

FEATURE STORY

Renaissance Surgery

BY BEVERLY A. CALEY

Using robotic arms, video cameras, and tiny incisions, cancer surgeons are changing what it means to go under the knife.

Surgery is one of the fundamentals of cancer treatment. Used alone, it is sometimes curative for early-stage cancer and is often combined with other forms of treatment to give advanced cancers a one-two punch. In addition, surgery can be part of the diagnosis or staging process and can be used to prevent cancer or relieve pain.

But surgery can be tough on the body. There can be complications such as excessive bleeding or a bad reaction to anesthesia. Typical cancer surgeries that have long recovery times in the hospital can make patients more prone to infection. There may be swelling and soreness around the incision, and there is usually some post-surgical pain.

To reduce these risks, surgeons continue to look for ways to improve their methods. One set of techniques is known as minimally invasive surgery. “Minimally invasive cancer surgery is the direction most surgery is going,” says Raja Flores, MD, a thoracic surgeon at Memorial Sloan-Kettering Cancer Center in New York.

Early advances in minimally invasive surgery were made possible in large part by the development of the laparoscope, a thin, tube-like instrument with a light and a lens for viewing. Many recent innovations are based on improving the laparoscope.

An Advanced Robot

The da Vinci Surgical System consists of a control console and a surgical cart in which robotic arms hold laparoscopes and various other surgical instruments. The system provides a magnified three-dimensional view of the inside of the patient’s body using two independent cameras.

One limitation of traditional laparoscopes is that they are straight and inflexible, which limits their maneuverability inside the body. The da Vinci system's laparoscopes are equipped with an innovation called the EndoWrist that enables it to bend and turn.

Other advantages of operating with the robot include a reduction of hand tremors and five-to-one motion scaling of the instruments, which allows the surgeon to make a cut five times smaller than the motion actually made by hand. These attributes help surgeons make smaller, more precise incisions than are possible using the human hand alone.

Mani Menon, MD, director of the Vattikuti Urology Institute at the Henry Ford Health System in Detroit, has performed thousands of surgeries using the da Vinci system. Menon, known for his development of a robotic procedure for removing the prostate, explains that with open surgical techniques, the major emphasis is on controlling bleeding and getting the prostate tumor out. But with the robot, bleeding is "really not an issue," which allows Menon and his team to concentrate on the reconstructive aspects of the surgery.

View Illustration: The da Vinci Robot

Illustration: The da Vinci Robot

For example, Menon explains that surgeons have traditionally used only one layer of stitching to put the bladder and urethra together, "because that's all you can see." However, the magnification and three-dimensional view provided by the da Vinci system allow surgeons to see well enough to put in a second layer of stitching, resulting in a stronger connection that appears to allow urinary function to come back sooner, Menon reports.

The improvement allowed Menon to develop a procedure that does not require a post-operative catheter. Now that the technique has been developed, it can also be used in traditional open procedures, but without robotics, Menon says, "no one would have had the courage to try it."

Effectiveness at removing cancer is the crucial measurement. A recent review found that the robotic procedure for removing a prostate tumor resulted in a decreased number of patients who had cancer cells at the edge of the removed tissue—12.5 percent for robotic procedures compared with 19.6 percent for laparoscopic procedures and 23.5 percent for open procedures. Other recent reviews found similar cancer control outcomes for the three types of procedures.

These data must be kept in perspective, however. "Robotic technology is a great technology, but success ultimately depends on the ability of your surgeon," cautions Jeffrey Cadeddu, MD, director of the Clinical Center for Minimally Invasive Treatment of Urologic Cancer at the University of Texas Southwestern Medical Center in Dallas. He has recently seen two patients who had robotic surgeries at other hospitals that did not remove all the cancer.

Similarly, Menon adds, "I don't want to give the impression that anybody can buy the robot and do the things we've talked about. While the robot is a great tool, we

need to bear in mind that great surgeons and great tools make a great combination.” In order to use the robot effectively, surgeons need to develop a completely different set of skills, especially the ability to rely on visual clues rather than sense of touch for feedback.

““ While the robot is a great tool, we need to bear in mind that great surgeons and great tools make a great combination.””

—Mani Menon

The da Vinci system is being used to perform surgeries for patients with many other kinds of cancer. For example, Menon reports that during the past year, surgeons at the Vattikuti Urology Institute have used it extensively for complex kidney cancer, including operations on young children. The da Vinci is also being used at some institutions for ovarian and cervical cancer surgery. And although the system was originally designed for use on the lower and middle sections of the body, techniques are now being developed that allow it to be used in the narrow spaces inside the head and neck.

In simple procedures, a robot is not needed, but, according to Menon, the da Vinci robot is an asset in almost every kind of surgical procedure. “There’s no downside to using the robot except for the costs,” he says.

The basic da Vinci system costs more than \$1 million, with prices ranging up to \$1.6 million depending on the number of robotic arms and other options. In addition, a yearly maintenance fee of \$100,000 is required. The high cost of the robot leads to limited availability, meaning that patients often need to travel long distances in order to undergo a robotic procedure.

Because a surgeon does not have to be in direct contact with the patient to use the da Vinci system, it’s possible that in the future, surgery will be performed long distance by someone not even present in the facility, a concept called telemedicine.

