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Awake robotic liver surgery: A case report

New frontier for HCC resection

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Abstract

BACKGROUND

In recent years, minimally invasive liver resection has become a standard of care for liver tumors. Considering the increased need to treat fragile patients, general anesthesia is sometimes avoided due to respiratory complications. Therefore, surgical treatment with curative intent is abandoned in favor of a less invasive and less radical approach. Epidural anesthesia has been shown to reduce respiratory complications, especially in elderly patients with pre-existing lung disease.

CASE SUMMARY

A 77-year-old man with hepatitis C virus (HCV) related chronic liver disease underwent robotic liver resection for hepatocellular carcinoma (HCC). The patient was suffering from hypertension, diabetes and chronic obstructive pulmonary disease. The National Surgical Quality Improvement Program (NSQIP) score for developing pneumonia was 9.2%. We planned a combined spinal-epidural anesthesia with conscious sedation to avoid general anesthesia. No modification of the standard surgical technique was necessary. All life parameters were stable during the procedure and bleeding was minimal. The postoperative course was uneventful.

CONCLUSION

Robotic surgery in loco-regional anesthesia with conscious sedation could be considered a safe and suitable approach in specialized centers and in selected patients.

Key Words: Robotic Surgery; Awake Surgery; Liver Resection; Frail Patient; Case Report; Locoregional Anesthesia; Conscious Sedation

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Core Tip: Liver resection represents a gold standard for the treatment of liver malignancies. Minimally invasive approach guarantees less invasiveness and faster post-operative recovery. Frail and elderly patients undergoing liver resection under general anesthesia have a high risk of respiratory and cardiac complications. Local-regional anesthesia preserves better intestinal, cardiac and pulmonary function compared to general anesthesia. The combination of robotic surgery and local-regional anesthesia guarantees minimal surgical and anesthetic invasiveness and could be considered a safe approach in selected patients and specialized centres.

INTRODUCTION

Liver resection is a gold standard for the treatment of liver malignancies. In recent years, first laparoscopic and then robotic approaches have emerged as first-line treatments for liver resections [1,2]. The minimally invasive approach guarantees less invasiveness and faster post-operative recovery. This kind of surgery is usually performed under general or combined general and epidural anaesthesia.

In most cases, liver resection was performed on frail patients with many comorbidities and liver diseases [3]. The surgical approach is not the only one to ensure a good peri-operative course but also the type of anesthetic approach.

In frail and elderly patient with many comorbidities, general anesthesia is associated with high risk of respiratory and cardiac complications.

Sometimes the high perioperative risk excludes the possibility to perform surgery with curative intent.

In this kind of patient, loco-regional anesthesia reduces cardiac and pulmonary complications and the use of opioids while preserving a better intestinal, cardiac and pulmonary function compared to general anesthesia [4,5].

Locoregional anesthesia is integrated with conscious sedation also to avoid patient movements under the robotic platform as reported in the literature for robotic partial nephrectomy [6].

The combination of robotic surgery and loco-regional anesthesia guarantees both surgical and anesthetic minimal invasiveness.

We showed a case of robotic liver resection under epidural and spinal anesthesia in frail patient with many comorbidities.

CASE PRESENTATION

Chief complaints

A 77-year-old man with hepatocellular carcinoma on HCV-related chronic liver disease was enrolled for robotic wedge resection of segment II.

History of present illness

During the six-monthly follow-up for chronic liver disease, diagnostic investigations revealed a liver lesion in segment II.

History of past illness

The patient had previously undergone to subtotal gastrectomy for peptic ulcer disease, lumbar discectomy for disc herniation and bilateral carotid endarterectomy with stenting.

The patient had: hypertension, diabetes, peripheral vascular disease, chronic obstructive pulmonary disease, COPD, (Global Initiative for Chronic Obstructive Lung Disease, GOLD 2: FEV1 75% predicted – mMRC grade 1-2). The home medications were: olmesartan, clopidogrel, insulin, doxazosin, statin. No COPD therapy had ever been started.

Personal and family history

The patient denied any family history of malignant tumours.

Physical examination

Body mass index (BMI) was 28 kg/m^2. Chest auscultation revealed mild rhonchi on expiration in both lung bases. No pathological sounds were heard on cardiac auscultation. The abdomen was treatable over the entire area.

Laboratory examinations

Levels of serum tumour markers were: carcinoembryonic antigen, 5.3 ng/mL; carbohydrate antigen 19-9, 5.0 U/mL; alpha-fetoprotein, 50 ng/mL. No abnormality was found in routine blood analyses.

Imaging examinations

CT scan and MRI had detected a 3 cm lesion of the II segment characterized by "wash in" in the arterial phase and "wash out" in the portal phase.

