ACS 2023 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Promoting Technology and Collaboration

Utilizing 3D Printing and Injection Molding to Create Kidney Models for Surgical Resident Training Prior To Transplant Rotations

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Background: UW Transplant faculty expressed a desire to introduce residents to kidney transplant vascular anastomosis prior to beginning their transplant rotation to improve both learning and patient outcomes. Increased warm ischemic time due to prolonged anastomoses have been found to affect early graft function and long-term graft survival (Halloran et al 1988; Hatsuse et al 1998; Hellegering et al 2012). To counteract these deleterious effects, a curricular session was implemented, tracking both time and quality of anastomoses, and collecting data about resident experience/comfortability with kidney transplants. UW Clinical Simulation Program created a novel clock face 3D—printed simulator for use in these sessions to address the educational gap.

Technology Overview: MRI images were converted to STL files by the Radius Medical Imaging Analysis team at the University of Wisconsin School of Medicine and Public Health's Department of Radiology to create a 3D printed negative mold of a solid kidney without internal structures or vasculature. This was secured within a plastic cylinder approximately three inches below the surface to create a cavity. Silicone blood vessels were created and attached to the kidney to simulate the renal artery and renal vein, while a second pair of vessels were suspended within the cylinder to imitate the recipient vessels. The objective of this session was to perform two end-to-side anastomoses while recording the time needed to complete.

Potential Application in Surgical Simulation and Education: This cost-effective method of surgical training allows for rapid-cycle-deliberate-practice by learners in order to gain proficiency in time-sensitive procedures that do not allow for a traditional teaching approach while in the operating room. With minimal investment in 3D printing technology and software, the patient imaging that is collected on a regular basis allows for rapid model creation.

Potential Opportunities to Collaborate: The process utilized with our Division of Transplantation can easily be replicated with additional partners from respective disciplines to create low-cost models to address specific learning and training objectives.