High frequency micro-ultrasound for vascular access in young children: A feasibility study at the High frequency Ultrasound in Kids study (HUSKY) group

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ABSTRACT

Cannulation of small arterioles and veins in young children can be challenging. Although anesthesiologists frequently use ultrasound for placement of central venous lines and nerve blocks, its use for cannulation of small, peripheral vessels is less helpful. Ultrasound systems (7.5-15 MHz) currently used in clinical practice focus poorly at the sub-10 mm space and thus lack the resolution to allow accurate ultrasound-guided cannulation of small vessels. High frequency micro-ultrasound (HFMU) is a new technology that allows higher resolution (15-50 MHz) compared to conventional ultrasound. Limited human studies have been performed thus far with HFMU, and none have been performed in young children or for vascular access.

This study was conducted to determine the feasibility of using HFMU to visualize and cannulate peripheral arteries and central veins in children under the age of 6 years old. The diameter of radial and ulnar arteries were also measured.

The anesthesiologists involved in this study found the 50 MHz HFMU probe useful for cannulation of peripheral arteries, especially in the youngest children. The experience gained in this feasibility study suggests that HFMU could be a valuable addition to our armamentarium for difficult vascular access in the future.

METHODS

- **Cannulation of small arterioles and veins in young children.** Arteries of the wrist are usually shallower than veins in young children. Portable ultrasound systems used in clinical practice focus poorly at the sub-10 mm space and thus lack the resolution to allow accurate ultrasound-guided cannulation of these small vessels.

- **High frequency micro-ultrasound systems.** In anesthesia, there is a need for high resolution of the vessel wall to allow accurate ultrasound-guided cannulation of small vessels. The Ultrasound system (High frequency micro-ultrasound) has been shown to be very useful in this regard.

- **Current limitations of portable ultrasound systems used in anesthesia.** The Urosonic 2000 machine (Visual Sonics, Inc., a subsidiary of Sonosite, Bothell, WA, USA) is the first commercially available machine to feature this high frequency micro-ultrasound (HFMU) imaging system. The machine is equipped with 5.0, 10, 30, 40, and 50 MHz probes. The 50 MHz probe is only capable of imaging to a depth of 50 mm but has a resolution of 30 microns; for comparison, a red blood cell has a diameter of 8 microns.

- **Limits of HFMU.** While the HFMU system has been shown to be very useful, it is limited by the size of the probes available. The probes are only 2 cm in length, which limits their use in small children.

- **RESULTS.**

  - **40 children under 6 years who required arterial access were recruited.** No parent refused consent. All arterial lines were placed after induction of general anesthesia for a surgical procedure, and all were placed with HFMU. The success rate of HFMU cannulation was 92%.

  - **Safety and efficacy.** No complications were reported with the use of HFMU. The success rate of HFMU cannulation was 92%.

  - **Comparison to conventional ultrasound.** The HFMU system was compared to conventional ultrasound, and the HFMU system was found to be more effective in cannulating small vessels.

  - **CONCLUSIONS.** The HFMU system is a valuable addition to our armamentarium for difficult vascular access in young children.