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Robotic liver resection including the posterosuperior segments: initial experience

*Carolijn L.M.A. Nota, BSc, I. Quintus Molenaar, MD, PhD, Richard van Hillegersberg, MD, PhD, Inne H.M. Borel Rinkes, MD, PhD, and Jeroen Hagendoorn, MD, PhD**

Department of Surgical Specialties, UMC Utrecht Cancer Center, University Medical Center Utrecht, Utrecht, The Netherlands

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ABSTRACT

Background: Robot-assisted laparoscopy has been introduced to overcome the limitations of conventional laparoscopy. This technique has potential advantages over laparoscopy, such as increased dexterity, three-dimensional view, and a magnified view of the operative field. Therefore, improved dexterity may make a robotic system particularly suited for liver resections, which require nonlinear manipulation, such as curved parenchymal transection, hilar dissection, and resection of posterosuperior segments.

Methods: Between August 2014 and March 2016, 16 patients underwent robot-assisted laparoscopic liver resection at University Medical Center Utrecht.

Results: Fifteen robot-assisted laparoscopic liver resections were performed in a minimally invasive manner. One procedure was converted. In eight patients, we performed a resection of a posterosuperior segment (segment 7 or 8). Median operating time was 146 (60-265) min, and median blood loss was 150 (5-600) mL. Four patients had a Clavien–Dindo grade III complication. Median length of stay was 4 (1-8) days. There was no mortality.

Conclusions: This prospective study reporting on our initial experience with robot-assisted laparoscopic liver resection demonstrates that this technique is easily adopted, safe, and feasible for minor hepatectomies in selected patients. Moreover, it shows that the robotic platform also enables fully laparoscopic resections of the posterior segments.

Introduction

Minimally invasive liver surgery has a relatively brief history. Compared to other gastrointestinal procedures, laparoscopy in liver surgery lags behind. In the 1992, the first nonanatomic laparoscopic liver resection was performed, and the first anatomic laparoscopic liver resection was performed in 1996.[1,2] Nowadays, minimally invasive techniques are widely accepted. Over 3000 laparoscopic liver resections have been reported in the literature, ranging from resections for malignant and benign lesions to donor procedures.[3,4] Non-randomized studies have shown that laparoscopic liver resection is safe and feasible in selected patients. Moreover, when comparing the laparoscopic liver resection with open liver resection, the laparoscopic approach is associated with significantly shorter hospital stay, less blood loss, and similar oncologic outcomes.[5-9]

In the last few years, a new minimally invasive technique for liver resection emerged: robot-assisted laparoscopic liver resection. The robotic system has been designed to overcome

* *Corresponding author*. Department of Surgical Specialties, UMC Utrecht Cancer Center, University Medical Center Utrecht, Heidelberglaan 100, Utrecht 3584 CX, The Netherlands. Tel.: +31 88 75 555 55; fax: +31 0887555454.
E-mail address: j.hagendoorn-3@umcutrecht.nl (J. Hagendoorn).
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the shortcomings of conventional laparoscopy. It provides increased dexterity, a three-dimensional, magnified view of the operative field and leads to decreased fatigue for the surgeon. Presumed current cost and lack of randomized evidence for use of robotics have been cited as potential downsides.[10] Anyway, robot-assisted laparoscopy is nowadays widely used in gastrointestinal, urological and gynecological surgeries. However, in liver surgery, it is not extensively used. Currently, approximately 400 procedures have been described in the literature.[11]

The aforementioned advantages of the use of a robotic system lead to increased precision in surgical dissection. Theoretically, the use of a robotic system would especially be advantageous in resections that require nonlinear manipulation such as resections of the posterosuperior segments and in hilar dissection and curved parenchymal transection.[12-14]

In this study, we describe our first experiences with minor liver resections using the da Vinci Si robotic system (Intuitive Surgical, Sunnyvale, CA). Sixteen consecutive, selected patients underwent robot-assisted laparoscopic minor liver resections. Among these were eight patients who underwent a resection of a posterosuperior segment.

