



“These 3D printed models have tremendous value in developing surgeons’ skills...students agreed the 3D printed heart models were tremendously helpful for them.”

Dr. Shi-Joon Yoo / head, pediatric cardiac imaging, The Hospital for Sick Children

Surgeons practice suturing on a Stratasys BIOMIMICS™ 3D printed heart model.

#### CASE STUDY

# Stratasys BIOMIMICS™ Enhances Training on Rare Pediatric Heart Surgeries

**ADVANCED 3D PRINTED MATERIALS MIMIC REAL HEARTS**

## PRACTICE MAKES PERFECT

Becoming a surgeon takes years of practice. Becoming a pediatric heart surgeon takes even more. Surgical training begins with a new surgeon looking over the shoulder of a practicing surgeon before moving on to practice on cadavers or animals. Though hands-on, these training scenarios are often imperfect due to lack of complex pathology, expense and repeatability. Nevertheless, the importance of surgical practice cannot be underestimated. In fact, Dr. Glen Van Arsdell, head of cardiovascular surgery at The Hospital for Sick Children (SickKids), in Toronto cites a direct correlation between volume of practice and outcomes in difficult surgeries.

Early 3D printed medical models attempted to bridge this gap in availability and training. The ability to practice in a no-risk setting, on a model closely approximating the human body, gave surgeons the ability to envision anatomy in three-dimensions. Although helpful, these models still lacked the realism, haptic feedback, and functionality to enable practice in a laboratory setting. Dr. Shi-Joon Yoo, head of pediatric cardiac imaging at SickKids, became interested in 3D printed medical models some years ago to help enable education and training. He persisted even though one impediment to success remained; most 3D printers were only capable of printing hard materials.

According to Yoo, the role of the radiologist is to “provide the precise image information necessary to make the right treatment decision, and then facilitate these procedures.” Scans and images satisfy the first half of his job description; Yoo believes improved 3D printed medical models with soft materials are the answer to the latter.

### New Surgical Instrument

“Human organs are complex, with combination structures,” said Yoo. “It’s very difficult to tease out all the different elements and replicate them. During one of the SickKids ongoing simulation training courses, Yoo realized “what I needed was a 3D printer capable of printing flexible models.” He worked with Stratasys to develop a way to print 3D printed pediatric heart models in-house. “We now have the capability to 3D print clinical scenarios that are problematic and challenging,” said Yoo, “and with a softer, more realistic material.”

“The reality of training on anatomically accurate, realistic models finally became a reality. Stratasys® BIOMIMICS™ models are anatomically accurate, have the ability to mimic various pathologies, and provide true haptic feedback for surgeons-in-training,” said Van Arsdell. “Stratasys asked if they could partner with us to advance our efforts. They came and printed some models for us and we ended up with models that actually had better tissue quality. We’re making progress on mimicking something much closer to real human feel,” said Van Arsdell.

“We practice some very complex surgeries such as hypoplastic left heart syndrome,” said Van Arsdell. “These are tough operations to do, involving complex three-dimensional geometry using patches. It’s just fantastic for these trainees to have an opportunity to get the feel of it and learn to cut patches and learn the sequencing on models instead of learning it on a baby. All the moves are the same, so that when a surgeon does it on a baby, it’s much more familiar and much safer.”

Patient mortality rate for this procedure at SickKids is significantly lower than average. “Are we better surgeons?” said Van Arsdell. “I don’t think so. The difference is practice. The more opportunity a surgeon has to practice before a procedure, the better the outcome.”

Yoo is equally enthused about the new material. Surgeons responded, saying ‘it’s almost like the real thing,’” said Yoo. “In the past year, we’ve had the opportunity to have a direct relationship with the Stratasys team, helping to develop the material and models for application in congenital heart disease cases.” Surgeons are also able to practice for other complex procedures as well, such as transposition of the great arteries. “For the first time in history, we are providing



New, flexible material allows for greater realism and feedback when training on a 3D printed pediatric heart model.



Dr. Van Arsdell working with surgeons-in-training on a simulated cardiac procedure.

real physical models for surgical practice.” In SickKids’ most recent course, “students agreed the 3D printed heart models were tremendously helpful for them.”

Always looking to the next frontier, surgeons at SickKids hope medical models will someday be able to 3D print the four valves of the heart. “This would have a great impact in medicine,” said Yoo.

Van Arsdell agrees, saying “Eventually, we’ll be able to print valves and when we can print valves we could completely change how they are repaired. You could take an adult heart that’s developed valve disease unique to them, print it out and say to the surgeon, ‘here it is. Plan your surgery before you go in the operating room’ or ‘rehearse your surgery before we go into the operating room.’”



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**HEADQUARTERS**

7665 Commerce Way,  
Eden Prairie, MN 55344  
+1 800 801 6491 (US Toll Free)  
+1 952 937-3000 (Intl)  
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,  
PO Box 2496  
Rehovot 76124, Israel  
+972 74 745 4000  
+972 74 745 5000 (Fax)