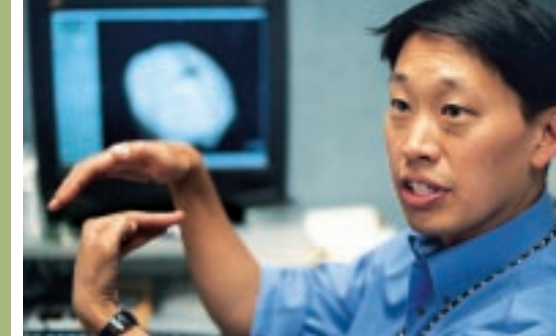


# Picture Perfect

Vivid images from 3-D scans give Children's doctors a powerful diagnostic tool.

An arterial venous malformation (AVM) is a spidery mass of blood vessels that forms in a concentrated area and can grow over time. Jay Jensen's AVM covered the left side of his face, creating a bulge above the eyelid, causing severe headaches, wrecking his vision and marring his appearance.

3-D images constructed from a CT angiogram helped doctors plan the delicate surgeries to remove the web of blood vessels causing these problems and gave Jay and his mom, Lona Jensen, a clear picture of what was causing the bright red mass that had covered the left side of his face. "It looked like someone had taken a red crayon and scrawled all over it," says his mom.



Dr. Raymond Sze

**"THAT WAS FAST," SAYS JAY JENSEN, GREETING HIS MOTHER, LONA, IN THE CT WAITING ROOM AT CHILDREN'S.**

Jay, 12, had just completed a CT (computerized tomographic) exam to check the outcome of an earlier surgery. This was no ordinary CT exam, though. Thanks to advancements in CT technology and a sophisticated 3-D imaging system, the exam was not only many times faster than a conventional CT, it produced far more vivid — and valuable — images.

"Just awesome," says Lona Jensen of the detail revealed by the images.

How awesome? "It blows away what we were working with before," says Dr. Raymond Sze, Children's radiologist.

While the system's gee-whiz quotient is off the charts, its many practical advantages over previous imaging technologies — speed, accuracy, versatility — are what have Children's physicians so excited about the hospital's high-speed scanner and powerful Vitrea 2 computer workstation — the only such three-dimensional imaging system at a pediatric hospital in the region.

"We're making diagnoses we otherwise wouldn't have been able to make," says Dr. Michael Cunningham, director of Children's Craniofacial Center.

The emergence of 3-D imaging is the latest step in the evolution of CT technology. The basics remain the same: Patients lie still on a moving couch that is advanced through the rotating X-ray beam of the scanner. Data from the scan are then fed into a computer, which creates composite images of the patient's anatomy.

That's pretty much where the similarities between conventional CT imaging and CT with 3-D imaging stop. Conventional CT imaging produces flat, black-and-white cross sections with limited depth information. The new

16-slice multidetector CT captures more detailed data, enabling the Vitrea 2 workstation to create realistic color images bursting with depth, context and detail — all of it invaluable for diagnosis.

Dr. Sze recalled the reaction of a group of Children's surgeons as they witnessed their first demonstration of the Vitrea 2's wizardry: "You could almost hear the thunk of their jaws hitting the floor."

## Getting a better look

Connor Wakefield, the 5-month-old son of Wes and Kira Wakefield, was born with craniosynostosis, a condition in which a portion of the plates that form the skull are fused, potentially interfering with the normal growth of the skull and development of the brain. In Connor's case, the fused plates are inside his left orbit, behind his eye — a rare form of the disease that is virtually impossible to see in two-dimensional CT scans. By providing the element of depth and anatomical detail, magnified images from a 3-D scan indicated the precise location of the tiny fusion, setting the stage for an upcoming surgery. "The images speak for themselves," says Wes Wakefield. "Without this technology, they never would have been able to pinpoint the problem."

Other examples of the system's applications abound. Hydrocephalus — sometimes called water on the brain — is a condition in which fluid builds up within the brain. Surgeons typically install a shunt to drain the excess fluid away and prevent brain damage. Traditional methods for determining whether fluid levels have changed have an accuracy range of plus or minus 20 to 30 percent, says Dr. Sze. Using a 3-D volume-calculation feature of Vitrea 2, Dr. Sze and Victor Ghioni, Children's chief CT technologist, developed a highly accurate technique to measure the volume of fluid within the brain to determine if the shunt is working.