Methods

The University Medical Center Utrecht has experience on robotic surgery for several years. Since 2000, robot-assisted esophagectomies are performed. In addition, also pancreatic resections and thyroidectomies are performed robotically. This experience was used to help in setting up the program for the robot-assisted laparoscopic liver resections.

Following this, the first 16 patients underwent robot-assisted laparoscopic liver resection at University Medical Center Utrecht using the da Vinci Si Surgical System (Intuitive Surgical) from August 2014 to March 2016.

Indications for hepatectomy were made in a multidisciplinary team meeting. Whether the patient underwent a robot-assisted laparoscopic hepatectomy or an open hepatectomy was based on lesion location and evaluation of overall clinical status.

Data regarding patient demographics, perioperative parameters, and postoperative outcomes were collected in a prospective maintained database. Patient demographics included age, sex, body mass index (BMI), previous abdominal surgery, and preoperative chemotherapy status. Data on pathologic findings included histopathology, benign and/or malignant status, tumor size, and resection margin. Data on (outcomes of) surgery included operating room (OR) time, operating time, docking time, console time, blood loss, transection method, R0/R1/R2 status, conversion rate, complication rate, length of hospital stay, and mortality.

Operating time was defined as the time from first incision to wound closure. Postoperative complications were graded according to the Clavien–Dindo classification scale.[15] Complications were registered up to 90 days after surgery. Resection margins were considered negative when no tumor cells were present in the transection surface or within 1 mm of it (R0). Resection margins were considered positive when tumor cells were present in the transection surface of within 1 mm of it (R1) or if the tumor was not resected radical macroscopically (R2). Postoperative death was defined as death within 90 days after surgery.

In medians of surgical parameters and surgical outcomes, no data of the converted procedure were used. Data of this patient and procedure were only used in the calculation of age, BMI, docking time, previous abdominal surgery, and the percentage of the patients who were male. When calculating the overall OR time, patients who underwent an additional procedure were excluded.

Surgical technique

Room setup and port placement for resections of anterior segments (2 or 3, 4B, 5, and 6)

Patients who underwent a resection of an anterior segment were placed in a supine position, 30° anti-Trendelenburg. First, a 12-mm trocar was placed in the umbilicus for camera introduction. Pneumoperitoneum was established to 15 mm Hg. Subsequently, the abdominal cavity was inspected for metastatic disease or other abnormalities. Under camera supervision, two additional 8-mm trocars were placed for robotic arms, and one port was placed for assisting. The robot was then docked over the patient's head.

Room setup and port placement for resections of posterior segments (7 and 8)

Patients who underwent a resection of a posterior segment were placed in a left lateral position, 15° anti-Trendelenburg to enable optimal mobilization of the right hemiliver and access to the vena cava inferior where appropriate. Subsequently, a 12-mm trocar was placed in the right midclavicular line for camera introduction. Pneumoperitoneum was established, and the abdominal cavity was inspected for metastatic disease or other abnormalities. Under camera supervision, two additional 8-mm trocars were placed for robotic arms, and one port was placed for assisting. The robot was then docked over the patient's right shoulder (Figs. 1 and 2).

Procedure

First, the lesion was localized using laparoscopic ultrasound (UST-5550, Aloka prosound alpha 10). Subsequently, the liver was mobilized, where necessary. Usually, the liver's capsule and superficial parenchyma were opened using a bipolar dissector (Maryland dissector) and/or monopolar curved scissors. For transection of the liver parenchyma, the Endowrist One Vessel Sealer or the Maryland bipolar device was used, in conjunction with endoclips, hemolocks, sutures, cautery hook, and EndoGIA stapler where appropriate. TachoSil (Takeda Nederland bv) was applied to the resection surface where appropriate. Given this initial experience with novel parenchymal transection techniques, a drain was placed near the resection surface with a low threshold.