Clinics in Surgery

Editorial
Published: 18 Jul, 2018

# Robotic Liver Surgery – Where Do We Stand?

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## Editorial

Minimal invasive surgery is a well-accepted alternative approach for resection of anterior liver segments and left lateral secterectomies [1-3]. The well established advantages of minimal invasive liver surgery are less estimated blood loss, postoperative pain, morbidity and hospital stay as well as improved cosmoses and equivalent oncological outcomes compared to traditional open surgery [2,4-6]. Most of these studies have reported the outcomes of minimal invasive surgery primarily in the form of conventional laparoscopy. However, there are inherent disadvantages of conventional laparoscopy such as limited motion of the instruments due to fulcrum and lack of dexterity, unstable camera platform poor ergonomy, 2D vision and not to downplay surgeon fatigue in long hepatobiliary procedures. Robotic platform by virtue of overcoming these limitations has been gaining momentum as evident by the constantly growing number of reports in literature [7,8]. The basic requirement to start a successful robotic liver surgery program is dedicated team along with equipment, surgical expertise, and proctorship. The experience of Choi, Lai et al. [7,8] have demonstrated that robotic liver surgery is safe and feasible even for complex liver resection. However, the authors have cautioned that such experience are limited to only very few high volume center, safety and feasibility of this approach need to be defined in large multicentre studies. The indications of robotic liver resections are same as laparoscopic resections with the added advantage of better access to the lesion in a posterosuperior segment of the liver which is difficult to access in conventional laparoscopy [4,9]. The available evidences in the literature suggest that robotic and laparoscopic hepatectomy similar in terms of blood loss, morbidity, mortality and hospital stay but with prolonged operative times and increased costs [4-8,10] in robotic arm. Therefore, robotic surgery is usually considered as an alternative minimally invasive approach for liver resection. Studies have shown that the minimal number laparoscopic minor and major hepatectomies to overcome learning curve are 22–64 cases, and 45–75 cases, respectively [11,12]. However, the learning curve numbers for robotic liver resections are lacking at present. One of the major proposed advantages of robotic surgery is the possibility of shortened learning curve for complex liver resection based on the study of pancreatic resection studies [13] which is considered equally complex as compared to liver resection. Also laparoscopic complex liver resection needs both expertises in open complex hepatobiliary surgery as well as advanced laparoscopy. Same doesn't hold true for robotic liver surgery, one can easily translate expertise in open Liver surgery to robot. Computer simulated and dual console training modules for robotic surgeries are well standardised, thus new trainee doesn't need real patient experience to learn robotic surgery skills. The advantages of the robotic surgery are improved view via three-dimensional vision, visual magnification, tremorfilteration, scaled surgeon movements as well as flexibility and dexterity of the instruments which increases precision in operative techniques. This allows the surgeons to perform delicate and precise dissection especially in narrow and deeper areas and inaccessible areas with better depth perception, transection of liver in curved planes and precise intra-corporeal suturing.

The major advantage of robotic hepatectomy may lie in sectoral, segmental, or subsegmental resections in difficult-to-reach positions like posterior-superior segments and caudate lobe. Thus patients may be spared the large incisions and extensive mobilization required in an open approach for such incision dominant areas. Hepatic resections for hilar cholangiocarcinoma, caudate lobectomy and bile duct anastomosis [14,15], especially for small ducts is difficult via pure laparoscopic approach and generally not performed. Use of robotic surgical system may allow these to be approached in a minimally invasive manner with decreased tremor and fatigue for the surgeon.

Similarly, robotic approach may of greater value in facilitating a parenchymal-sparing liver resection as limited ability of laparoscopic approach in transection in transverse and curved planes which translates into to substantial normal liver volume loss. Several authors have reported that the parenchymal-sparing resection of the posterosuperior segments was performed more often by a robotic approach as compared to laparoscopic procedures [16,17]. The less surgeon fatigue,

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**Received Date**: *22 Jun 2018*
**Accepted Date***: 13 Jul 2018*
**Published Date***: 18 Jul 2018*

***Citation:***
*Goja SK, Yadav SK, Soin AS. Robotic Liver Surgery – Where Do We Stand?. Clin Surg. 2018; 3: 2041*

especially in longer procedure, is an additional advantage of robotic liver surgery.

Augmented reality by integrating image guided navigational surgery is new useful a aid for intraoperative manoeuvres in robotic liver surgery [18]. Also integrated near infrared fluoroscopy is an important asset in robotic platform. Visualization of arteries and veins in 5 seconds to 60 seconds and biliary tract in 45 min to 60 min helps in identifying anomalous anatomy, thus increasing safety of procedures.

The disadvantage of present day robot starts with their sheer size and bulk thus needing spacious operating room size. The separation of patient and operating surgeon along with time needed for change of instruments as well as undocking if needed, creates sense of anxiety for delay in managing any emergency situation.

The main disadvantage robotic liver surgery is its cost variably reported .In our experience, robotic liver resections cost on an average 1700 USD higher than open surgery [19], regardless of its complexity. Lack of tactile feedback which results in suture breakages more so initially as well as gauging retraction pressure on Liver so important especially in steatotic and post chemotherapy livers is certainly limitation. Similarly the range of instruments available for robotic liver surgery is limited for liver surgery. Non articulating harmonic shears defeats the very advantage we have with robot because lack of endowrist function. Non availability of all transection devices like CUSA makes transection difficult especially in donor hepatectomy. The other disadvantage includes the need for another equally trained assistant by patient side for change of instruments, application of staplers and suction.

We reported the first robotic left hepatectomy in India in 2015 [20] and the first robotic right hepatectomy year later [21]. Since 2015, we have performed 22 robotic liver resections which include 2 right hepatectomy, 3 left hepatectomy, 7 left lateral hepatectomy, 3 right posterior segmentectomy, 4 bisegmentectomies and 3 monosegmentectomies. Out of 22, 12 robotic liver resections were for benign lesions. Benign cases included Haemangioma (n-5), polycystic liver disease (n-1), Hepatic adenoma (n-2), Focal nodular hyperplasia (n-1), Hydatid cysts (n-2) and recurrent pyogenic cholangitis with liver abscess (n-1). Malignant cases (n-10) included primary liver cancers (n-7) such as Hepatocellular carcinoma (n-6) and intrahepatic Cholangiocarcinoma (n-1), Gall bladder carcinoma (n-1) and liver metastasis (n-2). One patient had Child A cirrhosis.

The mean blood loss was 300 ± 135 ml and operative time was 413 ± 211 min. 21% had minor complications and 5% had major complications as per Clavien Dindo classification. The median length of hospital stay was 5 days and median follow up duration was 18 months. Four patients required an intra-operative blood transfusion, and one was converted to open due to arm malfunction. For malignant cases, positive resection margins were found in none, mean tumor size was 6.4 cm and 3 patients had local recurrences in follow up.

In our experience, the robotic system can be safely used to perform major hepatectomies, with greater ease of hemostasis and biliary pedicle suturing and rest findings corroborating with available literature.

In the near future, robotic liver surgeries will not only be feasible and safe but also available for the vast array of patients with all advantages of minimal access surgery. Miniaturization, availability of all instrument gadgetry, easy and faster docking and de docking, navigation based surgery and more use near infrared fluoroscopy, cost effectiveness will not only make it safe but affordable.

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