Editorial

Minimally invasive liver resections: a changing landscape and the rise of the robot

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Minimally invasive techniques are increasingly employed for liver resections for both oncologic and non-oncologic indications, and the safety and non-inferiority of both laparoscopic and robotic-assisted techniques as compared to the gold standard of open surgery is increasingly well-established (1-9). The variation in adoption of minimally invasive approaches amongst hepatobiliary surgeons, and overall preferences for laparoscopic versus robotic-assisted methods, warrant further consideration. Robotic-assisted surgery, as compared to a laparoscopic approach, offers distinct advantages including better visibility with a three-dimensional camera system, articulating instruments that mimic the motion of the human wrist and allow for easier suturing and fine dissection, and elimination of surgeon tremor. Disadvantages of a robotic approach include, arguably, greater expense, the loss of tactile feedback, and the removal of the surgeon from the patient bedside (10). From 2010 to 2016 there were 19 major series (including at least nine patients) which described 631 robotic liver resections (1,2,11-27).

In their paper "*A multi-institutional analysis of minimally invasive liver resection*", Smith *et al.* examine the changing practice patterns of liver resections from 2000 to 2016 at three high-volume institutions in the United States, in particular the operative volumes and techniques of three senior hepatobiliary surgeons. In total they describe 1,323 liver resections consisting of 746 open procedures (56.4%), 530 laparoscopic procedures (40.1%) and 47 robotic-assisted procedures (3.6%). The paper illustrates the trend of liver resections over their 17-year study period in Figure 1. It is interesting to note that though there were certainly more minimally invasive liver resections performed in 2016 as compared to 2000 (40.5% *vs.* 0.5%, P<0.001), the proportion of laparoscopic liver resections peaked at >60% in 2006 and subsequently decreased to around 20% in 2015, while open liver resections increased from around 30% to more than 60% over the same time period. As the paper also states, the first robotic-assisted resection was performed in 2009 and subsequently increased though 2016, when this technique comprised 25.5% of all reported liver resections. Though this may explain in part the decline in laparoscopic resection rates, it does not seem to wholly explain the trend, especially in light of the significant increase in open resections.

Recent papers have focused on comparing outcomes following laparoscopic versus robotic-assisted liver resection, with mixed results (2,12-14,16,17,19,21,23-27). Some studies have shown longer operative times, an increased need for the Pringle maneuver and higher blood loss with robotic-assisted surgery. Other outcomes have largely been shown to be equivalent, and some studies failed to show difference in these parameters as well. More studies, including propensity matched reviews and randomized trials, are needed. When the differences in outcomes or lack, therefore, between the two techniques are better clarified, hepatobiliary surgeons may have more objective data to assist in their decision making in preferring one technique to the other.

This study also demonstrates that minimally invasive liver resections offer significant clinical benefits, including decreased intraoperative blood loss, decreased operative times, decreased hospital length-of-stays, and decreased

major morbidity in particular lower rates of postoperative infections. Similar findings have been demonstrated in other studies, however it is worth noting that in this study population there were a significantly higher proportion of major resections in the open cohort as compared to the minimally invasive cohort (47.5% *vs.* 29.6%, P<0.0001) (1,28,29). Additionally, the rates of oncologic resections in the open group were nearly double that of the minimally invasive group (86.3% *vs.* 49.9%, P<0.0001). Both of these factors likely influenced, at least to some extent, the differences observed in perioperative and postoperative outcomes.

In conclusion, we congratulate the authors on an interesting overview of how the utilization of minimally invasive techniques for liver resections have evolved over a 17-year period at three leading, high-volume hepatobiliary institutions in the United States. Further potential areas of exploration include randomization between the two techniques, more detailed cost comparisons, and an increased emphasis on long-term and oncologic outcomes in addition to the increasingly well-described short-term, perioperative results.

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