



Cardiac surgeon Robert Poston (second from right) adjusts the camera angle during robot-assisted coronary artery bypass surgery.

Minimally Invasive Surgery Techniques Reduce Risk for Heart Patients

BY BRUCE GOLDFARB

When Thomas Tantulo was told that his left anterior descending (LAD) artery was 85 percent blocked by atherosclerotic plaque, open-heart surgery was not his first choice of treatment options.

Known as the “widow maker,” the LAD is one of the main arteries supplying the heart. The “gold standard” treatment is an operation to re-route the blood supply around blocked arteries to restore perfusion to oxygen-starved heart muscle, a procedure known as coronary artery bypass graft (CABG) surgery. About 500,000 CABG procedures are performed every year in the United States.

Tantulo worked in hospitals during his training as a chaplain, and the 60-year-old Middletown, Conn., resident knew that he had to carefully consider his treatment options. “I wanted to do the least invasive, least traumatic thing to my body,” Tantulo says.

He wanted to avoid the chest soreness of open-heart surgery if possible. More important, as a survivor of blood cancer, he wanted to avoid the risks of the heart bypass machine that is used to support the patient during open CABG surgery.

Instead, Tantulo was interested in a relatively new and unusual procedure known as minimally invasive direct coronary artery bypass (MIDCAB). The operation is done through small incisions between the ribs, eliminating the discomfort of cracking the chest. And it is done “off-pump,” without the bypass machine, while the heart is still beating.

Keyhole Surgery

At the University of Maryland School of Medicine (SOM) clinical faculty practice within the University of Maryland Medical Center (UMMC), where doctors and surgeons are devising better ways of doing heart surgery. “The thing about heart surgery is that you don’t get a second chance. It’s pretty precious stuff,” says Robert Poston, MD, assistant professor of surgery in the School of Medicine and cardiac surgeon at the medical center.

“We have a number of programs focused on minimizing incisions and doing things through smaller and smaller holes,” says Poston. “We’re making a major part of our plan for the future focused on minimally invasive surgery.”

In the lab, Poston and his colleagues are working on the next wave of care—futuristic emerging technologies that push the limits of minimally invasive surgery to ever smaller and more precise scales.

A unique collaboration between cardiac surgeons and interventional cardiologists is leading to treatment options for people with coronary artery disease—and other diseases of the heart and blood vessels—that are safer, more effective, and more comfortable than traditional approaches.

Newer alternatives to CABG include percutaneous transluminal coronary angioplasty (PCTA). While the patient is sedated in the cardiac catheterization lab, a thin catheter is threaded through a leg vein into the heart. When placed within the coronary artery, a balloon is inflated to widen the blood vessel and restore circulation to oxygen-deprived heart muscle.

Other percutaneous methods to restore circulation in coronary arteries include removing blockages with a laser or small cutting tool or inserting a tiny wire-mesh tube called a stent. Newer models of “drug-eluting” stents are coated with medication to keep vessels from becoming blocked again.

The MIDCAB “keyhole” surgery has been performed on more than two dozen patients, including Tantulo, by surgeons on the School of Medicine faculty. Working with miniaturized instruments through an incision only three to four inches wide, the surgeon moves the left internal mammary artery—one of several large blood vessels inside the chest—so that it feeds into the coronary circulation.

Performing the surgery while the heart is still beating also eliminates the risks of using a heart-lung machine. A small but significant number of patients experience lingering effects from the heart-lung machine that include the formation of small clots that can affect the brain, kidneys, or lungs.

“Regular open-heart surgery is a morbid operation that involves cooling the body and stopping the heart,” explains Poston. “Instead of shutting down the whole circulatory system, the MIDCAB operation can be done without a heart-lung machine.”

Still considered investigational, MIDCAB can be used to restore circulation to the left anterior descending artery, which is the main blood vessel supplying the left side of the



Top: Robert Poston manipulates the arms of the da Vinci S Surgical System robot through a computer-controlled console in the operating room. He can monitor his actions through a video monitor. The device filters the surgeon’s hand tremors and “scales down” large movement to the more precise actions required for a minimally invasive procedure.

Bottom: Laparoscopic screen as viewed from the computer console video monitor, showing the position of robotic surgical instruments during surgery



Top: Prior to surgery, the surgical team positions the arms of the surgical robot over the patient.

Bottom: The da Vinci S Surgical System on display without the plastic surgical drapes shown above. The robot can be used for both cardiac and prostate cancer procedures.

heart. A second blood vessel can often be bypassed by re-routing the right internal mammary artery from the other side of the chest.

“The left mammary graft is superior to other bypass procedures, and perhaps better than drug-eluting stents,” says cardiologist Barry Reicher, MD, assistant professor of medicine at the School of Medicine and cardiac catheterization specialist at UMMC. The MIDCAB procedure “is very promising,” he says. “Despite the benefits of drug-eluting stents, they are not the Holy Grail.”

Tantulo was walking within 10 hours of undergoing surgery. Unlike patients who can expect weeks of soreness and recuperation from open-heart surgery, patients who undergo a minimally invasive procedure are often back to their normal daily routine within a day or two. “I felt great,” he says. “It was a wonderful experience.”

Hybrid Procedure

Patients with multiple blocked coronary arteries can receive an innovative “hybrid” procedure that combines MIDCAB with a stent to keep narrowed heart arteries open. Once the cardiac surgeon completes the bypass part of the surgery, the interventional cardiologist then inserts a stent.

