Journal of Visceral Surgery (2016) 153, 447—456

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REVIEW

Robot-assisted laparoscopic liver resection: A review

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Available online 21 September 2016

KEYWORDS
Hepatectomy;
Robotic;
Laparoscopic;
Cost;
Morbidity

Summary Surgery using a robotic platform is expanding rapidly today, with a notable surge since its authorization on the international medical market by the US Food and Drug Administration in 2000. The first hepatectomy by a robotic approach was reported in 2002, 10 years after the first laparoscopic hepatectomy. Yet, in hepatic surgery, series are scarce and the lack of relevant data in the literature is an obstacle to the development of robot-assisted laparoscopic hepatectomy (RALH). Based on a review of the literature, this update focuses on current indications, short-term and oncologic outcomes following RALH.

Introduction

The idea of using robotic assistance in surgery came from the US Army in the 1980s. The goal was to develop robotic platforms capable of performing surgery at a distance on soldiers who had been wounded on the battlefield [1]. Ultimately, however, the robot derived from this project was too big, too unwieldy and too dependent on human assistance to be useful in the battlefield setting (http://www.sri.com/engage/products-solutions/m7-surgical-robot). In 1995, the project was rejuvenated by ''Intuitive Surgical'', a private American corporation. The first *Da Vinci* prototype came to life two years later. The use of robotic platforms in gastrointestinal surgery has developed progressively since 2000 when the US Food and Drug Administration (FDA) approved the application for international market authorization. It is important to underline that the term robotic surgery is inappropriate, and that it is preferable to speak about robot-assisted laparoscopic surgery where the surgeon and particularly the assistant continue to control the entire flow of events during surgery.

Giulianotti et al. published the first report of a robot-assisted laparoscopic hepatectomy (RALH) in 2002 [2], i.e. 10 years after the first laparoscopic hepatectomy [3]. The advantages that a robotic tool offers the liver surgeon include: (i) high definition 3-D vision, (ii) an operating console that allows reproduction of complete mobility of the hand and

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http://dx.doi.org/10.1016/j.jviscsurg.2016.08.005
1878-7886/

fingers, while eliminating all background tremor, (iii) a better ergonomic working situation where the surgeon operates in a sitting position, and therefore added comfort that allows the surgeon to be quicker, more concentrated and less fatigued, and (iv) hepatectomy constitutes a good indication for the robotic platform because the operative field is fixed. However, currently there are no data to prove that robot-assisted surgery is any better than conventional laparoscopic surgery in terms of reduction of blood loss, decreased postoperative pain, quicker return to normal function and activity, or improved oncologic outcome. The goal of this update was to clarify the current indications, the intra- and postoperative characteristics as well as the oncologic outcomes of RALH through a review of the literature.

Methodology

This update identified studies in PubMed using the following key words: (''robot'' OR ''robotic'') AND [(''liver surgery'') OR (''liver resection'') OR (''hepatic surgery'') OR (''hepatic resection'') OR (''hepatectomy'')]. The main inclusion criteria were studies with $\geq$ 10 patients. Literature reviews with series < 10 cases, and all studies that did not concern RALH were excluded. Articles published between February 2011 and March 2015 were analyzed.

Fifteen retrospective studies were identified based on the above mentioned inclusion criteria, one of which was recently reported in a review of the literature by Buchs et al. [4]. One study published by our team [5] was included in this review, for a total of 19 potentially analyzable studies (Fig. 1). Of these [4—22], nine articles were published by four teams (Tsung et al. [15,18], Lai et al. [12—14], Troisi et al. [6,17] and Giulianotti et al. [9,10]). Therefore, only the most recent studies of each group were analyzed in this update for a total of 14 series [4,5,7—9,11,14,16—22], including a total of 447 RALH. Lastly, we analyzed six studies that compared RALH with conventional laparoscopic hepatectomy [16—19,21,22].

