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[A caveat: This is an overview of a relatively new technology and a new surgical endeavor. It is not an exhaustive review and it is not meant as a substitute for a scientific evaluation. It is a practical look at a new surgical world. Most importantly, what follows is an attempt to raise many questions and provide a few answers. The article is part fact, part observation and part editorial.]

The mere mention of robotic-assisted surgery evokes strong passions. “Love” and “hate” are words heard when discussions turn toward the robot in the operating room. Logic becomes murky as the debate rages. But one thing is clear: The technology works. And not only does it work, it works beautifully in every sense of the word. The surgical robot represents the intersection of science and art; a surgeon-controlled machine directed toward delicate human dissection. Talk about “no touch” technique. This is it. To watch one robotic operation, guided by a skilled surgeon, is to see surgery at its finest; to see it as we picture it. The technology works.

So what? To ask whether the technology works, or whether we should allot dollars to robotic surgery, is to ask important questions. However, these may not be the bigger, more important questions. Let’s look first at surgical history, and at the smaller questions.

Confusion and Fear

If you are a “traditional” surgeon (insert your own age here), then you may feel somewhat antiquated in the present-day, high-tech operating room. Fast forward. It gets worse. You are about to feel like a dinosaur. Stand in an operating room with an operating robot docked comfortably at the side of the patient who is lying on the operating table. Watch as the surgeon, dressed in a traditional sterile surgical gown and gloves, places several instruments and readies the operative field. So far, so good. But just as you are begining to feel comfortable in this new world, beginning to think that you are not really the ghost of the operating room past, and that you might actually fit in here, the surgeon abruptly turns, walks away, removes the sterile gown, snaps off the gloves and sits down at a console in the corner. Before you blurt out “Where are you going?” you realize that you have just stepped far out of your comfort zone and through the door marked “tomorrow.” Today. If you are a “young” surgeon (insert your own age here), this new world is the same old world of your present-day operating room. The transition likely will be but a small blip on your lifetime learning curve. But, if you are that “traditional” surgeon, you are going to begin to ask yourself a lot of questions. The answers to these questions may bother you or elate you. The answers are as much about your mind as they are about the operating room. The answers are about more than the date on your residency certificate or the date on your maintenance of certification certificate. You are about to find out if you are “traditional” or “young.” Perhaps you are both.

And should you become concerned that you, the surgeon, are about to become expendable, take heart. With all of the automation in our modern aircraft cockpits, two pilots guide and control the plane. Two pilots make sure that each of us arrives safely at our destination. The pilot, not the robot, is responsible for our safety. As with aircraft avionics, the surgical robot works for us. You are not expendable ... yet.

How Did We Arrive at the Present? Or Is This the Future?

The confined space of the human pelvis can hamper visibility and maneuverability in the operative field. Both laparoscopic and robotic systems are touted as helping the surgeon overcome this space limitation. This has spurred the explosive growth of minimally invasive technologies.

Robotic surgery was originally developed by the military for remote surgical use. Subsequently, its use was found to be more applicable as an on-site tool. The first robotic procedure, a prostate operation, was performed in 1992. To date, more than 1.5 million robotic procedures have been performed worldwide.

In 2000, the FDA approved the da Vinci robotic system for use in intraabdominal surgery. The initial popularity of robotic systems was for use in urologic and gynecologic procedures.

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Robotic colorectal surgery was first performed in 2001. Only six reported robotic colectomies were performed between December 2001 and April 2002 despite literature demonstrating the feasibility and safety of the da Vinci system. Fifty-three robotic colorectal procedures were performed between 2001 and 2003, with 22 of these cases being for malignancy. The general consensus was that robotic techniques could achieve the same operative and postoperative results when compared with conventional laparoscopic techniques. According to one review, the use of robotic surgery in colorectal operations increased by 100% from 1,188 cases in 2009 to 2,380 cases in 2010. In contrast, the use of laparoscopy increased only by 1.15%.