“People have been talking about this for the past 10 years,” Cadeddu says. “Whether we can do it and whether we will do it are two different things.” He says the technology is already in place that would allow long-distance surgery, but legal concerns of hospital administrators prevent it from taking place. In addition, the costs of a reliable communication network keep telemedicine from being readily available in economically disadvantaged areas of the world.

LESS Offers More

Cadeddu recently performed a first-of-a-kind operation—he removed a patient’s kidney through a single small incision in the navel, leaving the patient with a barely noticeable scar.

According to Cadeddu, single-incision procedures are so new that they have only

recently been given an official name: laparoendoscopic single-site surgery, or LESS. In addition to non-cancer applications, such as gallbladder and appendix removal, LESS is being used for early-stage colon cancer and removal of small kidney cancers.

The tool that makes LESS possible is called the RealHand, which allows for greater flexibility and control. Cadeddu explains that in traditional laparoscopy, straight, rigid instruments are spread out around the abdomen. In contrast, all the instruments in single-site surgery have to fit through a single hole.

“The instruments have wrists on the inside so they can move and curve, analogous to the da Vinci robot,” he explains. This flexibility allows surgeons to do the same kind of surgery through one consolidated belly-button incision rather than multiple spread-out cuts.

Early advances in minimally invasive surgery were made possible in large part by the development of the laparoscope, a thin, tube-like instrument with a light and a lens for viewing. Many recent innovations are based on improving the laparoscope.

Cadeddu cautions that the LESS procedure can be difficult for the surgeon to perform, and the benefits are mostly cosmetic. “I would say if the surgeon is experienced in the LESS technique and you’re an appropriate candidate, it might hurt a little bit less than regular laparoscopic surgery. But overall, the most important consideration in choosing a surgical approach is to get out all the cancer, not how large the scar will be.”

A similar technique now being explored is surgery through a natural opening in the body, such as the mouth, vagina, or rectum. This type of surgery, known as natural orifice transendoluminal endoscopic surgery, or NOTES, is performed by going through an opening in the body rather than making an incision on the outside of the body. Surgeons can therefore reduce the associated trauma and pain and improve the post-surgical cosmetic appearance.

It is not yet known whether LESS or NOTES will turn out to be the better approach, says Cadeddu.

Video View

In video-assisted thoracoscopic surgery, or VATS, surgeons operate through two to four tiny openings between the ribs while viewing the inside of the patient on a video monitor. Using a narrow tube-like instrument called a trocar, the surgeon gains access to the chest cavity through a space between the ribs. An endoscope (a thin tube with a camera at the end) is inserted through the trocar, giving the surgeon a magnified view of the patient’s internal organs on a television monitor.

According to Flores, VATS has many applications, including staging lymphoma and removing tumors in the chest. However, one of its most exciting applications is in lobectomy (surgery to remove a whole section of a lung). The VATS procedure results in less blood loss and shorter recovery time for a patient than

traditional surgery, and it is just as effective in completely removing the cancer. Each of the incisions is less than 1 inch long, compared with the 10- to 12-inch chest incisions frequently needed in an open lobectomy.

Flores says that despite the VATS lobectomy being a good operation, only a small percentage of lobectomies performed in the United States utilize the VATS approach.

“Most people don’t have easy access to a surgeon or medical center that offers the VATS procedure,” Flores explains. In these cases, he says, patients should be assured that the open procedure is well tolerated and effective at removing cancer.

“Would I travel miles halfway across the country to get the VATS procedure? I’m not sure that I’d recommend that,” he says. “The main thing you have to do is make sure the cancer is under control.”

Inspired Ideas

When Cadeddu was a resident in the late 1990s, he saw a story on the evening news about fastening lip studs with magnets. He had an “ah-ha moment,” he remembers. “I thought, ‘Holy cow, we could do that.’ ”

Inspired by the lip stud fastening device, Cadeddu and his associates developed a system for controlling laparoscopic surgical instruments by using magnetic coupling.

Even though advances in surgical instruments have enabled surgeons to develop NOTES and LESS, Cadeddu says an engineering problem remains that needs to be solved to make these techniques more user-friendly because the instruments collide and there are still problems with efficiently moving and controlling the instruments while they are in the body.

“You put an instrument inside the patient through the belly button or through the vagina or through the mouth, but once you put it in, how do you stabilize it? How do you control it?” he says.

A number of research teams are working on solutions to these problems. In the magnetic coupling system developed by Cadeddu, a magnet is attached to an instrument, such as a camera or a cautery device, and a second external magnet is coupled with the internal magnet. “Then you can stabilize it and move it around wherever you need from outside the body,” he explains. He and colleagues have tested this method in animals and hope to test it in humans in late 2008.

Despite all the technological advances in cancer surgery, “it’s still the surgeon who makes it a better surgery, not the tool he uses,” Cadeddu says. Menon agrees, adding that an experienced surgical support team can give the surgeon the backup needed to make improvements to surgical procedures.

It’s vital for patients not to get too focused on having a surgical procedure performed with minimal invasiveness, says Flores. The most important thing is to be sure the surgeon has the expertise and experience to perform the procedure most suited to a patient’s individual needs.

