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Robot-assisted Retrohepatic Inferior Vena Cava Thrombectomy: First or Second Porta Hepatis as an Important Boundary Landmark

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Abstract

Background: Robot-assisted retrohepatic inferior vena cava (IVC) thrombectomy (RA-R-IVCTE) has been reported only for limited series.
Objective: To describe in detail the techniques for RA-R-IVCTE with regard to the relationship of a proximal thrombus to either the first porta hepatis (FPH) or second porta hepatis (SPH).
Design, setting, and participants: From May 2013 to July 2016, 22 patients with R-IVC tumor thrombi were admitted to our hospital.
Surgical procedure: RA-R-IVCTE was performed using the Rummel tourniquet technique. For a proximal thrombus inferior to the FPH, we ligated some short hepatic veins (SHVs; typically 1–3). For a thrombus between the FPH and SPH, we mobilized the right lobe of the liver from the IVC by ligating additional SHVs. For a thrombus near or above the SPH but below the diaphragm, we mobilized both the right and left lobes of the liver to obtain high proximal control of the suprahepatic and infradiaphragmatic IVC, and simultaneously clamped the FPH.
Measurements: Detailed techniques were described for various scenarios and perioperative outcomes were recorded.
Results and limitations: The median operation time was 285 min (interquartile range [IQR] 191–390). Intraoperative estimated blood loss was 1350 ml (IQR 1000–2075 ml). Some 63.6% of patients required an intraoperative blood transfusion and 68% were transferred to the intensive care unit after surgery. Grade IV complications developed in five cases. Vascular injuries (4 cases) were treated with intraoperative endoscopic sutures. An intestinal fistula was found on postoperative day 7 in one case; treatment with gastrointestinal decompression and drainage resolved the condition by 1 mo.
Conclusions: Even though the risks involved are high, RA-R-IVCTE is feasible for selected patients. The FPH/SPH is an important boundary landmark for RA-R-IVCTE. The location of proximal IVC tumor thrombi in relation to the FPH or SPH should determine the technique used.
Patient summary: Robot-assisted thrombectomy for retrohepatic inferior vena cava tumor thrombus is feasible in selected patients.

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1. Introduction

Locally advanced renal tumors (RTs) with inferior vena cava (IVC) tumor thrombi are infrequent, occurring in only 4–10% of patients [1]. Open surgery for IVC thrombectomy (IVCTE) is a standard approach for RTs with IVC tumor thrombi. Robotic technology has been applied to this challenging procedure with good feasibility. In 2011, Abaza described the use of robotic surgery for management of IVC tumor thrombi [2], and Lee and Mucksavage reported a similar experience [3]. In 2016, we reported on our initial robotic experience on IVCTE [4]. Some clinical case reports on robotic level III thrombectomy have also been published [5–7]. Here, we describe detailed techniques for robot-assisted retrohepatic IVC thrombectomy (RA-R-IVCTE).

2. Patients and methods

2.1. Patients

From May 2013 to July 2016, 51 patients suffering from RT with IVC tumor thrombus underwent robotic IVCTE. Of these, 22 were diagnosed with retrohepatic IVC tumor thrombi. Patient characteristics (age, gender, body mass index, clinical stage, thrombus classification, and thrombus length) were assessed.

Of the 22 patients, one female (patient X) had IVC tumor thrombus due to a previous right-sided radical nephrectomy (RN) 2 yr before hospitalization. All patients underwent color Doppler ultrasound and magnetic resonance imaging (MRI) preoperatively to determine the location and vascular extent of their tumor. IVC cavography was used in 12 patients to determine the collateral circulation. Five patients with distant metastases in the lungs were administered 3-mo preoperative neoadjuvant targeted therapy. Lymph node involvement was suspicious in six cases. Renal cell carcinomas (RCCs) were classified according to the 2010 TNM staging criteria of the American Joint Committee on Cancer [8].

On the basis of MRI findings, an exclusion criterion was established for IVC thrombi suspected of infiltrating the IVC wall. IVC thrombi were classified according to the Mayo scheme [9]. Perioperative data were assessed and complications were graded according to the Clavien system [10].

This study was approved by the Ethics Committee of the Chinese PLA General Hospital. All patients provided written informed consent. The procedures were performed by three surgeons (X.Z., X.M., and H.L.) with advanced robotic skills.

2.2. Preoperative preparation

Preoperative preparation was the same way as reported for our previous series [4].

2.3. Surgical technique

RA-R-IVCTE was performed using the Rummel tourniquet technique followed by IVC control, liver mobilization or short hepatic vein (SHV) control, caval exclusion, tumor thrombectomy, and IVC repair. In this study, we focused on the relationship of a proximal thrombus with either the first porta hepatis (FPH) or second porta hepatis (SPH). The FPH is in a H-shaped sulcus of the visceral surface of the liver where the portal vein, common hepatic duct, and hepatic artery enter and leave the liver together. SPH refers to the position of the left, middle, and right hepatic veins entering the IVC. According to preoperative coronal MRI (delay period), if the proximal thrombus did not reach the portal vein, we categorized this as thrombus inferior to the FPH (Fig. 1A). If the proximal thrombus exceeded the portal vein but did not reach hepatic veins, we classified this as thrombus between the FPH and SPH (Fig. 1B).

2.3.1. Proximal thrombus inferior to the FPH

After administering general anesthesia, the patient was positioned in a modified left lateral decubitus position with a 70° bump (thrombectomy position). The seven-port method was used for thrombectomy (Fig. 2A). A 12-mm camera port; three 8-mm ports for the first, second, and third robot arms; and three assistant ports were used, similar to the previous set-up [4]. After the robot was docked, the hepatocolic ligament was incised. The liver was retracted cephalically and the ascending colon was reflected medially. Then the anterior surfaces of the IVC and right renal vein were exposed. The left renal vein was dissected circumferentially in the inter-aortocaval space. Feeding veins (eg, gonadal vein, SHVs, lumbar veins, and right adrenal vein) were clipped and divided. Then the thrombus-bearing IVC was dissected circumferentially. Vessel loops were wrapped twice around the IVC above and below the thrombus and around the left renal vein, and then secured with a Hem-o-lok clip for surgeon control. The caudal IVC, left renal vein, and cephalic IVC were clamped sequentially. Finally, the IVC wall was cut, the thrombus was removed, and the IVC was closed as previously described [4].

In summary, we applied the techniques previously reported for level II thrombi. We retracted the liver and ligated some SVHs (typically 1–3) but we did not mobilize the liver (Fig. 3).

2.3.2. Proximal thrombus between the FPH and SPH (liver vein)

The patient was placed in a 30°–45° dorsal elevated lithotomy position (liver mobilization position) and the five-port method was used (Fig. 2B). The 12-mm trocar placed into the lower right abdomen was designated the optical port and another 12-mm trocar under the umbilicus was used as the assistant port. Two 8-mm robotic working ports for the first and third robot arms were placed into the left lateral border of the rectus muscle above the umbilicus and into an anterior axillary line under the left costal margin. We placed the third 12-mm port into an anterior axillary line under the right costal margin for two uses (arrow in Fig. 2B): a robotic working port for the second arm and an assistant port. After disconnecting the right triangular and coronary ligament of the liver, we mobilized the right lobe of the live from the IVC by ligating additional SHVs, often three to five. After liver mobilization, the patient's position and port placements were changed to

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