

Surgeon uses 3D technology to make model heart for 4-year-old patient

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Adaenelie Gonzalez had two open heart surgeries by the time she was 4.

She was born with a [heart](#) condition that prevented blood from flowing properly into the heart from the lungs, and the surgeries yielded only a temporary fix.

On a recent Friday, Adaenelie underwent her third open-heart surgery, but this time, the results may be permanent.

The Heart Program at Miami Children's Hospital created a [model](#) of Adaenelie's heart using new 3D printing technology. The model allowed the heart surgeons to thoroughly examine the problem areas of Adaenelie's heart before carrying out the actual surgery. The program is believed to be the first in the region to use the technology for a child born with a complex heart anomaly.

"We were running out of options as she had already had a couple of surgeries in the newborn period," said Dr. Nancy Dobrolet, pediatric cardiologist at Miami Children's Hospital. "It became clear that to prolong her life ... she needed to have another procedure done."

Adaenelie was born with total anomalous pulmonary venous connection, a [heart disease](#) in which the four veins that carry blood from the lungs to the heart do not attach to the left atrium. Instead, the blood is transported to a wrong area of the heart, causing breathing difficulties and heart failures.

The 3D technology lets doctors manipulate blood vessels and explore how to repair the organ's damage before the actual surgery. The 3D model is identical to the heart being operated on, so doctors can envision the procedure in advance.

Dr. Redmond Burke, chief of cardiovascular surgery at Miami Children's, said before seeing the 3D model, he "couldn't picture," the operation. At the time, he said the child's life expectancy was in days or weeks.

Using the model, Burke was able to place a new piece of a heart, which came from a person who died, into the exact location it needed to be in Adaenelie's heart. Once Burke did that, her blood began to flow normally.

"I didn't know if it would work," he said. "But I thought at least we have a chance, and it's worth it for me to put her through the massive trauma of a third open-heart surgery."

To make the heart, the team took complex files and rendered them into a format that could be read by a 3D printer. Although looking at pictures and computer models helped Burke prepare for the procedure, by holding the model in his hands he could manipulate it and get a sense of the actual operation.

The process of creating the model included several steps, said Chelsea Balli, a biomedical engineer at the hospital. Rendering the files to send to the printer can take from two to 10 hours depending on the model's specifics. The files were then transmitted to an Atlanta company, AdvancedRP, which constructed the model heart over 24 hours. Advanced RP distributes Stratasys's 3D printers.

The hospital has purchased its own 3D printer, paying nearly \$100,000,

Balli said. The software costs an additional \$50,000, she said. Balli said the hospital is awaiting delivery of the printer.

Burke said the models will be beneficial both for planning surgeries and for medical education.

"I was able to teach fellows and students what we did using an actual model of her heart," he said. "It's invaluable."

Since the operation, Adaenelie has had an accelerated post-surgery recovery, Burke said. Although she is still in the hospital, she is walking around and playing.

Gabriella Alonso, Adaenelie's mother, said she was starting to lose hope, but Adaenelie will now be heading home soon.

"I didn't know it was possible," she said. "I'm happy."

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