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Challenges in Surgical Education

Improving Low-Cost, Reusable Pericardiocentesis Models with Synthetic Gelatin

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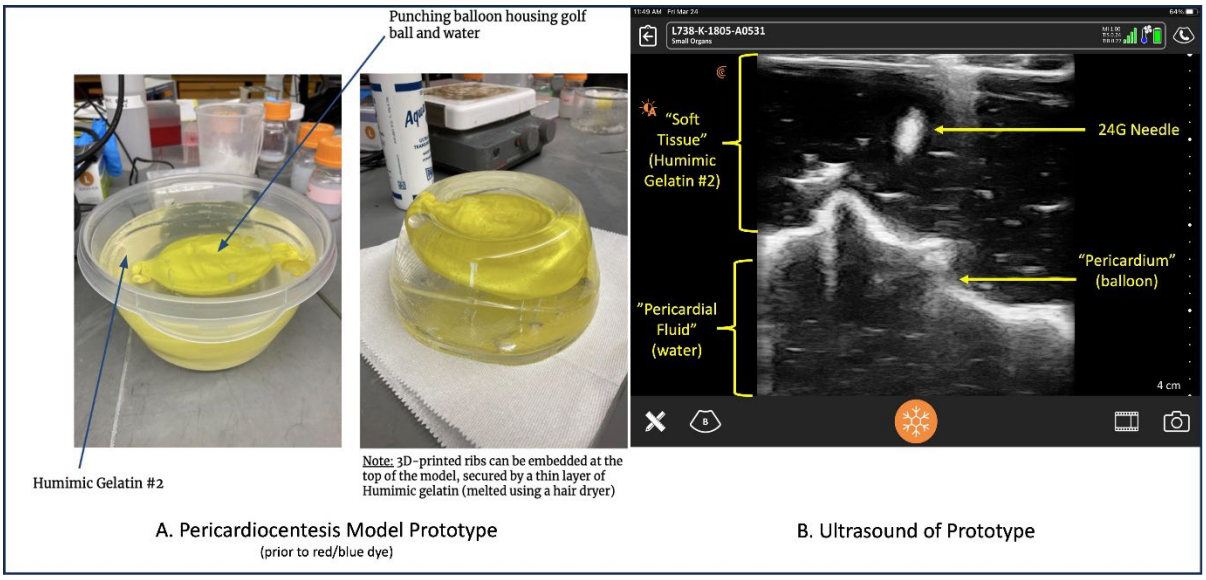
Background: Emergent pericardiocentesis is lifesaving in cardiac tamponade. Due to its rare occurrence, trainees must use simulation models to learn and practice this critical procedure.

Current Challenges: Commercially available models offer high fidelity, durability and reusability but are expensive. Literature-based DIY models are low-cost but often achieve fidelity with biologic gelatin/protein (ultrasoundable, but prone to mold), do not maintain structure at room temperature, and require prolonged assembly times.
Recent publications tackle issues of fidelity, cost, durability, and reusability; however, they focus on initial build and do not discuss the recasting process in detail.

Need of Innovation: Our prototype was based on a previous low-cost simulation model1, in which a golf ball (heart) was placed inside a balloon (pericardium), the balloon filled with water (pericardial fluid), and then embedded in biologic gelatin (skin/soft tissue). Our model replaced biologic gelatin with synthetic gelatin (Humimic Gelatin #2).

To create our model, melted synthetic gelatin was poured into a plastic container around the balloon. We melted and recast our model ten times. We conducted mechanical testing to verify that the synthetic gelatin maintained mechanical properties. After analysis, the ultimate tensile strength, modulus of resilience, and modulus of toughness were statistically similar between recasts. The synthetic gelatin resisted more punctures and set faster (20 minutes) compared to the original biologic gelatin model (overnight). All components were visible under ultrasound, and cost-benefit analysis determined that the synthetic gelatin was a better option than biologic gelatin due to improved recast-ability and decreased assembly time. Next steps include modeling heart contractility and beta testing with trainees.

[1]Zerth, H., MD, Harwood, Robert, MD, MPH, Tommaso, L., MD, & Girzadas, D. V., MD. (2012). An inexpensive, easily constructed, reusable task trainer for simulating ultrasound-guided pericardiocentesis. The Journal of Emergency Medicine, 43(6), 1066-1069. https://doi.org/10.1016/j.jemermed.2011.05.066



A. Pericardiocentesis Model Prototype
(prior to red/blue dye)

B. Ultrasound of Prototype