest approach. Under local anesthesia and aseptic conditions, skin nick was given. The initial renal puncture was made with 18G needle under continuous real time guidance with the free hand technique. After successful puncture of calyx, using Seldinger technique, a 0.35G guide wire was placed to dilate the tract. Dilatation and the insertion of nephrostomy tube were all carried out under real time Ultrasound guidance. Images shown in Figure 1a and 1b depicts guide wire and PCN catheter in situ. Diagnostic sample from calyx was saved for analysis.

Three patients (1.96 %) with ureteral rupture had non-dilated pelvicalyceal system underwent PCN in the Surgical ICU with the administration of IV fluids, diuretics and injection of normal saline into the calyx, that temporarily dilated the pelvicalyceal system aiding the procedure.

A postprocedural scan was performed to look for any complications. Immediate postprocedural antegrade Nephrostogram was performed in initial 30 procedures, which was hardly performed in the rest of the cases due to the improved level of our confidence and expertise.

Effectiveness of ultrasound guided percutaneous nephrostomy in terms of successful tube placement and safety in terms of complications was observed.

RESULTS

One hundred and fifty-three percutaneous nephrostomies were performed in 140 patients between January 1997 and July 2005, at the Jinnah Postgraduate Medical Centre, Karachi. Thirteen patients had bilateral procedures. All the patients were referred from the department of Urology and Transplantation, Jinnah Postgraduate Medical Center, Karachi.

Except 3 cases, pelvicalyceal systems of all patients were dilated more than 1.0 cm secondary to obstruction of the lower urinary tract because of stone, stricture, benign or malignant growth. Three patients with rupture of ureter had non-dilated pelvicalyceal system and they underwent PCN for urinary diversion.

There were 78 males (55.7%) and 62 females (44.3%), aged between 13 to 68 years. The success rate in terms of PCN placement was 100%. No major complications such as sepsis or periorgan bowel, liver, spleen or lung injury or hemorrhage requiring transfusion or open control occurred. Only 13 patients (8.5%) developed transient small hematoma or small perinephric collection i.e. urinoma, but were effectively managed by conservative measures. In 5 patients (3.3%) upto three punctures from the same skin nick were made due to unsatisfactory site of puncture and position of needle in calyx while in 4 cases (2.6%), due to unsuccessful placement of catheter, new skin nick was given at a different site and new tract was made for insertion of PCN. Out of these 4 patients, in 2 cases, guide wire also got kinked while dilating the tract and PCN got displaced at the time of pulling the guide wire and new guide wire was used. Average time taken in the procedure was 20 minutes ranging from 15 to 25 minutes.

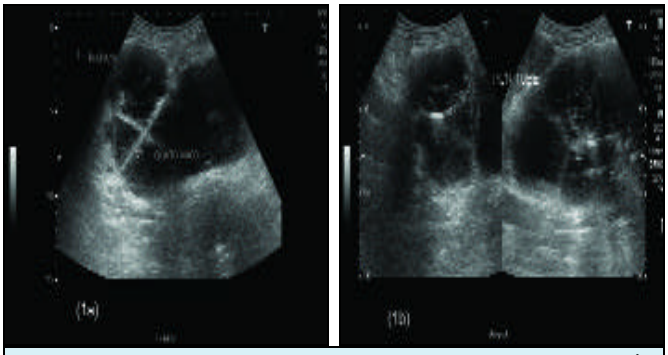

Figure 1a: Depicting guide wire in pelvicalyceal system, and **(1b)** PCN tube in situ.

DISCUSSION

Percutaneous nephrostomy is now an established stock in the urologic armamentarium with a success rate of at least 90%.[3] It allows imaging of an effective therapy in selected patients with urinary tract pathology. A thorough knowledge on the anatomical relationships, variations and topographical landmarks remain a more effective key to prevent the complications.[9] Many radiologists with various levels of training perform this procedure with obvious variations in success and complications rate. PCN is an invasive procedure with recognized risk of complications. Lack of proper guidance system may lead to hazardous results. Fatal lumbar artery bleeding, as a complication of PCN, in a patient with coagulopathy, has been reported.[16] Use of self-fabricated Nephrostomy catheters are more cost-effective compared to commercially available catheters with internationally comparable results.[17]

