ACS 2025 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

P-C-07

Research In-Progress

Simulation and Visualization of Left Ventricular Outflow Tract Obstruction

Rabin Gerrah; Danielle Niemann; and Maycee Gielow

Stanford University, Palo Alto, CA; Good Samaritan Regional Medical Center, Corvallis, OR

Introduction: Left ventricular outflow tract (LVOT) obstruction is a complex cardiac problem. Currently no optimal model for studying this problem exists. We designed a model to simulate the hemodynamic effect and to visualize LVOT obstruction, for better understanding and planning the treatment of this disease.

Methods: A fresh porcine heart was used in this study (Figure 1). First, a circulatory mock system was created on this porcine heart by suturing a Polytetrafluoroethylene (PTFE) inside the left atrium as an inflow and another PTFE tube to aorta as the outflow. The inflow tube was connected to the outflow of a continuous flow pump and the outflow was connected to a rigid tube filled with variable amount of sponge to simulate peripheral resistance. A borescope was placed in the apex of the heart to visualize the LVOT. A solution of water and glycerin, that mimics blood properties was used as the flow media. LVOT obstruction was simulated by injection of water in the LVOT, creating tissue expansion and narrowing. Pressures were measured to assess the LVOT obstruction, and the developing gradients in the LVOT.

Preliminary Results: With a fixed pump flow of 4 L/min, the amount of sponge in the aorta was adjusted to achieve a distal pressure of 120mmHg, representing the aortic pressure. With this adjustment, the pressure in the inflow (pre-LVOT), was 135mmHg, indicating a near-normal intracardiac gradient. LVOT obstruction that was simulated by injection of water in the LVOT, increased the gradients up to 80mmHg. The pressure gradient escalation visually corresponded to degree of LVOT obstruction.

Next Steps: This simulator was designed to operate on continuous flow. In the next step, we plan to study the model under pulsatile flows that better mimic the real-life conditions and add doppler studies to achieve a perfect model.

Setup and Visualization of the Simulated Left Ventricular Outflow Tract Obstruction