The hybrid procedure results in “less morbidity, less pain, less recovery time, less blood loss, and shorter intensive care unit stays,” says Reicher. “This gives the patients the best of both worlds.”

In order to perform the hybrid surgery, an operating room is equipped with fluoroscopic imaging technology and other equipment typically found in the cardiac catheterization laboratory. “It’s the operating room of the future, with a cath lab built right in,” Poston says.

The operating room facility is also used to repair aortic aneurysms, a dangerous thinning of the main artery as it leaves the top of the heart. The cardiac surgeon replaces the damaged blood vessel with durable synthetic material, and the interventional cardiologist makes the connections to the carotid arteries that deliver blood to the head and neck.

A minimally invasive approach is used to repair the mitral valve, the in-flow valve for the left side of the heart, which can become narrowed or leaky. About 250,000 people a year develop a leaky mitral valve, which, if left unchecked, can lead to an enlarged heart and heart failure.

Typically treated through open-heart surgery, University of Maryland physicians perform about 90 percent of mitral valve repairs through a small incision in the patient’s armpit. A miniaturized camera is slipped through tubes into the chest cavity, and the surgeon performs the operation through small incisions while watching on a video monitor—similar to working the controls of a video game.

However, doing minimally invasive surgery takes more than fine motor skills. Minimally invasive surgery requires a higher level of expertise and a solid foundation in traditional surgical technique.

“One of our great challenges is to train the next genera-

tion of surgeons to use these techniques,” says Poston.

“Patients are demanding smaller incisions, but our trainees still need to learn the fundamentals. To do it well, you need to have that foundation. If you don’t see it big, then seeing it small won’t have any relevance. Looking at the screen doesn’t give you all the perspective you need.”

Knifeless Surgery

The partnership between cardiac surgery and interventional cardiology is helping develop new percutaneous procedures that are replacing procedures customarily done through open-heart surgery.

“We’ve revolutionized how we treat patients,” says Reicher. “A lot of ‘first-in-humans’ stuff is going on now.”

School of Medicine researchers also are testing the development of a replacement mitral valve that doesn’t require open-heart surgery. Composed of plastic or engineered tissue, the replacement valve is folded until it is a diameter smaller than a pencil. Using fluoroscopy, the interventional cardiologist guides the valve into the heart through a catheter threaded in a leg vein. Once in place, the valve is “deployed in a way that the natural valve is pushed aside and the new one fits snugly in its place,” says Poston.

Human trials with percutaneous mitral valve repair may begin in the near future, according to Reicher. Although the replacement valves are probably not as durable as conventional valves in use today, the fact that they are less traumatic to install makes the procedure available for a greater number of patients.

Percutaneous heart valve repair is “particularly well suited for patients who are too sick for traditional open-heart surgery, or who are unable to go onto a heart-lung machine because of hardening of the arteries or advanced age,” explains Poston.

Another innovative University of Maryland project is testing a miniaturized pump that can be installed percutaneously in cases of heart failure. About 2.5 inches long and also no thicker than a pencil, the high-performance pump—known as a ventricular assist device—helps push blood through the circulatory system, taking some of the load off of the heart and giving it a better chance of healing. In many cases, the rest is enough to avoid risky heart transplantation.

Researchers were contracted to help design a percutaneous ventricular assist device intended for use in children, but “there’s enough flow in this pump that it could be used on adults,” says Poston.

Early tests with the ventricular assist device show great promise, says Poston, who predicts that doctors will use the minimally invasive pumps in earlier stages of heart failure.

The experience gained by University of Maryland cardiac surgeons and interventional cardiologists serves in turn to

attract companies and laboratories interested in developing or improving their products.

“Having very sophisticated fluoroscopic imaging technology in the operating room puts us in a fast-forward position to attract manufacturers,” says Poston. “Our surgeons are at the leading edge of receiving this technology. The fact that we have been selected by the forward-looking companies that develop this technology is a credit to the surgeons.”

School of Medicine health professionals are not only developing and testing new technology, but also bringing innovation from the laboratory to the patient’s bedside. Techniques that seem like science fiction today will soon become routine in clinical practice.

“We see a day when percutaneous valve replacement will be part of what we do routinely,” says Poston.

Robotic Surgery

Poston and his colleagues moved from science fiction to operating-room reality last September with the acquisition by UMMC of a surgical robot. The first robot-assisted bypass surgery was performed at UMMC on Sept. 27, 2006. The da Vinci surgical robot takes minimally invasive surgery to a level of precision that is literally beyond human capabilities.

The hybrid procedure results in “less morbidity, less pain, less recovery time, less blood loss, and shorter intensive care unit stays,” says Reicher.

While the surgeon operates controls at a console, a computer filters out hand tremor and “scales down” the movement, so that a large motion of the fingers is translated to a small motion of the instruments while they are inside the patient. All of the motions of the surgeon’s hands and fingers are executed on a small scale.

Made by Intuitive Surgical, the \$1.3 million da Vinci surgical robot was approved in 2000 by the U.S. Food and Drug Administration for minimally invasive surgery. Robotic surgical techniques are being developed for general surgery, gynecologic surgery, urologic surgery, and cardiac surgery.

The da Vinci surgical robot ushers in a new era of improvement in surgical techniques—even smaller incisions with even less risk—for cardiac surgery patients. Through their focus on minimally invasive surgery and emerging technologies, Poston and his colleagues will keep improving the safety and comfort of heart patients like Thomas Tantulo. □