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Original Contribution

FEASIBILITY AND USEFULNESS OF INTRA-CAVITARY CONTRAST-ENHANCED ULTRASOUND IN PERCUTANEOUS NEPHROSTOMY

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Abstract—The aim of this study was to evaluate the feasibility and utility of intra-cavitary contrast enhanced ultrasound (ICCEUS) in guiding percutaneous nephrostomy (PCN) and assessing complications. Forty-five ultrasound-guided PCNs were performed in 35 patients with hydronephrosis resulting from urinary tract obstruction. Ultrasound contrast agent (0.1 mL diluted in 20–30 mL saline) was injected through the puncture needle and the drainage tube to precisely locate the device and obstruction, with the fluoroscopy results considered the gold standard. ICCEUS was performed again the next day to assess complications. All 45 PCNs were successfully performed under the guidance of ultrasound. With ICCEUS, we could confirm the correct insertion of needle and catheter and locate the obstruction in all 35 patients, with fluoroscopic results as the gold standard. Catheter dislodgement was diagnosed by administration of ultrasound contrast agent in 5 patients. Hematoma (1 patient) and urine leakage (1 patient) were also observed. With the advantages of lack of exposure to radiation, performance in real time and bedside availability, ICCEUS has the potential to become a new modality to guide PCN and assess catheter-related complications. (E-mail: christoph.dietrich@ckbm.de) © 2016 World Federation for Ultrasound in Medicine & Biology.

Key Words: **Percutaneous nephrostomy, Ultrasound, Contrast agents, Kidney, Complication.**

INTRODUCTION

Percutaneous nephrostomy (PCN) has been performed for 60 y and remains the prime procedure for temporary drainage of an obstructed collecting system when the transureteral approach is not indicated or feasible (Hausegger and Portugaller 2006; Wah et al. 2004). PCN is also used for urinary diversion and to gain access to the urinary tract for subsequent interventional urologic procedures. The different imaging methods used to guide PCN have been widely described, and the technique used in this procedure varies among institutions and countries.

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The procedure can be performed under the guidance of fluoroscopy (Barbaric et al. 1997), ultrasound (US) (Nielsen and Grossmann 1990; Pedersen 1974; von der Recke et al. 1994), computed tomography (Barbaric et al.1997; LeMaitre et al. 2000) and magnetic resonance imaging (Fischbach et al. 2011; Kariniemi et al. 2009), as well as various combinations of these (Barbaric et al. 1997; Moschouris et al. 2009; Sim et al. 2002). US plays an important role in PCN because of its advantages of bedside availability, low cost and lack of radiation (Fischbach et al. 2011). However, radiologic methods with contrast agents may be necessary to determine whether the puncture needle and PCN catheter have been successfully inserted into the renal pelvis, the site of obstruction and some complications, such as catheter dislodgement and urinary leakage. Therefore, US-guided puncture of the collecting system with subsequent placement of the drainage tube under fluoroscopic control is regarded as the standard modality for PCN (Fischbach et al. 2011; Kavanagh et al. 1997).

Ultrasound contrast agents (UCAs) are administered intravenously in most indications (Ignee et al. 2013), and intravenous contrast-enhanced ultrasound (CEUS) has been established as a tool for clinical applications. Less is known of the intra-cavitary administration of UCA (intra-cavitary CEUS [ICCEUS]), except in imaging of vesico-ureteral reflux or the passage of the fallopian tube (Darge 2008; Lanzani et al. 2009). In general, ICCEUS can be used to image physiologic body cavities (*e.g.*, peritoneal cavity, pleural cavity, biliary tract, gastrointestinal tract, urinary tract) and non-physiologic body cavities (abscesses, cysts, hypopharynx diverticulum) (Ignee et al. 2009, 2013; Piscaglia et al. 2012). ICCEUS does not require exposure to ionizing radiation and can be performed at the bedside. The limitations are similar to those for conventional US; for example, ICCEUS is limited by superimposed structures like bones and air. The use of ICCEUS is still off-label, but it is considered a safe technique (Cui et al. 2015; Papadopoulou et al. 2014).