FURTHER DIAGNOSTIC WORK-UP

Preoperative diagnosis was based on the non-invasive criteria established by the European Association for the study of the Liver (EASL) [7].

FINAL DIAGNOSIS

Combined the patient's medical history, the laboratory and imaging examinations the final diagnosis was HCC.

TREATMENT

ANESTHETIC PROCEDURE

Before procedures, we performed a thromboelastography (TEG) platelet mapping test (TEG 6s), which showed normal values for adenosine-5′-diphosphate (ADP) and Arachadonic Acid (AA) test; ADP test: 64.4 mm (normal values 45-69) and AA Test: 66.4 mm (normal values 51-71). Non-invasive monitoring with multi-parameter monitor (Figure 1) was initiated: electrocardiogram (ECG), non-invasive Blood Pressure (NIBP) and pulse oximetry. Instead the mechanical ventilation monitor was turned off, as shown in the figure 2. A combined spinal-epidural was planned for the patient. An epidural catheter was inserted at T6-T7 and subsequently subarachnoid anesthesia at T12-L1 with ropivacaine 10 mg + dexmedetomidine 10 mcg (a total volume of 5 mL, diluted with distilled water). After patient positioning, an epidural bolus of ropivacaine 0.2% + midazolam 5 mg (a total volume of 10 mL) was administered. Ten minutes after the epidural bolus, the pinprick was negative at C4, with Bromage IV. We added intravenous sedation with dexmedetomidine 100 mcg + ketamine 50 mg + remifentanil 1 mg in 50 mL of saline at 3 mL/h and with a Richmond Agitation-Sedation Scale (RASS) -2/-3 target around remifentanil at 0.01 mcg/kg/min, dexmedetomidine 0 .07 mcg/kg/h, ketamine 0.03mg/kg/h. Supplemental oxygen was administered *via* nasal cannula at 2 L/min. In our protocol, we did not routinely monitor central venous pressure (CVP) for liver resection [8], but intra-arterial cannulation of the left radial artery was placed without local anesthesia and patient discomfort. We use the FloTrac® sensor for intraoperative monitoring [9].

Given the unreliability of stroke volume variation (SVV) in spontaneous respiration in the resection phase, we aimed to have a 10% reduction in stroke volume until the end of the resection, with restrictive fluid therapy and using diuretics. Anesthesia, in spontaneous respiration, was maintained with epidural injection of ropivacaine 0.2% - 10 mL every 60 minutes.

The hemodynamics remained stable throughout the entire surgery; a continuous infusion of crystalloid solution 1 mg/kg/h was given until the end of the liver resection. The cardiac index (CI) was in the normal range and the stroke volume index (SVI) decreased from the initial value of 50 mL/m^2 to 30-35 mL/m^2 at the end of the resection (figure 3). We aimed for a mean arterial pressure (MAP) of 65 mmHg and 4 boluses of 5 mg ephedrine were required (figure 4).

SURGICAL PROCEDURE

Robotic surgery was performed using the da robotic platform Da Vinci Xi. Patient was awake and placed in a supine position with 30° reverse Trendelenburg position (Figure

5). A pneumoperitoneum was created using an open technique through a supraumbilical incision. Insufflation of pneumoperitoneum at 12 mmHg was uneventful. Other 3 robotic trocar and 2 Laparoscopic 12 mm trocar assistant were inserted under direct vision. Trocars position was standardized and shown in Figure 6. The surgeon was sitting at the robotic console and the assistant surgeon was between the patient's legs. The assistant performed retraction, suction, cutting and stapling. The procedure began with exploration of the abdominal cavity and intraoperative ultrasound to check liver tumor. Transection of hepatoduodenal and falciform ligaments was performed for preparation the hepatic hilum to Pringle manoeuvre. We placed the Foley catheter around the hepatic hilum for intermittent intracorporeal clamping. Liver parenchymal transection was performed with double crash clamping technique and vessel sealing for main pedicle. Indocyanine green (ICG) was administered the day before the procedure and used in positive staining in association with intraoperative ultrasound to better highlight the parenchymal transection margin. Hem-o-lock clips were used for the section of vascular and biliary structures. Specimen was placed into a laparoscopic extraction bag and removed through enlargement of the trocar.

No modification of the usually adopted surgical technique was necessary and no Pringle maneuver was adopted to minimize blood loss. The patient had an uneventful post-operative course and was discharged at 4 post-operative day.

OUTCOME AND FOLLOW-UP

At 1 year postoperatively, the patient was still alive and free of disease.

