ACS 2022 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Promoting Technology and Collaboration

High-Fidelity Simulation: A Perfused Cadaver Model to Teach and Practice Vascular Access, Control, and Repair

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Background: Increased utilization of minimally invasive and endovascular techniques as well as changes in the residency training environment have resulted in declining trainee experience with complex open surgical cases, particularly in vascular and trauma surgery. Low incidence and high mortality of major vascular injuries require trainees and practicing surgeons to improve and maintain their skills using high-fidelity simulation.

Technology Overview: Cadaveric tissue dissection is the most "realistic" model for surgical anatomy, particularly of major vascular structures. In our surgical dissection lab, we use cadavers combined with a pump system to achieve perfusion and thus maximal realism to practice access, control, and repair of major vascular structures. We trialed multiple pump systems, including centripetal, interrupted flow, and peristaltic methods prior to settling on a diaphragm roller pump design for this application. The valved and regulated design allows for establishment and control of pulsatile rate, stroke volume, and pressure using a closed-loop feedback control system. The result is realistic peripheral flow and venous return from proximal cannulation. The model uses retroperitoneal access to the aorta allowing for torso perfusion without disrupting anatomy in important junctional areas such as the groin. Figure 1 demonstrates femoral vessels before (1a) and after (1b) perfusion.

Potential Application in Surgical Simulation and Education: High-fidelity simulation for surgical and vascular anatomy is critical for trainees and surgeons in all operative specialties as well as clinicians in anesthesia (practice of airway management and vascular access), interventional radiology and cardiology, and pre-hospital personnel in both civilian and military settings. Perfused cadaver models also allow for practicing ultrasound-guided access to vessels, which is an invaluable skill for emergencies in the pre- and in-hospital setting.

Potential Opportunities to Collaborate: Successful establishment of a high-fidelity, pressurized cadaver model requires collaboration between surgeons of different specialties, engineers, and trainees. It promotes collaboration between in-hospital and pre-hospital providers as well as providers in a civilian and military environment.
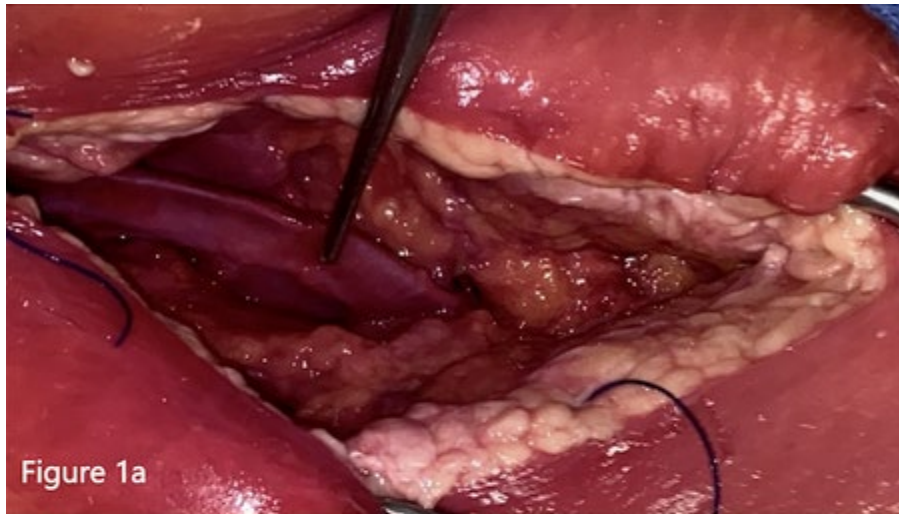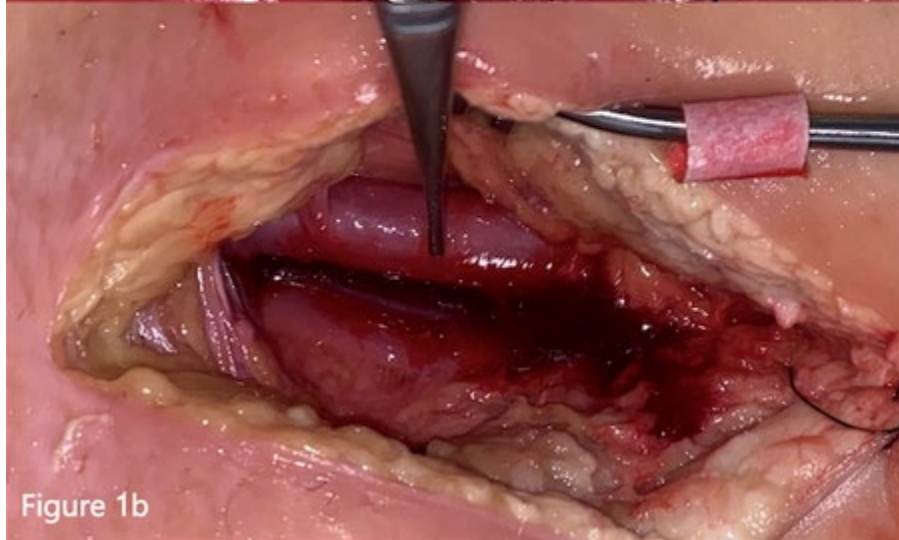
Figure 1a

Figure 1b