Indications and types of hepatectomies

The mean age of patients was 60 years. Of the 447 RALH, 319 (71%) were indicated for malignant tumors and 128 (29%) for benign disease and non-tumoral disease such as intrahepatic lithiasis. Hepatocellular carcinoma (n = 163; 51%) and metastases (n = 97; 30%) made up the bulk of malignant tumors. For the benign tumors, the most prevalent were angioma (n = 29; 23%), focal nodular hyperplasia (n = 17; 13%) and adenoma (n = 9; 7%) (Table 1).

Of these 447 RALH, 138 (31%) were major hepatectomies, 301 (67%) were minor hepatectomies while eight types of resections (2%) were not specified (Table 2). Very few studies have analyzed or compared the robotic approach with the laparoscopic approach in terms of site of lesions, in particular, only one study compared the robotic approach with

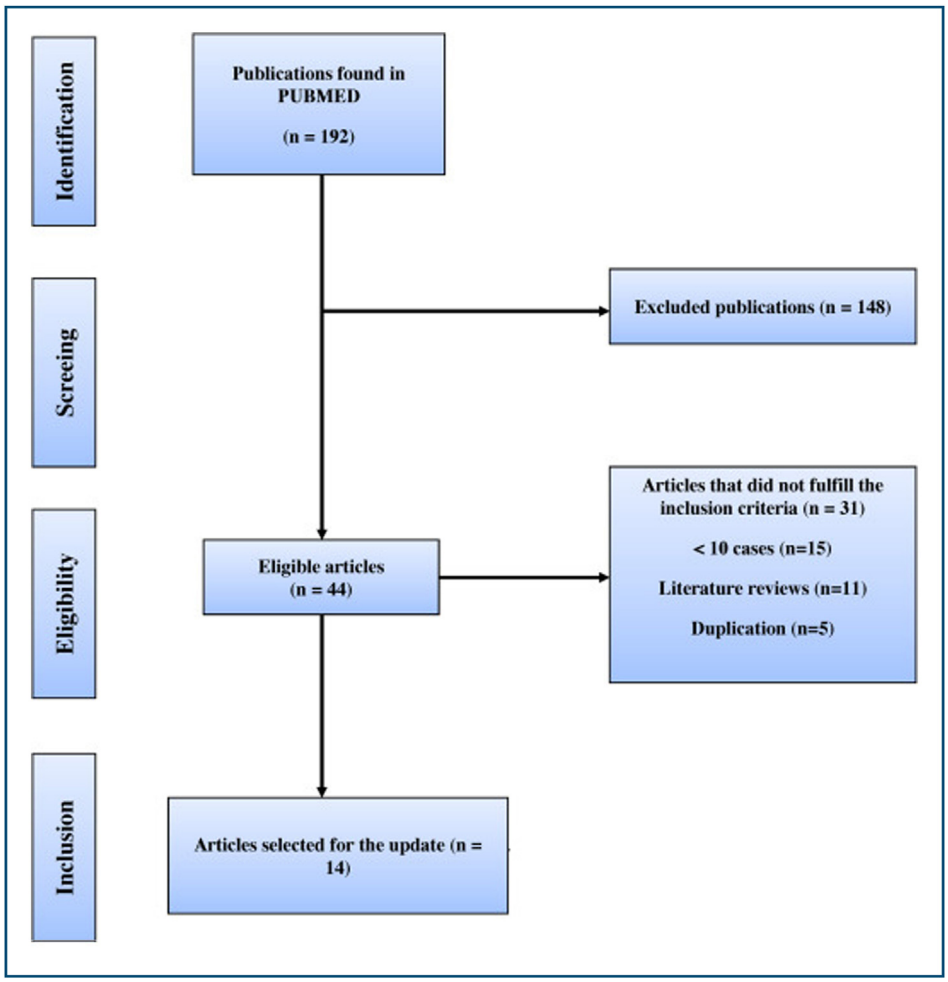

Figure 1. Methodology and results of bibliographic research.