Revolutionary developments in the radiological diagnosis and interventional therapy of diseases of the genitourinary tract have made percutaneous nephrostomy as the procedure of choice in almost all cases of urinary obstruction requiring temporary drainage of the urinary tract.[18,19] In some cases, it may increase the opportunity for later reconstructive surgery and decrease likelihood of renal loss.[9-11] PCN under sole ultrasound guidance has been reported in pregnant women and children to avoid radiation exposure.[20-23]

PCN can be accomplished in a number of ways and the guidance system used varies from institution to institution (including fluoroscopy, ultrasound + fluoroscopy, CT or MRI). While in earlier series, intravenous contrast media and fluoroscopy were used to visualize the pelvicalyceal system; now ultrasound is being generally used.[10,11] The most common practice worldwide is to use ultrasound for the initial renal puncture and fluoroscopy for the subsequent procedure.

Because of the limited availability of fluoroscopy in the third world and its high cost, we investigated the role of Ultrasound as a reliable guidance system for percutaneous nephrostomy. Ultrasound was found to be a very useful modality in this

interventional procedure. Though Color Doppler is helpful for vascular mapping but the decision for tract was hardly influenced by the Color Doppler findings, that is why only gray scale guidance system was included in this study.

Compared to prone position used in fluoroscopy, the lateral decubitus position with a pillow on the opposite side lumbar area has many advantages: First of all, it widens the access (subcostal area) and stretches the skin facilitating instant skin puncture and pushing the abdominal structure that gravitates down exposing the kidney; and hence lateral abdominal wall was the preferred site of cutaneous puncture in our study. Finally, the kidney in this position rests on the vertebral body and so does not get displaced while being pricked. It is well fixed and supported by the vertebral body facilitating renal puncture.

In contrast to fluoroscopy, the real time ultrasound imaging provided excellent cross-sectional anatomic details[9] that enabled to access the kidney in a single puncture with confidence, except in nine cases (discussed in the result section). The characteristic "give" and aspiration of urine confirmed the correct placement of the needle but in cases of mild dilatation 10-20 cc of normal saline was injected through the needle and observed under ultrasound guidance while injecting.

In fluoroscopy, the operator can only image contrast-filled pelvicalyceal system and cannot see renal and extra-renal structures. While ultrasound shows all the tissues along an intended nephrostomy tract from skin to renal pelvis including bowel loops and/or vessels, if any, which the operator has to avoid and can prevent hazardous results.[16] By simply shifting, tilting and rotating the head of the ultrasound transducer, a three-dimensional information during puncture is easily obtained.

Free hand technique was used that allowed direct visualization of the needle, but the operator has to make sure that the position of the needle remains confined to the slice thickness of the transducer. To further aid needle visualization, instead of moving the needle in and out (a risky procedure), it was preferred to move the stylet back and forth within the needle.

A single hold of breath before the renal puncture was all that was necessary but in uncooperative patients or those who could not hold their breath, it was crucial to synchronize the timing of puncture with the rhythm of renal movements with respiration, otherwise the needle tip would cause fissuring injury to the kidney.

In 04 patients (2.6%) kinking of the guide wire occurred as the dilator was advanced too farther. This resulted in displacement of the catheter as the kinked guide wire was pulled out, therefore, a new guide wire was required for reinsertion of the same catheter. So the "technical-tip" is that after passing the guide wire, mark the needle from the cutaneous puncture site before removing the initial puncture needle; after withdrawing the needle, accurately measure the depth of needle from the skin to calyx and make sure that you don't advance the dilator more than the calculated depth or maximum 1.0 cm more.

The other advantages of ultrasound are, it does not use ionizing radiation or contrast material, less expensive and widely available. It is less time-consuming and especially useful in emergency situations. With portable ultrasound, PCN can be done on the patient's bedside (e.g. in surgical ICU etc). Moreover, ultrasound can also identify pathologies like stone, cyst, growth and can facilitate a variety of therapeutic procedures. Its usefulness is also obvious in pregnancy and non-dilated systems.

CONCLUSION

Ultrasound was found to be a rapid, effective, radiation-free, portable and safe imaging modality with minimum rate of complications that could be used as a reliable guidance system for percutaneous nephrostomies without using fluoroscopic units.

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