Advancing Interventional Radiology Training through 3D Printed Resin Molds

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Introduction

- Integration of 3D printing in medical education has resulted in a rapidly growing field of hands-on, immersive learning experiences
- Within the field of IR, simulation training provides trainees the opportunity to practice in a risk-free environment while providing tactile feedback, an easier way to understand the spatial relations between anatomical structures, and procedural realism.
- Although there are numerous commercially available models for hands-on education, 3D printing provides an avenue for the creation of endlessly customizable models with varying anatomies, pathologies, and scenarios for all levels of training and education.
- Resin printing allows for a more accurate, detailed, and smoother model when compared to traditional extrusion printing

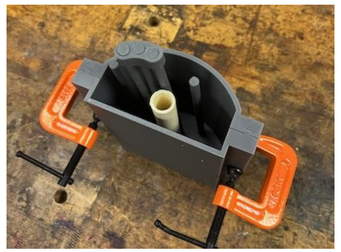
Methods

Creating a relatively low-cost model for practicing ultrasound-guided femoral vein and upper-arm vein access:

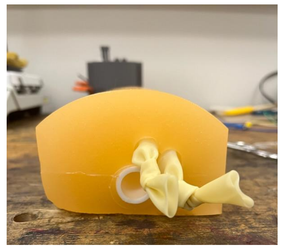
- Resin printers can create smooth-walled molds that can include hollow structures such as arteries, veins, or ducts.
- Ballistics gel poured into these molds creates a surrounding soft tissue structure.
- After removing the cooled gel from the mold, Penrose drains are inserted to create pressurized vessel walls, and PVC pipes are used to create bone cortex.

Models

A.



B.



C.

A. 3D printed resin mold with inserts for vessels and bone for arm (above) and leg (below)

B. Axial (above) and coronal (below) view of leg model

C. Clear models (left), dyed models (middle), and clear models with embolization beads (right)

Results

- One mold was able to create multiple models, convenient for large group teaching and easily rebuilding gel models that develop air artifacts.
- Embolization beads can be mixed into the gel to replicate the heterogeneity of skin and fascia seen on ultrasound.
- Additionally, dyes can be added to create a more realistic model.
- This technique can create models to simulate a variety of procedures such as ultrasound-guided arterial or venous access and fluoroscopically-guided catheterizations with various levels of difficulty.

Discussion

- Hands-on simulation training remains a critical method for learning IR skills.
- Femoral and arm vein access models can be created using relatively inexpensive materials.
- Educators can create and share computer designs for local 3D printing using increasingly accessible resin printers, allowing greater access to simulation.

Acknowledgements

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