An Uncommon Variation of Femoral Vascular Anatomy Complicating Central Venous Access in an Infant

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Abstract

An infant with severe hydrocephalus presented to the operating room for a craniotomy and cyst fenestration. After the induction of anesthesia, an attempt was made to place a femoral venous catheter for use during the perioperative period. The cannulation was complicated by arterial puncture. Ultrasound imaging revealed the femoral vein in an uncharacteristic position, completely posterior to the artery. The vein was successfully cannulated using real-time ultrasound scanning to avoid the artery. Practitioners placing these catheters should be aware of the potential for anatomical variation, and consider using ultrasound imaging before or during the procedure to reduce the risk of complications.

CASE REPORT

A 6-month-old male was admitted to San Diego Children's Hospital for evaluation and treatment of congenital hydrocephalus (Figure 1.) He was born in Mexico, and his initial treatment there was not successful, so his parents sought a second opinion in the US. Evaluation of the child, which included intracranial imaging, revealed severe hydrocephalus due to multiple large cysts, and significant brain tissue loss (Figure 2.) After review of the case, the decision was made to surgically fenestrate the cysts and place a shunt. The patient arrived in the operating room with a 24 gauge intravenous catheter in place, after an eight-hour fast. Following the induction of anesthesia, the left radial artery was easily cannulated with a 22-gauge catheter. Due to the need for significant post-operative care for this infant with a history of difficult venous access, we opted to place a central venous catheter in the femoral vein. The groin was chosen for this access site due to the patient's large head and to avoid potentially impeding cerebral venous drainage with a catheter in the jugular vein.

After a sterile prep and drape, and using aseptic technique, a 21-gauge, 2.5 cm introducer needle (Argon Medical Devices) was used to puncture the femoral vein just proximal to the inguinal ligament. The needle was inserted at a 30-degree angle, just medial to the palpated arterial pulse. After 2 failed attempts, both of which resulted in inadvertent arterial puncture, real-time ultrasound was used to image the vascular anatomy (Figure 3.) Ultrasound imaging revealed the femoral vein was directly posterior to the artery just superior to the inguinal ligament. This anatomic anomaly was seen throughout the course of the femoral vein from the inguinal ligament to the takeoff of the profunda vein in the proximal thigh. This was also seen on the right femoral vessels. To assist with accessing the femoral vein, real-time ultrasound was used to image the vessels during the procedure. The needle was moved lateral to the vessels and was aimed medially underneath the artery, avoiding arterial puncture. After venipuncture, a 0.18 gauge J-wire was inserted through the needle, followed by dilation and catheter insertion to 8 centimeters over the wire. Repeat ultrasound scanning revealed no evidence of arterial puncture with the wire only in the vein. Radiography confirmed correct placement and the catheter was used for the surgery and postoperative care (Figure 4.) This central venous catheter was removed after ten days of use in the ICU and it caused no complications for the patient.

Figure 1

Enlarged head due to hydrocephalus.

Figure 2

Computerized Tomography: a. Sagittal view showing large cysts and minimal brain tissue b. Axial view showing septa between the cysts

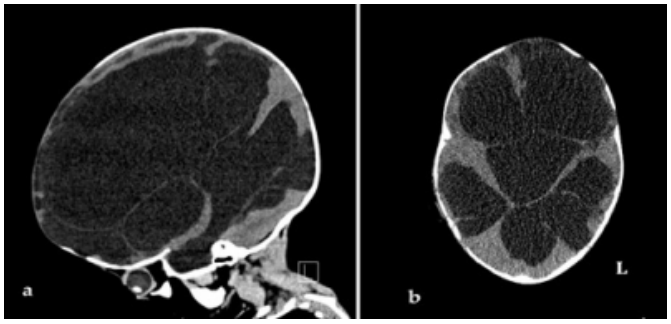


Figure 3

Ultrasound image of femoral vascular anatomy. Femoral vein (white arrow) seen directly posterior to the femoral artery just at the inguinal ligament

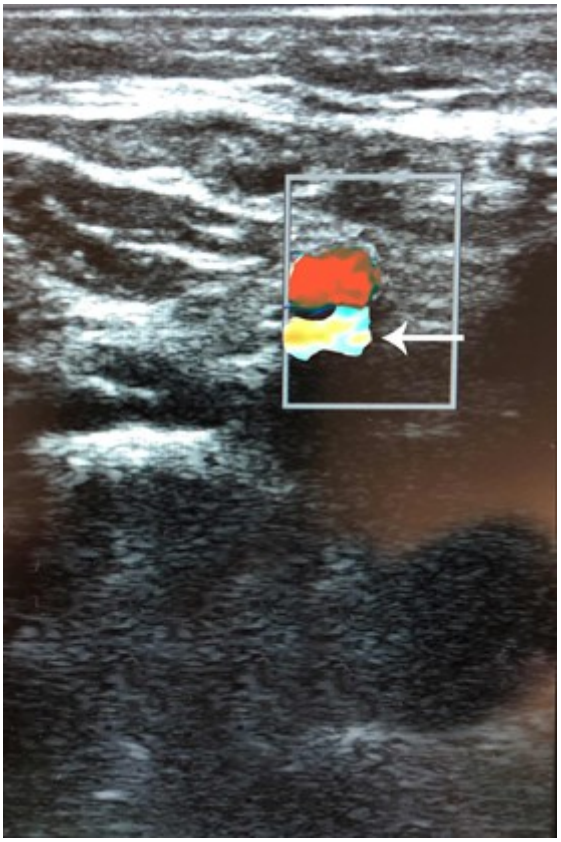
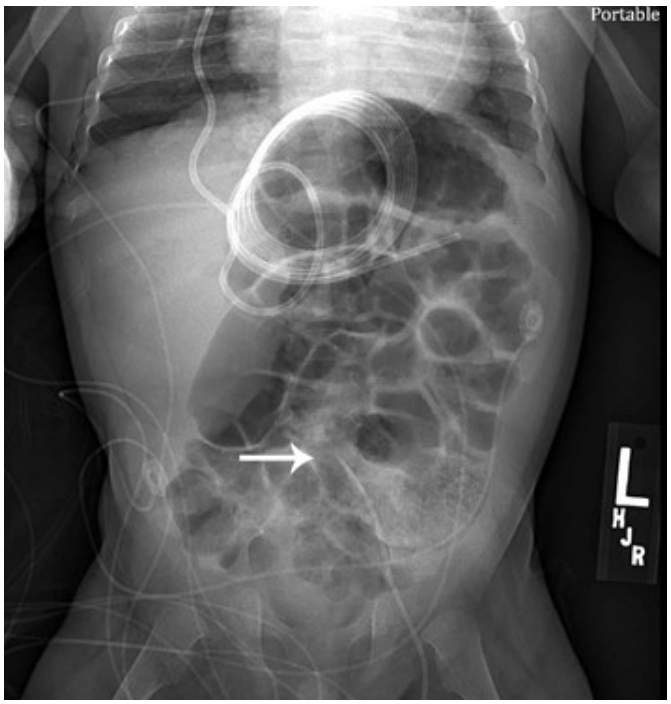


