technology today

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Improving Surgery with 3D Printed Practice Organs

For some very special surgeries, surgeons ask technicians to use a 3D printer to convert the 3D images from modern medical scans into patient specific physical body parts. You can explore a 3D image with your mind, but you can't hold it in your hands.

When a surgery is very complex and has no room for error, this extra step before surgery becomes critical. The models can be used to physically plot out the operation. With anatomically accurate models, surgical teams can try to anticipate every possible problem before they make their first incision.

This past June in Gainesville, FL, conjoined twins were separated with the help of a 3D printer. The 3D medical scans were converted by 3D Systems into STL build files, which were used to create anatomically accurate models of the twin girl babies' hearts. The surgical team used these models (Photo 1) to perform simulated separations, to perfect the procedure that they used during the surgery.

Though their hearts were physically joined, each twin's heart was properly formed; if the connected tissue and vessels could be separated, each child could survive on her own. Photo 1 shows just how tiny the conjoined hearts were. Imagine how difficult it was to successfully separate them. The girls had a number of other surgeries to fix all the other connected parts. They are healthy and home now with the help of many very skilled surgeons and a very expensive 3D printer.

The next leap forward in anatomically accurate human organs for surgical planning and practice has recently been developed at the University of Rochester Medical Center. Doctors here, working with bioengineers, have developed a procedure using 3D scans to create faux organs that bleed during practice surgeries.

University of Florida Health

Photo 1—3D-printed conjoined hearts created from 3D scans of the babies. Imagine doing the eight-hour surgery to separate hearts that are so small.

The doctors have named their process Simulated Inanimate Models for a Physical Learning Experience (SIMPLE). Photo 2 shows a kidney created by this process. It is so accurate that a doctor could easily mistake it for a real human kidney.

To create these organs, actual CT, ultrasound, and MRI scans are converted into 3D mold STL files using CAD software. The 3D image of each organ is changed from the positive mass of the physical organ into open cavities in a casting mold. Each part of the organ is then cast using hydrogel that is colored to match the real thing. If the 3D-imaged organ has a cancer mass that needs to be surgically removed, the faux organ will also have that mass.

After the hydrogel hardens, the organ parts are assembled so the different vessels and the organ with its accurate internal structure are all together, but can bleed separately just like a real organ. During surgery, liquid fake blood is pumped through; when you cut into them these organs bleed red fluid.

The hydrogel has a water base that perfectly matches the feel and texture of a real organ; when it is cut during a practice surgery, the organ has bleeds must be clamped off properly. These organs are perfect for practicing complex surgeries or for use in medical schools for hands-on training of future surgeons.

They have also used the same basic steps to create muscle, blood vessels, bone, and other body parts needed to create the perfect fake human for practice surgery. You can see a University of Rochester Medical Center video about SIMPLE online at: https://www.youtube.com/watch?v=Ah7gJ4Vgr-w.

University of Rochester Medical Center

Photo 2—Kidney built using human 3D scans and a 3D printer. It is so real that during practice surgery, it bleeds when cut.

Taking It a Step Further

1. Use the Internet to research other times that 3D printing was used to help plan a surgery.

2. Do you feel that the definition of the words "simple" and "faux" accurately fit the organs and process that was developed to create practice surgery body parts that bleed when cut? Why?

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.