Colorectal surgeons were thoughtfully slow to adopt robotic technology. Questions arose as to what, if any, were the advantages of robot-assisted colorectal surgery. In contradistinction to the improved, hand-sewn, robot-guided urethral anastomosis, the stapled colorectal anastomosis performed during robot-assisted surgery was no different than the stapled anastomosis performed during laparoscopic procedures. And then, there was the issue of cost. New systems were expensive to purchase or lease, and to maintain, to say nothing of the cost of the disposable items for each case. And, what about the steep learning curve?

With the inevitable development of new equipment and experience, coupled with a never-ending drive to advance in fertile directions, surgeons and industry have begun to look again at robotic technology.

Costs have come down and instruments are being made to better fit the needs of the colorectal surgeon and the general surgeon, as well as various other surgical specialists. The surgical community has begun to re-evaluate robotic-assisted technology and operative strategies. Does the improved experience in urologic surgery translate to colorectal surgery? To other specialties? Specifically, in colorectal surgery, current robotic techniques are focused on the treatments of rectal cancer, rectal prolapse, enterocoele repair and diverticulitis.

Similarities Between Laparoscopic and Robotic Systems

As in laparoscopic surgery, robotic surgery makes use of small incisions. In both techniques, patients recover faster compared with recovery times following open operations. With a more rapid recovery, needed chemotherapy can begin sooner when laparoscopic or robotic surgery is used for rectal cancer. In surgery for very low rectal tumors, the increased visibility using modern optic systems and improved precision and access to the most distal surgical sites—allowing for increased rates of sphincter-sparing procedures—could potentially decrease the permanent ostomy rate. Additionally, postoperative pain is minimized by an extraction site incision of just 6 to 8 cm (and in some cases even shorter) compared with an incision length of 15 to 20 cm in open surgery. Large, comparative clinical trials are under way, and results thus far indicate that robotic surgery is as effective as open surgery, and yields results "no worse" than the results in laparoscopic surgical procedures.

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The (Advertised) Bells and Whistles of Robots

The robotic system has certain benefits for both the surgeon and the patient. These are:

Three-dimensional high-definition vision. The robotic system has two high-definition cameras that provide the surgeon with a magnified, stereoscopic view of the surgical site, combining accurate depth perception with a sharp image.

An additional arm. This additional arm, which can be used to hold a retractor or other surgical instruments, gives the surgeon 50% more operating capability.
Weaknesses and Drawbacks

The robotic system has a few drawbacks.

An important clinical drawback is the lack of both tactile sensation and tensile feedback to the surgeon. Thus, tissue damage can occur unintentionally during traction by the robotic arm and during movement of the robotic instrument.

Learning safe robotic surgery is associated with a steep learning curve.

Importantly, robotic technology seems to put the eyes of the surgeon closer to the operative field; an advantage and a drawback as the view of the operative field is often “too close” and a larger frame of reference is required in order to get the “big picture.”

Ureteral catheters may be placed before beginning the robot-assisted operation. As robot-assisted procedures are associated with limited tactile sensation, lighted catheters may better improve ureteral identification. The catheters may assist in visual confirmation, identification and added protection of the ureters. This practice varies by institution and by surgeon, depending on factors related to training and personal preference. The use of catheters also may be related to the surgeon’s initial comfort with robot-assisted procedures. The use of ureteral catheters may decrease over time. More study is needed to evaluate the use and safety of robotic colon procedures with respect to genitourinary complications.

A dedicated team must be assembled and trained to allow for consistency, safety and reliability in the conduct of the operation.

The robot is an expensive system. A new system can cost up to $1.5 million to purchase, and, as in laparoscopic surgery, each operation can require the use of more expensive, single-use equipment. Service contracts are required. As of now, the manufacturer has no competitor and no competitive pricing pressure beyond the current regulatory forces. Clearly, there is a financial impact of added operating time, materials and personnel needs.

Is ‘No Worse’ the Same as ‘Better’?

There are studies showing that the results after robotic procedures are “no worse” than laparoscopic procedures. However, there are no prospective, randomized controlled trials demonstrating a clear-cut advantage of this new technology when compared with the now “traditional” laparoscopic technology. Unlike a urethral anastomosis, the colorectal anastomosis is no different between laparoscopic and robotic techniques, negating an important potential advantage of the robotic system.

