Editorial Commentary

Robotic liver surgery from the patient's perspective

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Minimally invasive hepatobiliary surgery began in 1987 with the first laparoscopic cholecystectomy (1,2). Over the next two decades, the use of laparoscopy in liver resection was reported on by multiple groups (3-5). However, it was not until 2008, when the first consensus guidelines for laparoscopic liver surgery were published, that these new minimally invasive techniques were standardized (6). Despite advances in instrumentation including laparoscopic staplers and energy devices, laparoscopic liver resections were still limited by the rigid instruments and 2D vision. While the laparoscopic techniques were maturing, the first robotic cholecystectomies were performed by Himpens (7) and Gagner (8) in the early 1990s. This was followed by the release of the da Vinci robotic surgical system in Europe in 1999 and its approval by the Food and Drug Administration (FDA) in the United States in 2000.

The robot-assisted surgical system has many advantages over laparoscopy including better ergonomics for the surgeon, EndoWrist articulated instruments, tremor filter, and a clear 3D, high definition, magnified field of vision. However, the system is criticized for the lack of tactile feedback as well as its high cost.

The first series of robotic-assisted laparoscopic liver resections was reported by Giulianotti *et al.* in 2003 (9). Since then, there have been multiple reports out of several countries describing their own robotic liver experience (10-15). Robotic liver surgery has slowly matured over the past decade and the surgical indications have expanded as surgeons push the boundaries including extended hemihepatectomies and liver donor hepatectomies. The first international consensus on robotic hepatectomy surgery just convened in 2018 suggesting the standardization of robotic-assisted liver surgery (16). Despite this, minimally invasive liver resections still make up a small fraction of all liver surgery (17).

Some of this delay in uptake of robotic-assisted laparoscopic liver surgery is due to technical challenges as well as a lack in training curriculum. Even now, nineteen years after the da Vinci system was approved by the FDA in the United States, there is no universal consensus regarding the appropriate training or credentialing standards. In an attempt to track and study safety, robotic-assisted surgery-associated adverse events are collected by the FDA's Manufacturer and User Facility Device Experience (MAUDE) database. Several of these reported adverse events have been front and center in the media with stories in newspapers such as the *New York Times* detailing patient deaths attributed to robotic surgery and documentaries including "*The Bleeding Edge*" chronicling complications of a few patients, who are in the extreme minority. The media focuses on these negative outcomes as they garner significant attention from the public.

However, on the other side, there is significant hospital marketing aimed at robotic surgery, highlighting the perceived benefits including small incisions and quicker recovery time. This dichotomy of easily accessible but simplified information has led to a very varied patient perception of robotic-assisted surgery. Some patients prescribe to the theory that it is new technology, and therefore, assume it must be better. Other patients see the negative media portrayal and are filled with a sense of fear. They envision a machine performing the procedures instead of their surgeons. The patients see the complications depicted in newspaper articles and documentaries and immediately discount it as a positive attribute to surgery.

Unfortunately, patient satisfaction with robotic-assisted surgery is not well studied in liver surgery. However, studies in other specialties including gynecology have shown that

a majority of their patients who underwent robotic-assisted surgery were pleased with their overall care and 91% would recommend robotic-assisted surgery to others (18). This high rate of satisfaction within gynecologic surgery patients suggest that it is possible to have patient satisfaction with robotic-assisted surgery in other specialties.

Specifically, in liver surgery, one of the greatest advantages of robotic hepatectomy over open or laparoscopic is for sectionectomies in difficult to reach locations such as the posterosuperior sections as these are not easily reached with laparoscopic instruments and would require a large incision to perform open (19). In these cases, which can be referred to as incision dominant cases, the incision is often the driving factor behind length of stay and clinical outcomes. Patients who undergo robotic-assisted sectionectomies or wedge resections can often times safely be discharged within 24 to 48 hours post operatively with minimal pain and small incisions. This is paradigm changing in liver surgery where patients traditionally have at least a week-long hospital stay. Robotic-assisted surgery also shows significant advantages in combination surgeries such as colorectal liver metastases in which minor hepatectomy is combined with colon resection which would require a large incision if performed open. These advantages are not discussed in the media depiction of robotic surgery.

For minor non-posterior superior hepatectomies, there is likely little difference from the patient perspective with regard to minimally invasive technique used. As suggested above, the difference is most notable in these posterosuperior sections which are difficult to reach laparoscopically. However, while the patient may not note a difference between the techniques, there are surgeon-related factors that may be associated with robotic hepatectomies such as improved ergonomics and decreased surgeon fatigue that are currently being studied.

It is important to discuss the use of the robot as a tool in the operating room with patients pre-operatively so that they understand the benefits, how it is used as well as the possible complications. It is also important to stress that if the robot at any point becomes a hindrance that it will be undocked and the case will be completed in whatever fashion the surgeon feels is safe and will provide the best outcome. These conversations between the surgeon and patient are crucial to patient acceptance and satisfaction with robotic-assisted liver surgery.

As robotic-assisted hepatectomies become more standardized, widely used and the technology improves, robotic-assisted surgery will be an indispensable tool in the hepatobiliary surgeon's armamentarium. The key to patient acceptance is communication between the surgeon and their patients regarding the use of the robot in surgery and to emphasize that the robot is in fact a tool used by the surgeon in carefully selected cases to give the patient the best outcome possible.

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