# Robotic versus laparoscopic surgery of the liver

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In the era of minimally invasive surgery, laparoscopy and robotic surgery have to take a role in liver resection. Laparoscopy for liver resection was first documented in the early 1990s, proving to be as safe as conventional open hepatectomy (1,2). During the intervening years, laparoscopic liver surgery series have demonstrated that the laparoscopic approach is associated with a decreased length of hospital stay and decreased estimated blood loss compared to conventional celiotomy (3-5).

In 2003 the first robotic liver resection was described by Giulianotti *et al.* (6). The last decade has seen robotic liver surgery gaining increasing acceptance worldwide and a number of reports have been published in support of its safety and effectiveness (7,8).

Some of the well-known advantages offered by the robotic platforms have proved to be of valuable help in facilitating and broadening the application of minimally invasive method for liver surgery. However, the available evidence on robotic liver surgery is still limited and definitive conclusions on the actual role of robotics cannot be drawn, essentially due to the lack of randomized trial comparing robotics and standard laparoscopy (9).

In an article published in the *Asian Journal of Surgery*, Hu *et al.* reported an interesting meta-analysis on the safety of robotic assisted versus laparoscopic liver hepatectomy (10). They performed a systematic research and eventually included 17 retrospective studies. The analysis of pooled data showed that robotic surgery was associated with higher estimated blood loss and longer operative time compared to conventional laparoscopy. These results are different from previous meta-analyses, but the differences were not considered to be important in clinical practice, since they were either very small (weighted mean difference of 40 mL for blood losses and weighted mean difference of 45 minutes longer in robotic group). With regard to operative times, it is likely that the effect of the learning curve have contributed to the difference in the two groups, given that the relative levels of experience on robotic and laparoscopic procedures were significantly different between surgeons.

Tsung *et al.* (11) demonstrated that operative time could be reduced along with the increase of experiences with operating robotic techniques. On this argument, Efanov and co-workers recently published an intriguing analysis comparing the learning curve of robotic and laparoscopic liver resection (12). The authors reported on a consecutive series including 131 minimally invasive hepatectomies. Two surgeons, who were well trained in liver surgery but without expertise in laparoscopic surgery, performed all surgeries. Overall, the difficulty level of the procedures was comparable between the robotic and laparoscopic group with respect to the following criteria: number of resections of posterosuperior segments, rate of anatomical resection and presence of cirrhosis. Conversely, the proximity to major vasculature and tumor size increased with significance the complexity of the procedures performed with the robot compared to laparoscopic resections. Interestingly, the number of procedures required before proceeding towards more demanding resections was significantly lower for robotic surgery (16 versus 29). Moreover, the mean difficulty of robotic resections increased significantly between the early and the late phase of the experience, while it did not for laparoscopic procedures. The authors concluded that the use of the robot during the initial experience with minimally invasive liver surgery might contribute substantially to widen competently the range of its application from low-difficulty resections to progressively include more difficult hepatectomies.

An important point for liver resection was the decrease in the amount of intraoperative blood loss. Negative peri-operative events and a poor long-term survival are also associated with blood loss and consequent need for blood transfusions (13,14).

The meta-analysis of Hu *et al.* (10) reported an increase in blood loss in the robotic group probably due to the different techniques for liver transection. However, they not found significant differences between the two groups regarding the blood transfusion rate.

On the other hand, Qiu J *et al.* (7) reported a meta-analysis of robotic versus laparoscopic liver resection when they showed no significant differences between the two groups in blood loss.

Spampinato *et al.* (15) reported a retrospective study between laparoscopic and robotic major hepatectomy. The two groups were comparable for all baseline characteristics including type of resection and underlying pathology. No difference was noted in estimated blood losses. Nevertheless, intermittent pedicle occlusion was required only in laparoscopic group (32% *vs.* 0%; P=0.004).

The management of bleeding is generally easier in robotic surgery compared with open and conventional laparoscopy as a result of the high resolution 3D robotic camera controlled by the surgeon, wristed instruments, stable gap with the fourth arm, the aspiration and washing of the assistant, resulting with precise endosuturing in cases of intraoperative bleeding (16-18).

Some evidences from the literature suggests that robotic surgery may play a role in widening the application of minimally invasive surgery for liver resection in the posterosuperior segments (19-22). This is supported also by the Second International Consensus Conference, held in Morioka in 2014, where the posterosuperior segments, intended as segments 1, 4a, 7 and 8 were defined as representative locations that are difficult to approach laparoscopically (23). The Southampton Consensus Guidelines for Laparoscopic Liver Surgery (24) also reported that minor laparoscopic resection in segment 1, 4a, 7, and 8 are associated with greater operative time and blood loss than equivalent resections in the anterolateral segments.

Robotic systems provide the surgeon with a full range of motion, with a global range of movements within the abdomen that is similar to open surgery. This is an enormous advantage, especially when angulated or curved lines of section are needed and the parenchyma-sparing principle is to be followed. Furthermore, a fully robot-integrated ultrasonography, which currently affords maneuverability in all robotic degrees of freedom, permits better localization of the lesions to be excised and precise visualization of neighboring vascular and biliary structures (8). Both the operative field and the ultrasound image are simultaneously displayed in real time above the surgeon's goggles. In this regard, robotic surgery may also reduce the high proportions of major hepatectomies reported by some series, as noted by several authors (9,19).

Robotic surgery may also permit easier management of possible intraoperative complications such as major bleedings or bowel injuries (7,10,18), possibly resulting in lowered rate of conversion to laparotomy.

Tsung *et al.* (11) performed an interesting matched comparison of surgical and postsurgical outcomes between robotic (n=57) and laparoscopic (n=114) hepatic resection. They showed no significant differences between the two groups in operative and postoperative outcomes as measured by blood loss, transfusion rate, R0 negative margin rate, postoperative peak bilirubin, postoperative intensive care unit admission rate, length of stay, and 90-day mortality, although the robotic approach allowed for an increased percentage of major hepatectomies to be performed in a purely minimally invasive manner (81% versus 7.1%; P<0.05).

For the higher cost of robotic surgery, the intrinsic economic burden has been originally considered as a main drawback and limiting its widespread application. Actually, although for several, more routinely procedures the advantages in the postoperative course do not translate into cost effectiveness, in other more complex surgeries (such as those of liver oncological surgery) it seems that the robotic technique could actually prove to be financially beneficial.

The Henri Mondor Hospital group of Paris, which has an internationally renowned expertise in laparoscopic liver surgery, has published a further, very recent analysis (25). The authors reported on a propensity-score matched comparison between laparoscopic and robotic left lateral sectionectomy. Overall, the two techniques were equal on both perioperative and postoperative outcomes. Interestingly, the cost of the robotic surgery was lower than that of laparoscopy, although without statistical significance.

Robotic surgery is still in its infancy, and probably a reliable evaluation of its actual economic impact on clinical practice should include some indirect aspects, most of which are not fully predictable at present. Furthermore, given the exponential evolvement of robotic surgery and that there is still one sole supplier of robotic instrumentation, it is likely that a wider variety of products will enter the market in the near future, resulting in more competition.

In conclusion, increasing evidence exists that the application of minimally invasive techniques to liver surgery may offer good perioperative outcome. Robotic technique has emerged as a promising innovation in surgical practice and initial experiences have shown that it can be considered a safe and effective option for liver resection. However, definitive conclusions on the actual role of robotic surgery cannot be drawn, and prospective evidence will be crucial in the near future.

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