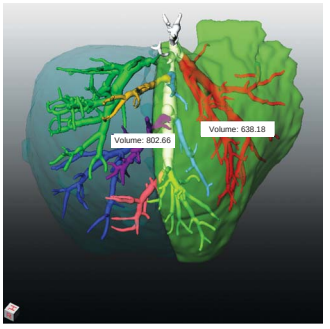
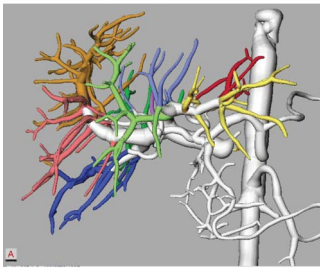
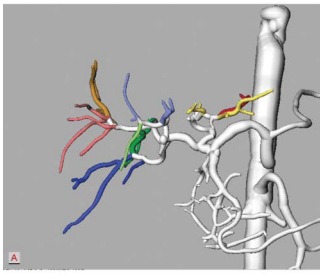
3-D Imaging to Advance Surgery

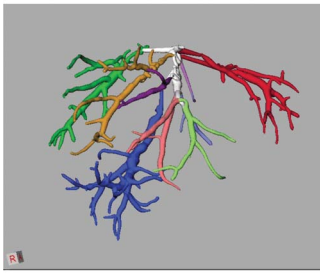
(Above) 3-D imaging has made live donor liver transplantation safer because physicians can examine the volume and vasculature of the livers before surgery.

(Below) Radiologists highlight important vasculature in the donor's and recipient's livers, allowing surgeons to choose the safest way to bisect the organs.









As one of the top live-donor liver transplant centers in the nation, Lahey Clinic is constantly seeking ways to advance surgical outcomes.

The new, state-of-the-art 3-D Laboratory for Advanced Image Analysis and Virtual Surgical Planning at Lahey optimizes a modern approach to surgery—where operations may be simulated and assessed before they are actually performed.

In one of the largest US-based studies comparing noninvasive computed tomographic angiography (CTA) with digital subtraction angiography (DSA), radiologist Christoph Wald, MD, PhD, showed that studying 3-D models of arteries in the liver before surgery is as good or better than traditional DSA. The process is a viable way to not only reduce mortality in liver donors and recipients, but also increase the donor pool.

"CTA will help us expand the donor pool, because when we had less accurate methods of projecting the anatomy of each patient's liver, the surgeon would say 'if I'm not sure, I'd rather not do it,'" says Wald. "Whereas today, a surgeon can take what would have been a borderline case and say 'we know exactly what's going on inside, and we'll do it.'"

The term angiography describes an X-ray procedure used to take pictures of a patient's blood vessels. During CTA, a contrasting agent is injected into the patient's arm. As the dye circulates throughout the body and lights up various organs and blood vessels, a CT scanner is used to take a series of pictures at rapid intervals. The radiologist then uses a specialized computer to process these pictures into 3-D images.

Unlike DSA—where a catheter must be placed in the patient's arteries through the groin and sedation is necessary—CTA is completely noninvasive. The patient's time spent in the hospital is only an hour, compared to six to 10 hours for DSA.

CTA is not limited to the field of liver surgery. It is being applied to a wide range of specialties at Lahey, including neurosurgery, kidney surgery, nuclear medicine, orthopaedic surgery, cardiology and pulmonary vein imaging.

"In the future, we also anticipate the routine use of 'fusion imaging,' which electronically combines CT and CTA with other studies such as PET (position emission tomography) in order to get structural and functional information about cancer and other disorders," says William F. Arndt, MD, Diagnostic Radiology.

"Dr. Wald works closely with surgeons at Lahey and focuses on what is important from their standpoint. This is what has made this study successful, and is an excellent example of how medicine should be: an exchange of ideas between people from different subspecialties," says surgeon Elizabeth A. Pomfret, MD, PhD, director of the Live Donor Liver Transplant Program.

Radiologists at Lahey are able to get exceptional images because they customize each CT scan to the individual patient. "Every patient's heart beats at a slightly different rate, so we measure the time it will take for the dye to circulate from the arm to the blood vessels or organs that we want to image," says Wald.

Once the image is acquired, Wald uses a procedure called "segmentation"—much like a sophisticated "Photoshop" for the human body—to highlight different regions of the patient's anatomy. "Using the 3-D model that we've highlighted, we can calculate when you cut through the liver how much of the liver is on each side, and how much is still being fed by vasculature," says Wald.

The surgeon may then use this 3-D image to plan exactly how the liver will be bisected during surgery. "If we see the presence of a large vein draining a significant portion of the donor's liver that will be transplanted, we may decide the vein needs to be surgically reconstructed using graft material. CTA allows us to prepare for the situation by having these materials available the day of the surgery—it is a great asset to surgical planning," says Pomfret.

Lahey Clinic is working with Mevis, a medical visualization research institute in Bremen, Germany, to refine the customized 3-D liver imaging software. At the same time, the Clinic has built a 3-D laboratory to house the software and technology, which was funded through the Robert E. Wise, MD, Research and Education Institute by the Eleanor Dana Naylor Charitable Trust, based in New York.