

Out of the Darkness and into the Era of Direct Visualization and Deliberate Practice

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ARTERIAL cannulation is often required in anesthetized pediatric patients to facilitate hemodynamic monitoring or frequent blood sampling during major surgical procedures such as intracardiac and neurosurgical procedures, among others. In small children and neonates, successful arterial cannulation is technically challenging and may require multiple attempts at different locations. Most anesthesia providers will initially target cannulation of the radial artery and possibly the femoral artery as a second choice. In contrast, specialists in pediatric critical care and neonatology may also rely on the vessels of the foot, including the dorsalis pedis and posterior tibial arteries.

In this issue of *ANESTHESIOLOGY*, Kim *et al.*¹ report their findings of a comparison of arterial cannulation success between different anatomical locations in small children. In their two-part study, Kim *et al.* first conducted a suitability trial by using sonography to compare the diameters, cross-section areas, and depths of the radial, posterior tibial, and dorsalis pedis arteries in infants less than 2 yr of age. The second part consisted of a single-blinded randomized study that evaluated the first-attempt cannulation success rates at these three anatomical locations using ultrasound guidance and the incidence of posterior arterial wall puncture. The authors demonstrated that first-attempt success rates were similar for the posterior tibial and radial arteries, both of which were significantly greater than for the dorsalis pedis artery. Similarly, the rate of posterior arterial wall puncture was significantly greater when



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the dorsalis pedis artery was targeted compared with the posterior tibial and radial arteries. These success rates directly correlated with increased vessel sizes as seen by ultrasound visualization. In other words, the authors demonstrated that the cannulation failure rate was inversely proportional to vessel size as seen by ultrasound.

The availability and utilization of sonography to facilitate performance of invasive procedures in pediatric anesthesiology (e.g., regional anesthesia, central and peripheral venous access) have continued to grow rapidly. However, despite a growing body of evidence demonstrating the superiority of the use of ultrasound with respect to arterial cannulation first-attempt success rate in adults and children, the routine use of ultrasound for arterial cannulation has not become standard practice.²⁻⁶ The use of ultrasound for real-time visualization offers a number of benefits above that of arterial pulse palpation. The use of ultrasound allows arteries to be preemptively imaged for size, depth from the skin surface, and tortuosity, all of which allow for selection of the most suitable artery for cannulation and will often vary between individual patients. The use of ultrasound provides magnification of the artery, thus avoiding having to use the transfixation (“through and through”) technique that necessarily results in posterior arterial wall puncture, which increases the risk of arterial leak and localized hematoma. Furthermore, using palpation only, the actual arterial size may be overestimated based on the perceived strength of the pulse. The impressively small size of an

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Fig 1. Photograph of a radial artery cut-down in an infant. A 0.38-mm guidewire is being placed inside the artery to be used to facilitate insertion of a 24-gauge catheter, seen at the *bottom left* of the photograph.

actual infant radial artery is nicely demonstrated during an arterial cut-down (fig. 1). The photograph shows the infant's radial artery being cannulated first by a 0.38-mm diameter intraluminal guidewire, which will be followed by over-the-wire insertion of a 24-gauge intravenous catheter (*bottom left* of the photograph). Looking at this photograph, it makes us wonder how these relatively tiny arteries are ever successfully cannulated without the use of direct visualization.

An additional advantage to the use of ultrasound for arterial cannulation is that it facilitates trainee education and acquisition of expertise. In a recent publication that used arterial sampling in an infant as an example of a difficult technical procedure, we proposed a framework that relies upon the principles of deliberate practice, which consists of the combination of continuous supervision and performance feedback to achieve independent expertise.⁷ Based on this principle, we predict that the consistent use of ultrasound to cannulate small pediatric arteries will facilitate the

subsequent success of this technique in locations or situations that do not have ultrasound availability and where practitioners must rely on arterial palpation and knowledge of arterial anatomy alone.

By demonstrating the use of ultrasound to determine alternate and effective sites of radial line access in young children, Kim *et al.* have provided an important contribution to the body of knowledge of pediatric anesthesia clinical practice and patient safety. In the interest of patient care and trainee education, we advocate for the standard use of ultrasound guidance to facilitate arterial cannulation in children of all ages, especially infants, and for practitioners to use this technique to evaluate alternate cannulation sites, in addition to the radial artery, when invasive monitoring is required.

Competing Interests

The authors are not supported by, nor maintain any financial interest in, any commercial activity that may be associated with the topic of this article.

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