The Smaller Questions

Surgeons are now performing most colorectal procedures using either laparoscopic or robotic technology. Our surgical group is transitioning to performing an ever-increasing number of robotic-assisted operations. New technologies usually engender new questions. Are there challenges in colorectal procedures that can be overcome, or clinical outcomes that can be improved by using robotic techniques? In both laparoscopic and robotic systems, the technical aspects of the operation are similar. Surgical principles remain unchanged. It is our (mechanical) hands that are different in robot-assisted operations. The view and clarity of the operative field and the precision of the surgeon’s movements are unrivaled. In many instances, the robotic optical view is improved over the view during laparoscopic procedures. Dissection is delicate andatraumatic. However, is one technology better than the other? Is robotic colorectal technology an advancement? Are we improving the results for our patients? Can hospitals and society afford the expensive robotic system? And, specifically in colorectal surgery, are we on the cusp of another surgical revolution? Is robotic surgery a fad or gimmick and sales tool, or perhaps a technology looking for another diseased organ system to repair? Many questions, few answers... so far.

The Big Questions

In science, a properly framed question is worth more than a king’s ransom. It is worth more than all of the equipment in all of the labs in all of our research facili-
remote planets. Who knows? But it is worth trying. It matters that in developing robotic technologies, we might just invent something totally unexpected, something that none of us can see now through our short-term lenses. We must think longer term. We must look further. We must go beyond small questions to big questions, to huge questions. And from this questioning will come small and large advances for all of us. We need to advance. To stand still is … to stand still. We need to keep moving forward, because we can. Robotic technologies are a part of this progress.

Robots R Us? A Few More Answers (Beginning With the Big Answer)

Should we be using the robot in the operating room? Yes. We may not know where this technology will lead us, but the story of mankind runs in lockstep with invention and exploration of all of our frontiers.

Is performing a robotic colorectal procedure exciting and fun? Yes.

Are robotic-assisted procedures being performed in our community and at our hospital? Yes. Surgeons of many specialties are in various stages of learning and adoption, and are evaluating the clinical applications of robotic-assisted operations. It is an intense learning process, and the field of robotic surgery is a rapidly evolving work in progress at both the national and personal levels.

Is robotic surgery safe? Yes, in trained surgical hands. (Remember, first do no harm.)

What about the learning curve? It is steep, very steep. For “traditional” surgeons, it involves didactic training, much practical training and “muscle memory” retraining. The curve is likely not as steep for the “younger surgeons” who already live in a high-tech, surgical and video game world.

Is laparoscopic surgery presently the most commonly used surgical system in minimally invasive general surgical and colorectal operations? Yes.

Will laparoscopic, minimally invasive surgery remain the most commonly used system in minimally invasive general surgical and colorectal operations for some time to come? Yes.

Is today’s robotic colorectal surgery an advance over our current laparoscopic techniques? Yes, in certain clinical situations.

Does robotic surgery have the potential to become the procedure of choice for the resection of pelvic tumors, left-sided tumors and complicated resections or reoperative resections, as well as in intraabdominal rectocele repair and enterocoele repair? Yes.

Do colorectal robotic systems allow for better clinical outcomes when compared with laparoscopic procedures? Possibly, for certain clinical applications. Much study is needed to clarify this point, however.

Are the results using robotic tools “no worse” than the results in laparoscopic surgery? Yes. (Remember, first do no harm.)

Is the promoted advantage of “greater visibility” using robotic technology an operating room advance when used in colorectal surgery? Possibly, especially if it turns out that nerve visualization and protection, and intraoperative vascular anastomotic perfusion evaluation are found to relate to improved clinical outcomes. Again, more study is needed to look at clinical outcomes.

Finally, is someone, somewhere working on an artificial intelligence program that will guide the robot-surgeon (or surgeon-robot) through an operation? Yes.

A Tool, a Toy and an Advance

Ultimately, as with any new intervention, the decision to use a robotic system in the operating room will depend on a clinical benefit analysis. There appears to be increasing acceptance and use of robotic technologies in many common operative interventions. The technology has improvements and advances over open surgical procedures and laparoscopic technologies as well. However, it will take the combined evaluations of both “traditional” and “young” surgeons to decide if the robot is a tool, a toy or an advance.

Disclosure

The authors report no financial relationship with Intuitive Surgical.

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