Figure 4

Abdominal radiograph showing the tip of the femoral venous catheter in the distal vena cava



DISCUSSION

The incidence of congenital hydrocephalus varies dramatically between continents, but is a little less than 1 per 1000 births in the USA, and about 3 per 1000 births in Latin America.[1] Massive cystic hydrocephalus is a rare cause of congenital hydrocephalus, although arachnoid cysts are common (one Swedish study found them in about 2% of adults,[2]) and usually asymptomatic. After reviewing the literature, we found no known association between brain cysts and anomalies of the heart or great vessels. Even in the absence of an anticipation of abnormal vessel anatomy, however, infants are more challenging for line placement than most adults, due to their small size. This baby required reliable vascular access for use during the surgery and afterward, thus necessitating a central line. Despite easy arterial catheterization, placement of a femoral central venous catheter was complicated by difficult access of the vein because it was aberrantly oriented posterior to the artery.

The anatomy of the venous system in humans varies, and truncular venous malformations of the femoral veins are not uncommon, 12% in the study by Ule et al. [3] Using anatomic landmarks has long been a standard method for cannulation of vessels, but since its introduction in the 1980s, ultrasound guided imaging has been gaining in favor for use for obtaining vascular access. In multiple studies, ultrasound utilization has been shown to increase success and decrease complications, especially in the trainee. Although much of the data is incomplete, and none of the studies clearly teases out the role that experience plays, practitioners with higher skill levels and more experience may not routinely utilize ultrasound guided imaging.[4,5,6] Complications including hematoma, hemorrhage, pneumothorax, thrombosis, vessel injury, pseudoaneurysm, and arteriovenous fistulae are all a concern when placing central venous access in a large vessel.[7,8] Interestingly, despite years of ample evidence that ultrasound improves many parameters of line placement, it has not been universally adopted by practitioners. A 2018 survey of Dutch intensivists and anesthesiologists found that only 68% of respondents used ultrasound always or most of the time when placing central lines.[9] Negative associations included not being in a teaching institution, an opinion that ultrasound added extra time onto the procedure, a fear of losing landmark skills, and a false perception that ultrasound does not reduce complications.

The anesthesiologist placing this particular catheter had extensive experience in line placement, both with and without real-time ultrasound, and frequently places lines using landmarks with great success. Saugel et al found in their meta-analysis that ultrasound use reduced complications most often with internal jugular catheter access, and that its benefits for femoral vein cannulation were less evident, thus they do not necessarily recommend routine use in this application.[8] For this patient though, upper body central venous lines were less desirable due to this significant hydrocephalus. In such a situation, where choices for venous access sites are limited, even the experienced practitioner would be prudent to use ultrasound initially to improve success on the first attempt. Given the availability of ultrasound at most institutions and training patterns which now favor the use of ultrasound as a first line technique, its use should become more routine. As it has essentially no side effects, ultrasound use to identify the anatomy before passing the needle, even if it is not used in real-time during the procedure, seems warranted.[10]

The ASA Practice Guidelines for Central Venous Access 2020 state:[7]

- Use real-time ultrasound guidance for vessel localization and venipuncture when the internal jugular vein is selected for cannulation.
- When feasible, real-time ultrasound may be used when the subclavian or femoral vein is selected.

- Use static ultrasound imaging before prepping and draping for pre-puncture identification of anatomy to determine vessel localization and patency when the internal jugular vein is selected for cannulation.
- Static ultrasound may also be used when the subclavian or femoral vein is selected.

CONCLUSIONS

An increased frequency of vascular anomalies in patients with hydrocephalus has not been reported. This patient had cannulation of the femoral vein complicated by its aberrant relationship, posterior rather than medial to the femoral artery. Real-time ultrasound was used to successfully guide needle placement to avoid arterial puncture during the insertion procedure, after the landmark technique was inadequate. We recommend the use ultrasound prior to central line placement to evaluate vascular anatomy, and possibly during the insertion to aid in cannulation of the desired vessel to improve success and decrease complications.

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