Kaohsiung Journal of Medical Sciences (2016) 32, 281–291

Available online at www.sciencedirect.com

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journal homepage: http://www.kjms-online.com

REVIEW ARTICLE

Current status and future perspective of laparoscopic surgery in hepatobiliary disease

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Received 10 March 2016; accepted 3 May 2016
Available online 1 June 2016

KEYWORDS
Hepatectomy;
Laparoscopic cholecystectomy;
Minimally invasive surgical procedures;
Robotic surgical procedures

Abstract Recent advances in minimally invasive surgery include laparoscopic and robotic surgery. These surgical techniques have changed the paradigm of surgical treatment for hepatobiliary diseases. Minimally invasive surgery has the advantages of minimal wound extension for cosmetic effect, early postoperative recovery, and few postoperative complications in patients. For laparoscopic liver resection, the indications have been expanded and oncological outcome was proven to be similar with open surgery in the malignant disease. Laparoscopic cholecystectomy is a classical operation for benign gallbladder diseases and the effort to decrease the surgical wound resulted to perform single incision laparoscopic cholecystectomy. For choledochal cyst, laparoscopic surgery is applied gradually despite of the difficulties associated with anastomosis, and robotic surgery for hepatobiliary disease is also performed for more minimally invasive surgery; however, while admitting the advantage of robotic surgery, robotic technology should be improved for development of more convenient and cheaper instrument and continuous efforts to enhance surgical technique to overcome long operation is necessary. In this review, the status and future perspectives of minimally invasive surgery for hepatobiliary diseases are summarized and discussed.

Introduction

Recent advances in minimally invasive surgery have changed the paradigm of abdominal surgery. Since the 1990s, laparoscopic surgery has become the treatment of choice for cholecystectomy [1–3]. Moreover, laparoscopic liver resection has shown satisfactory oncological and surgical outcomes and has witnessed major technical advances such as the use of robotic surgery [4–8]. Single-incision laparoscopic surgery is considered a type of minimally invasive surgery, given its feasibility and safety [9–11].

Conflicts of interest: All authors declare no conflicts of interest.

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http://dx.doi.org/10.1016/j.kjms.2016.05.006

Minimally invasive surgery has the advantages of minimal wound extension for cosmetic effect, early postoperative recovery, and few postoperative complications in patients [1—11]. Several studies have reported the superiority of laparoscopic surgery in terms of immunological aspects [12—14].

Although surgical innovations have accomplished formidable change of operation technique during past 2 decades, limitations to be overcome still remain and might be a challenge to surgeons and surgical technology.

The aim of this review is to focus on the current practice of laparoscopic and robotic surgery and predict the future perspective of minimally invasive surgery for hepatobiliary disease. This review is composed of five parts: (1) laparoscopic liver resection; (2) robotic liver resection; (3) laparoscopic and robotic cholecystectomy; (4) laparoscopic and robotic surgery for choledochal cyst; and (5) laparoscopic common bile duct exploration.

Laparoscopic liver resection

Feasibility and indications for laparoscopic liver resection

The scope of laparoscopic liver resection has widened considerably in the past 2 decades [15,16]. Although laparoscopic hepatectomy was initially used for resection of small and superficial lesions, laparoscopic left lateral sectionectomy has become a standard operation [17]. Recently, more complex liver surgery has performed from the segmentectomy, sectionectomy to hemihepatectomy [5,18—20]. Many laparoscopic liver surgeons have emphasized the merits and feasibility of laparoscopic hepatectomy [5—7,20].