Victor Ghioni,  
chief CT technologist

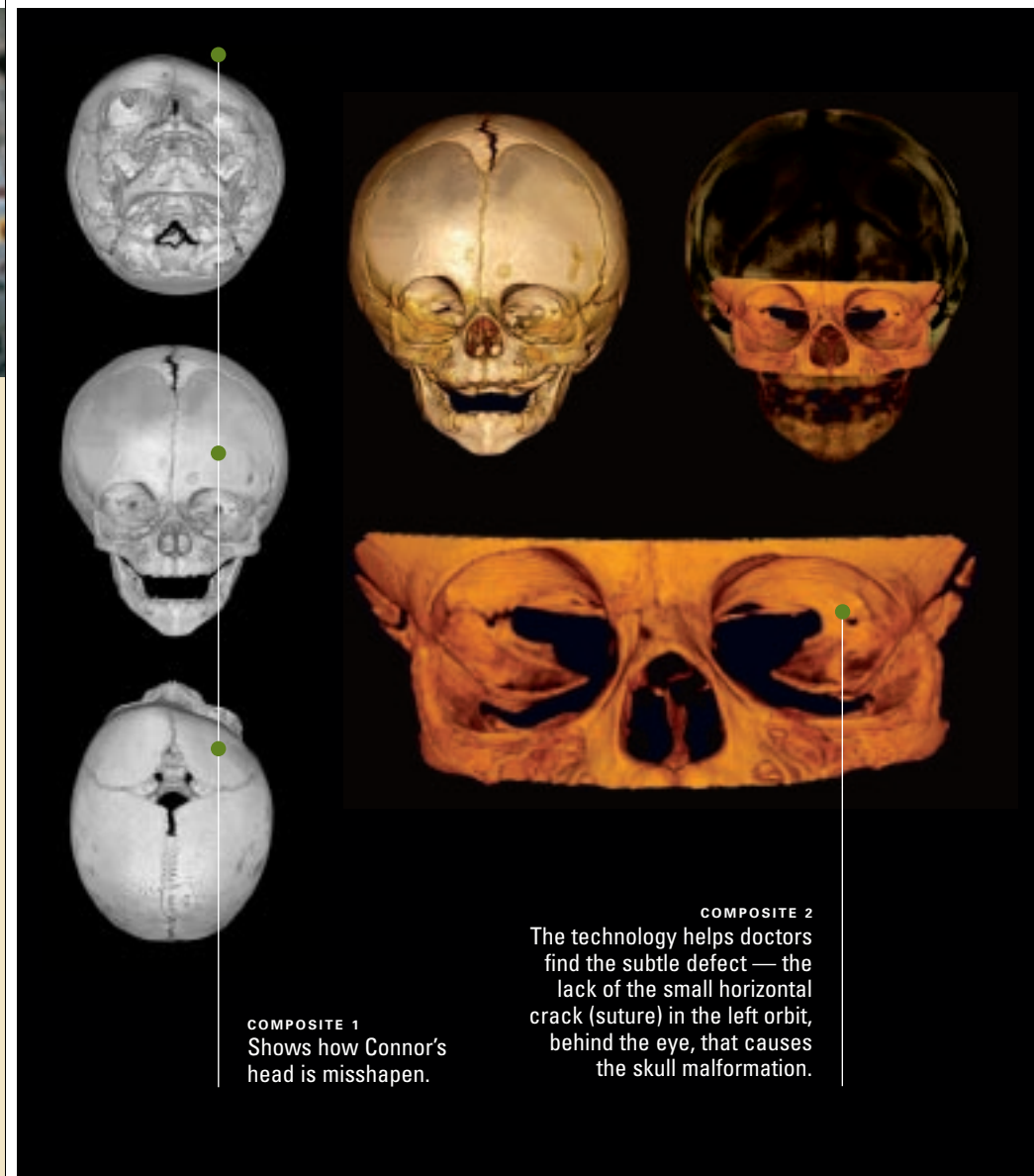


The system also helps surgeons address situations in which a child's facial structure is pushed too far inward. Correcting the condition involves separating the facial bones from the skull and attaching a metal halo around the child's head, explains Dr. Richard Hopper, a craniofacial surgeon at Children's. Over time, the halo slowly moves the entire face forward, a procedure known as distraction osteogenesis. Prior to surgery, 3-D imaging is used to determine the best angles at which to make the cuts. After surgery, 3-D images help determine when the time is right to remove the halo.

Although Children's has utilized a version of 3-D imaging for more than 10 years, the current system is a quantum leap forward. The old system worked well with bone, but not soft tissue. The current system excels with both. Better still, the system enables CT technologists to magnify, isolate, dissect or rotate images to reveal precisely as much or as little as doctors want to see and provide perspectives that would otherwise be impossible to obtain.

"You can take those images and do pretty much anything you want to do with them," says Dr. Hopper. "It's hard to imagine life before Vitrea. It's become a common tool now."

The clarity of the 3-D images also improves communication between doctors and patient families. "I can show a family what's wrong with their child and they can understand it easily," says Dr. Cunningham.



COMPOSITE 1  
Shows how Connor's  
head is misshapen.