The aim of this study was to evaluate the feasibility and usefulness of ICCEUS in US-guided PCN and assessment of complications. Furthermore, ICCEUS and fluoroscopy were compared to evaluate whether ICCEUS can replace fluoroscopy in PCN.

METHODS

Patients

From 2011 June to 2013 January, 35 patients underwent US-guided PCN. The sample comprised 26 males and 9 females. Mean age was 69 ± 12 (38–91) y, height 1.73 ± 0.08 (1.60–1.91) m, weight 82.77 ± 13.36 (48.00–104.70) kg, and body mass index (BMI) 27.62 ± 3.82 (18.75–35.29) kg/m^2, with values expressed as the mean ± standard deviation (range). Ten of the 35 (29%) patients had bilateral urinary tract obstruction; therefore, a total of 45 PCNs were performed. The dilation of the renal pelvis of 45 kidneys measured 22.71 ± 5.72 (12–33) mm. Criteria for inclusion in and exclusion from the PCN group are summarized in Tables 1 and 2, respectively, and the causes of urinary obstruction (indications for PCN) are summarized in Table 3. All patients had impaired renal function. Pre-procedural antibiotics were used in all patients. Written informed consent for the procedure and study was submitted by all patients. The study was conducted according to the principles of the Declaration of Helsinki and was approved by the institutional review board.

Study settings and materials

Percutaneous nephrostomy was performed in an X-ray room. Two US systems were used in the study: the GE Logiq E9 US system (GE Medical Systems, Milwaukee, WI, USA) was used to guide PCN in 12 of 35 (34%) patients and to assess complications in 25 of 35 (71%) patients; the Siemens ACUSON Sequoia 512 platform (Siemens Healthcare, Erlangen, Germany) was used to guide PCN in 23 of 35 (66%) patients and to assess complications in 10 of 35 (29%) patients. Multifrequency convex array probes with a puncture frame were used in each platform.

Table 1. Criteria for inclusion in percutaneous nephrostomy group

- Relief of urinary obstruction related to malignancy, urinary stones or iatrogenic causes
- Pyonephrosis
- Urinary diversion in patients with urinary fistula, leakage or hemorrhagic cystitis
- Providing access for endourologic procedure, such as nephrolithotomy and removal of urinary stones and dilation or stenting of a ureteral stricture
- Diagnostic testing, such as antegrade pyelography and ureteral perfusion (Whitaker test)

Dietrich et al. (2016).

The materials included a 21G puncture needle, 0.018- and 0.038-in. Teflon-coated stainless-steel guidewires, conventional 8F and 11F dilators, a polyurethane pigtail nephrostomy catheter (8F for drainage of non-infected urine, 12F for drainage of infected urine or pus) and a catheter plug (Peter Pflugbeil, Zorneding, Germany). The UCA was prepared by diluting 0.1 mL of SonoVue (Bracco, Milan, Italy) in 20–30 mL saline solution.

For conventional fluoroscopy, the non-ionic iodinated contrast agent Ultravist (240 mg I/mL, Schering, Germany) was diluted with sterile saline at a ratio of 1:3.

Procedure

All procedures were performed by a urologist with more than 20 y of experience in performing PCN, but no experience in using UCAs; therefore, a sonographer with more than 5 y of experience in performing CEUS assisted with administration of the UCA.

Patients were positioned in the prone-oblique or prone position. The kidney was assessed by US to identify the degree of hydronephrosis and the target "renal calyx"; in addition, the puncture site and entry

Table 2. Criteria for exclusion from percutaneous nephrostomy group

- Renal vascular malformations such as arterial aneurysm
- Severe life-threatening electrolyte imbalances such as hyperkalemia and severe metabolic acidosis
- Uncorrectable severe coagulopathy
- First-trimester of pregnancy to minimize radiation exposure to the fetus

Dietrich et al. (2016).