In the first consensus conference on laparoscopic liver surgery held in Louisville, KY, USA in 2008, the terminology and indications for laparoscopic hepatectomy were described [17]. The following three techniques can be used to perform laparoscopic liver resection: pure laparoscopy, hand-assisted laparoscopy, and the hybrid technique. In pure laparoscopy, the entire operation is performed through laparoscopic ports. Hand-assisted laparoscopy includes the elective placement of a hand port for facilitating the operation. In the hybrid technique, a pure laparoscopic or hand-assisted procedure is used, but resection is performed through a mini-laparotomy incision. The best indication for laparoscopic liver resection is solitary lesions of $\leq$ 5 cm located in the peripheral liver segments. Laparoscopic left lateral sectionectomy should be considered as the standard treatment (Figure 1A) [17].

In the second international consensus conference on laparoscopic liver resection held in 2014, expert recommendations were made on the basis of literature reviews and presentations [21]. Major laparoscopic liver resection including three or more segments of liver was defined as an innovative procedure, still in an exploration or learning phase of development of procedure with incomplete defined risk according to the Balliol classification of Innovation, Development, Exploration, Assessment, and Long-term study (the IDEAL model) [21,22]. Minor liver resection, defined as the resection of one or two liver segments, is regarded as a standard surgical treatment but is still in the assessment phase of development according to the Balliol classification of IDEAL [21,22]. Most studies on laparoscopic liver resection have been observational studies with low-quality evidence.

In technical aspects, the main conceptual change in laparoscopic liver resection is the caudal approach, which offers improved exposure around the vena cava and facilitates identification of the Glissonian pedicle at the hilar plate [23]. Moreover, the laparoscopic view facilitates the caudal—cranial transection of the hepatic parenchyma, allowing better identification of vascular structures. The anterior approach, which has been described for liver parenchymal transection before right liver mobilization, was described by Belghiti et al. [24].

In the 1990s, laparoscopic liver surgery was performed for left-sided and right-peripheral lesions requiring limited resection [4]. Generally, laparoscopic hepatectomy has been limited to patients with tumors ($\leq$ 5 cm) located in the peripheral liver segments (segments, 2—6) [17]. In a review of laparoscopic liver resection in 2804 patients, the most common type of resection was wedge resection or segmentectomy (45%), followed by left lateral sectionectomy (20%), right hepatectomy (9%), and left hepatectomy (7%) [25]. In a study comparing the surgical outcomes of laparoscopic liver resection for posterosuperior and

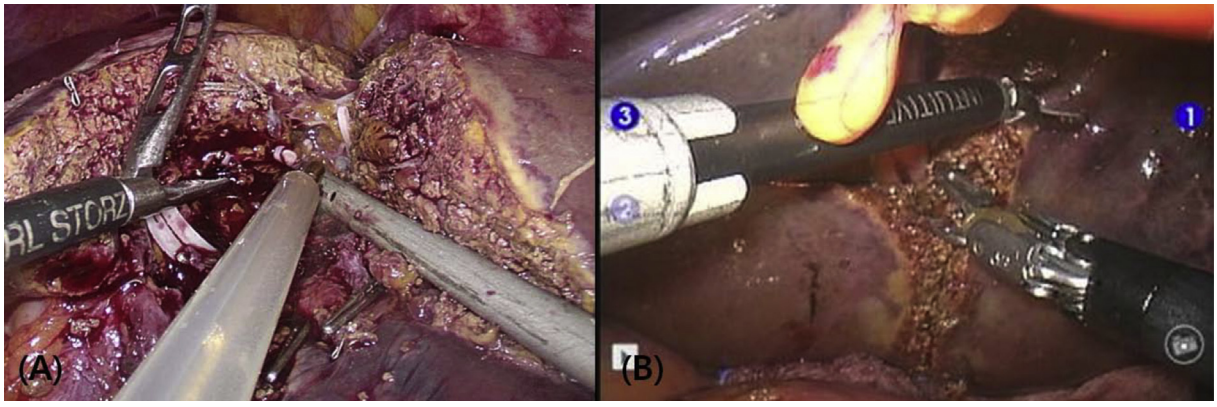

Figure 1. (A) Laparoscopic and (B) robotic left lateral sectionectomy.