COMPOSITE 2  
The technology helps doctors  
find the subtle defect — the  
lack of the small horizontal  
crack (suture) in the left orbit,  
behind the eye, that causes  
the skull malformation.

In Jay Jensen's case, his clinical diagnosis was clear — arterial venous malformation (AVM), in which a spidery mass of blood vessels forms in a concentrated area. A bright red mass covered the left side of his face and created a bulge above his eyelid, marring his appearance, wrecking his vision and causing severe headaches. The super-accurate 3-D images from an angiogram performed with the high-speed scanner — impossible with older, slower scanners — helped surgeons better plan Jay's delicate surgeries.

Angiograms involve injecting contrast (X-ray dye) that highlights blood vessels as the dye passes through them. The CT scan is taken of the targeted area. Since the dye remains in one place for only a few seconds, the window to acquire images is small. Conventional CT technology is too slow to capture the dye within the blood vessels before it flows away. By capturing 16 slices per half second, the high-speed scanner gets the job done before the dye disappears.

Dr. Michael  
Cunningham



## Understanding What We See

Not only does 3-D imaging help Children's radiologists and their colleagues see what's wrong with their patients more clearly, it is also a powerful catalyst for research.

Currently, Dr. Raymond Sze is working with computer scientists and electrical engineers at the University of Washington to develop tools that better analyze the information captured by the 3-D imaging system. "We hope these tools will identify specific shapes and measurements that will predict how patients are going to do, what complications they might have and how they will respond to various therapies," he explains.

Tools that quantify and categorize various conditions will enable doctors to look for patterns, including genetic links, that can help them understand potential causes — and treatments.

Although Dr. Sze is focusing on craniofacial abnormalities, the tools he hopes to create could potentially apply to any bone, tissue or organ. "Radiologists are always pushing for better and more accurate images. Right now there is a need to better understand what the image we see actually means," he says.

"We're making diagnoses we otherwise wouldn't have been able to make."

— Dr. Michael Cunningham

The use of CT angiograms in AVM cases has become one of the leading applications for 3-D imaging. "Normally, we can't see all the blood vessels clearly," says Dr. Jonathan Perkins, a head and neck surgeon with Children's vascular anomalies program. "With a CT angiogram, it lights up very clearly. I can look at it and get a grasp on what needs to be done."

Speed pays other dividends as well. With the high-speed scanner, CT exams that once took many minutes to complete now take less than 10 seconds, reducing the need to sedate fidgety young patients. Radiation exposure is also limited, because the speed of the scanner reduces the need for repeat imaging due to patient motion. Because the images can be rotated for any point of view, patients needn't repeat exams when doctors want more than one perspective.

While 3-D imaging was always theoretically possible, it didn't become practical until computers became fast enough and powerful enough to capture and process the additional data needed to account for density and add the dimension of depth to images that previously featured only length and width.

The result is a vivid, selective and enlightening virtual window into patients that even surgery can't always provide. "It's as if you could reach into a patient and remove a piece of bone or tissue and examine it in your hand," says Ghioni.

In fact, the system's data can be translated into physical models that enable doctors to create synthetic reproductions that are so realistic surgeons can rehearse upcoming operations.

## Evaluating outcomes

Just as important as presurgery preparation is postsurgery evaluation — another instance in which the superior visuals produced by 3-D imaging paint a more telling picture for patients.

In the months following a September 2002 operation to remove the mass of blood vessels from his face, Jay's headaches waned, his skin regained its normal color and the bulge above his eyebrow retreated, leading him and his mother to cross their fingers that the AVM was gone for good.

Their faith was confirmed in April of this year, when 3-D images from a follow-up exam — taken in preparation for a surgery by Children's head of plastic surgery, Dr. Joseph Gruss, to remove the last tiny mass of blood vessels and repair a droopy eyelid — revealed no evidence the mass was regrowing.

"You could definitely see the difference between the first set of images and the latest set of images," says Lona Jensen. "I'm not sure who invented 3-D imaging, but I'm sure glad they did." **END**

## CENTER TEACHES DOCS TO "READ"

Teaching medical students and physicians to evaluate and learn from diagnostic images is now easier, thanks to the Children's Radiology and Medical Imaging Education Center.

Diagnostic images from a variety of modalities (e.g., CT, MR, ultrasound, etc.) are uploaded to the Center's Web-based tool and organized into sets of cases that help teach users to identify normal versus abnormal results, and, if abnormal, what some of the diagnostic possibilities might be.

The Center was created by a generous gift from Cliff Garl, a retired Chevron employee who wanted to help children in a practical, effective way. "It's a great resource for interactive teaching at all levels," says Dr. Eric Effmann, director of Radiology.



Dr. Jonathan  
Perkins with patient  
Joshua Vilhelmsen