

Title:

Prospective Comparison of Standard Technique, Doppler Ultrasonography, and Arterial Pressure Transduction for Confirming Correct Intraosseous Catheter Placement

Authors:

Vanessa Soetanto, MD¹; Scott Ferrara, DO²; Omry Zuckerman, DO¹; Ariel Sena, MD³; Ilya Ostrovsky, MD³; Stephen Alerhand, MD³; Yonatan Greenstein, MD², FCCP

Institution:

1. Department of Internal Medicine, Rutgers New Jersey Medical School; 2. Division of Pulmonary & Critical Care Medicine and Allergy & Rheumatology, Rutgers New Jersey Medical School, Newark, NJ; 3. Department of Emergency Medicine, Rutgers New Jersey Medical School

Background:

Intraosseous (IO) catheters allow rapid administration of medications to critically ill patients when intravenous access is not feasible. Improperly placed IO catheters can cause complications such as limb necrosis and osteomyelitis. There have not been prospective studies comparing methods to confirm correct IO catheter placement. This study utilizes a novel method using pressure transduction (Method 3) as the control comparison to the standard of care (Method 1) and ultrasound Doppler (Method 2).

Methods:

This is a single-center prospective study of IO catheter placement confirmation. Method 1 criteria for correct placement: (1) stability of catheter; (2) ability to aspirate blood or marrow; (3) ability to flush without extravasation. Method 2 criteria: Doppler signal only in the IO space. Method 3 criteria: a pulsatile arterial waveform by pressure transduction of catheters. Since bone marrow is contiguous with the intravascular space, the presence of pulsatile waveforms correlating with the heart rate indicates correct placement. Images of Methods 2 and 3 were stored and reviewed by two blinded physicians. Results of Methods 1 and 2 were compared to Method 3.

Results:

Twenty-nine IO catheters were placed. Gold standard confirmation from expert blinded physicians (Method 3) demonstrated 21/29 to be correctly placed. Using method 1, bedside clinicians incorrectly classified 7/8 misplaced catheters as correctly placed and correctly classified all properly placed catheters (100% sensitivity, 12.5% specificity). Using method 2, bedside clinicians incorrectly classified 4/8 misplaced catheters and 2/21 properly placed catheters (90.5% sensitivity, 50% specificity). Blinded physicians reviewed the images from method 2, incorrectly classifying 4/8 misplaced catheters and 3/21 properly placed catheters (85% sensitivity, 50% specificity). Inter-rater agreement for Methods 2 and 3 were 89.7% and 93.1%, respectively. No complications from IO catheters were observed.

Conclusion:

The standard and Doppler ultrasonography techniques have poor specificities, making them unreliable for detecting misplaced IO catheters.

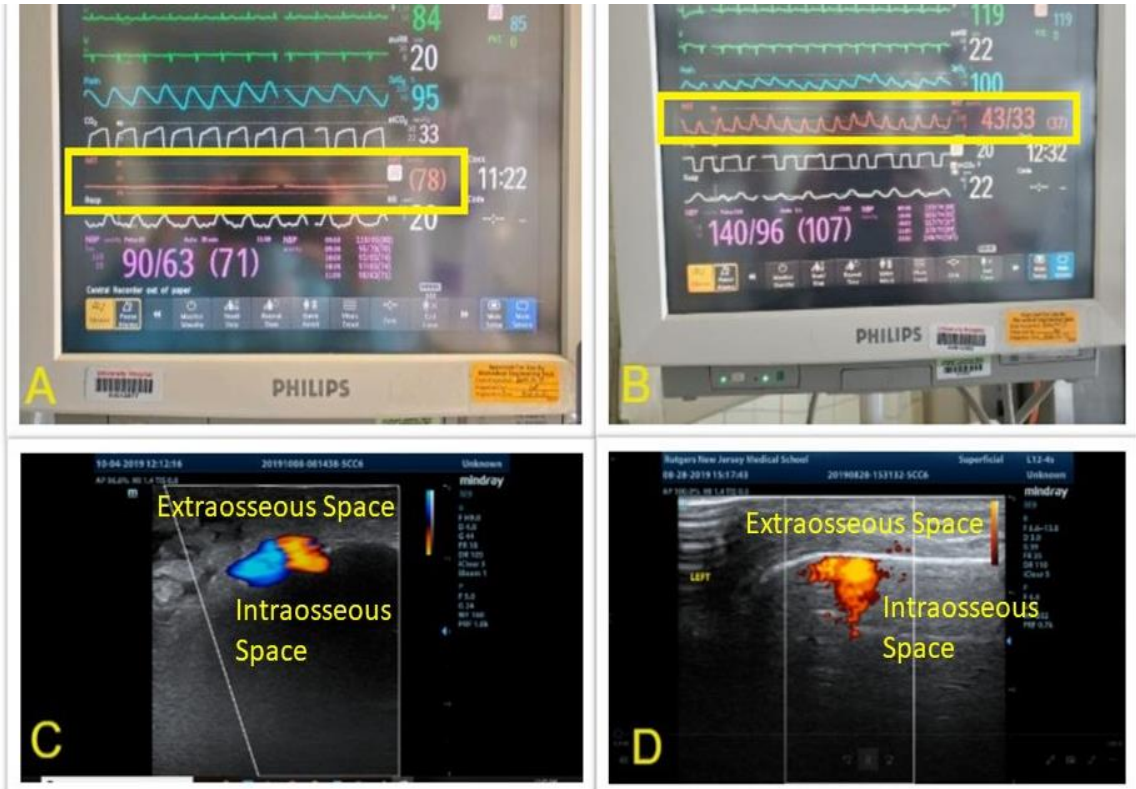


Figure 1A. Incorrect IO catheter placement by pressure transduction with flatline waveform.
 Figure 1B. Correct IO catheter placement by pressure transduction with pulsative waveform.
 Figure 1C. Incorrect IO catheter placement by ultrasound Doppler method with extrasosseous Doppler signal.
 Figure 1D. Correct IO catheter placement by ultrasound Doppler method with intraosseous Doppler signal.