DISCUSSION

In the last decades, minimally invasive surgery has emerged as gold standard for the treatment of liver tumor. During Consensus Conferences of Louisville in 2008 [10] and Morioka in 2014 [11], and the Southampton Guidelines Meeting in 2017 [1], the minimally invasive techniques were standardized also for complex procedures. The minimally invasive approach guarantees less invasiveness, reduction of post-operative complications and faster post-operative recovery.

Despite technological advances, laparoscopic liver resections are still limited by rigid instruments and two-dimensional vision resulting in high learning curves and difficulties in performing major hepatectomies and resections of lesion located in postero-superior segments [12].

The robotic platform overcomes some limits of laparoscopic surgery thanks to the high definition of 3D vision, magnified field of vision, tremor filter, EndoWrist articulated instruments and augmented surgeon's ergonomy; it allows to perform some complex procedures, such as the hilar dissection or the biliary-enteric anastomosis and resection of posterosuperior segments [13].

These technical properties guarantee a lower estimated blood loss, less narcotic use, shorter length of hospital stay and improved short-term life quality in complex liver resection [13]. However, the benefits of robotic approach in liver surgery have not yet been clearly defined and some recently published studies comparing robotic and laparoscopic techniques have not provided conclusive results in favor of either approach [14,15].

The diffusion of robotic platform has exponentially increased in the last 10 years and, in 2018, was published the first international consensus statement on robotic liver surgery [2]. In most cases, liver resection was performed on frail patients with many comorbidities and liver diseases [3]. The surgical approach is not the only one to ensure a good peri-operative course but also the type of anesthetic approach. Liver resection was usually performed under general or combined general and epidural anesthesia. In more frail and old patient with many comorbidities, general anesthesia is associated with high risk of respiratory and cardiac complications. Sometimes the high perioperative risk excludes the possibility to perform surgery with a curative intent.

General anesthesia for high-risk surgical patients with significant lung disease may trigger some adverse effects, including: pneumonia, heart failure, biotraume and barotrauma and subsequently intra and post-operative hypoxemia [4,16].

3

Epidural anesthesia blunts the decrease of tissue oxygen tension caused by surgical stress and adrenergic vasoconstriction during the major abdominal surgery that provides sufficient oxygenation of organs with improved cardiac, respiratory and gastrointestinal function [17]. Loco-regional anaesthesia reduces the invasiveness of general anesthesia and the use of opioids preserving a better intestinal and pulmonary function and could be used in frail patients. The reduction of post operative pulmonary complication in epidural anesthesia were confirmed also by two systemic reviews [5,18].
Awake surgery is a specialized surgical technique performed on a patient who remains awake and conscious during the procedure. The patient receives sedative drugs to help them feel relaxed and less anxious during the operation. The decision to perform awake abdominal surgery depends on several factors, including the type of surgery, the patient's medical condition and the surgeon's expertise. This approach may be preferred in certain situations, such as for gynecological procedures, brain surgery, hernia repairs or appendectomies.

In 1994, a case of colectomy under awake epidural anesthesia was reported in a patient with high peri-operative risk. The procedure was safe and effective [19]. Since then, other awake procedures under epidural anesthesia have been reported including awake laparoscopic cholecystectomy in COPD patient [20]. During the COVID-19 pandemic, the surgical community focused on the potential risks of minimally invasive surgery and general anesthesia because they are both aerosol generation procedures that could cause the spread of contamination in operating theatres [21].

For these reasons, it was supported and encouraged an increased use of regional anaesthesia during the pandemic era. Loco-regional anaesthesia was reported also for emergency abdominal surgery in high risk patients with decreased morbidity and mortality [22] [23] . The combination of robotic surgery and loco-regional anesthesia guarantees minimal surgical and anesthetic invasiveness, excellent quality of surgery and enhanced recovery [17].

There are cases in the literature of awake robotic cardiac surgery [25], awake robotic partial nephrectomy [6] and awake video-assisted thoracic surgery [26]. However, in our knowledge, there are no cases in literature that show an awake robotic liver resection, but just a case series of awake open hepatectomy [24]. Our patient was very frail with liver cirrhosis, heart, vascular and lung disease. In other Hospitals, for high peri-operative risk, the patient wasn't a candidate for radical surgery. Our patient received the least invasive treatment possible, thanks to the close collaboration between surgeons and anaesthesiologists. The patient had an uneventful post-operative course and was discharged at 4 post-operative days as in the average of our robotic liver resection series.

CONCLUSION

We believe that spinal epidural anaesthesia and analgesia is very suitable technique, especially for selected frail patients. This technique associated with robotic surgery offers a better short-term outcome, especially in co-morbid patients with serve lung disease. The patient benefits from a quicker return to home and hospital stay costs are also reduced.

Robotic surgery associated with loco-regional anesthesia and conscious sedation could be considered a safe and suitable approach but only in specialized centers and in selected patients.

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