HIGH-FIDELITY, LOW-COST PORCINE TRAINING MODEL FOR ARTERIAL LINE PLACEMENT

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Background/Introduction:
Ultrasound-guided arterial line technique is a crucial skill in many medical specialties. New trainees can benefit from gaining familiarity in ultrasound maneuvering and arterial line technique in a safe simulation environment. We designed a novel, low-cost, high-fidelity, meat-based model that also incorporates a flashback mechanism that mirrors placement of arterial line in real patients.

Methods:
We used a meat-based vascular access model made from pork shoulder and other common materials found in our anesthesia supply room. This model is low cost and can be easily constructed within 5 minutes. The final setup is as shown in Figure 1. A list of ingredients and materials is as follows:

> Pork shoulder, hemostats, plastic tray, gravity blood set tubing with pressure pump or primary IV tubing, pressure sleeve, 1000mL or 500mL NS, ultrasound gel, arterial line kit, ultrasound, sutures (to enclose IV tubing within pork slices).

We prepared the pork by slicing thinly across roughly 3mm from the surface. Next, the tube is primed partially, making sure to leave some air at the distal tip and capping it off or clamping it off with a hemostat. This column of air generates increased compressibility of the fluid and aids in generation of pulsatile fluid movement within the tube, detectable with ultrasound color mode. The tubing and fluid bag is pressurized in the sleeve, and a syringe is attached at the proximal end to facilitate the generation of pulsations (Figure 2). In addition to the pressurized system, the depressed syringe generates pressure (likened to systolic pressure) on top of the baseline pressure (likened to diastolic pressure), resulting in reproduced pulsatile flashback (Figure 3). Lastly, the tubing is placed between the pork flaps and the layer is filled with ultrasound gel.

Discussion:
Ultrasound guided arterial line placement requires spatial orientation and hand-eye coordination. Radial arterial line is arguably the most challenging and humbling procedure out of the vascular access procedures we commonly perform. Advances in simulation suggest that early exposure to simulation for medical students and residents is beneficial [1-3]. The ideal phantom should be affordable, easy to assemble, have similar tissue texture resistance and tactile feedback to human tissue and arteries. It also needs to have comparable ultrasound appearance as the real thing, not just the vessels but the background echogenicity. Lastly, the phantom should be able to replicate the entire arterial insertion experience from beginning to the end. We believe that the model we have described fits all of the criteria described. Our training model is able to produce ultrasound images and tactile feedback that resemble real human tissue. In addition, the arterial blood flashback mechanism with varying “blood pressure” points can be adjusted mimicking hypotensive patients in shock. Immediate period after getting arterial

puncture can be a common point where trainees panic or freeze up, especially with arterial blood shooting out. This allows trainees to experience the “real deal” in a simulation situation without putting real patients at risk.

Conclusion:

Ultrasound guided arterial line insertion is a must have skill, especially for procedural heavy fields. This procedure can be particularly challenging and frustrating for new trainees. This article describes a cost-effective model that simulates many essential aspects of the arterial cannulation procedure. This concept is intended to help medical students and residents learn and practice arterial line insertion in a low-risk, low-cost, and low-stress environment.

References:

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2. Lenchus J, Issenberg SB, Murphy D, et al. A blended approach to invasive bedside procedural instruction. Med Teach 2011; 33:116–123
3. Wang EE, Quinones J, Fitch MT, et al. Developing technical expertise in emergency medicine: the role of simulation in procedural skill acquisition. Acad Emerg Med 2008; 15:1046–1057.

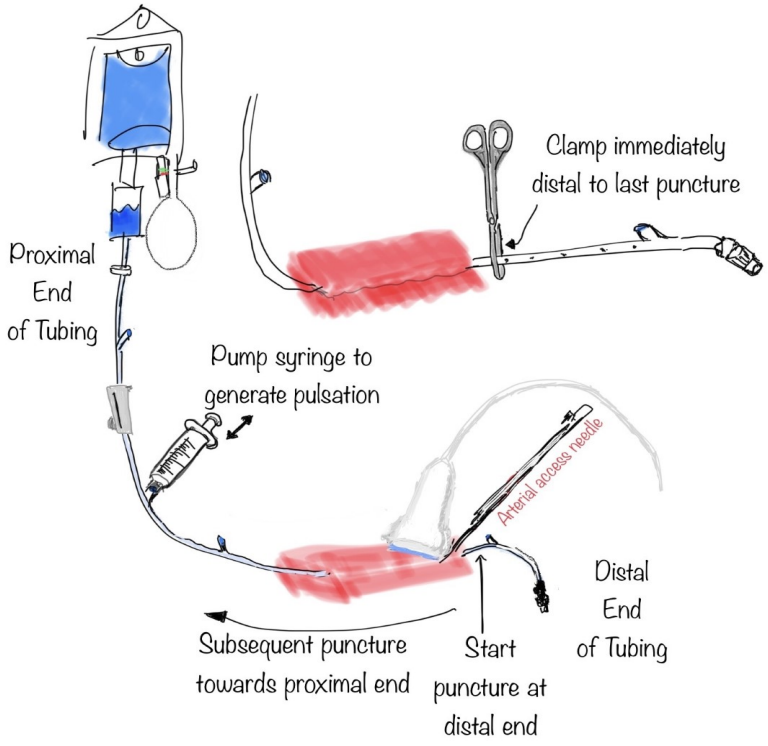

Figure 1. Setup schematic

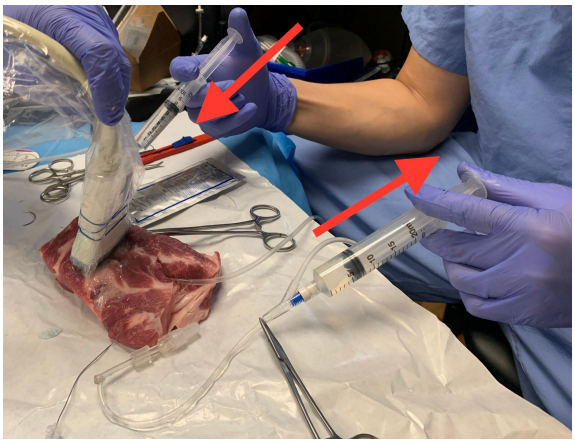

Figure 2. Demonstrates pulse generation with syringes

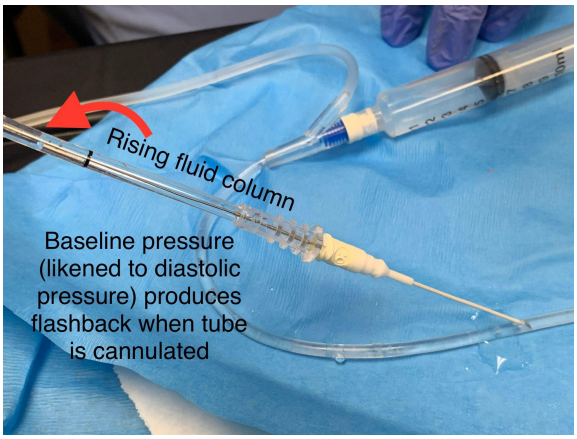

Figure 3. Flash back mechanism simulated