Simulation Lays Groundwork for Complex Robot-Assisted Transplant Surgery

Last September, URMC become one of only five medical centers in the U.S. to perform a robot-assisted live donor kidney harvest and transplant. This milestone was made possible due to an innovative, immersive simulation program developed by the Department of Urology that prepared transplant surgeons for this complex procedure.

The Simulation Innovation Laboratory (SIL), led by URMC urological surgeon Ahmed Ghazi, M.D., employs a technique that combines advancements in image segmentation, polymer molding, and 3D printing to produce lifelike replicas of organs, bones, tissue, and circulatory systems. These components – which are obtained via patient imaging – are assembled into a 3D printed torso that can then be used in robotic and minimally invasive surgical simulations.

While the practice of using robotic surgery to remove a donor kidney is common, typically the recipient receives the organ via an open incision. Employing robotic-assisted surgery for the recipient is complex, due to the speed with which the transplant must be completed in order to preserve kidney function and the complex suturing techniques required to re-vascularize the kidney. As a result, only a handful of medical centers in the U.S. have attempted the procedure.

Working with the URMC transplant surgeons, including Randeep S. Kashyap, M.D., M.P.H., the SIL first developed a series of simulation models that allowed the transplant team to transition from laparoscopic to robot-assisted removal of the donor kidney, allowing the surgeons to progress to surgical proficiency within a safe environment without exposing patient to harm. The team then moved to developing a simulation platform for the recipient portion of the surgery, constructing a bleeding simulation platform that included a kidney model fabricated from the donor's imaging and a pelvis model with pelvic vasculature and bladder, developed from the recipient's imaging. These patient-specific surgical rehearsals were unique in that they allowed surgeons to realistically practice, plan, and address potential problems related to a specific patient's case prior to the real intervention.

"This platform marks a distinctive shift in the use of simulation from the practice of a specific skill to a tool allowing complete rehearsal of a multi-step event like an operation, which realistically replicates a complete procedure with characteristics specific to each individual patient," said Ghazi. "At the same time it allows us to quantify performance and measure improvements in clinical parameters such as blood loss and ischemia time which are essential in these cases to result in improved patient outcomes."