Editorial

Laparoscopic caudate lobe resection: navigating the technical challenge

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Introduction

The caudate lobe of the liver is an anatomically complex liver segment that poses significant technical and oncologic challenges to surgeons (1). Its unique and intimate location with the hepatic hilum and inferior vena cava (IVC) coupled its dual supply from both portal pedicles and direct venous drainage into the IVC make vascular control a particular challenge (*Figure 1*) (2). With the progress of laparoscopic liver resection (LLR), technically challenging liver resections are increasing performed laparoscopically with its attendant benefits of improved perioperative outcomes (3,4). However, these benefits have to be balanced against the risks of intraoperative bleeding and gas embolism, which are inherent in LLR of the caudate lobe.

Currently, LLR is recommended as the standard approach for the more laparoscopically accessible liver segments (3). The technical challenge in LLR for major hepatectomies have prompted experts in the field to propose a LLR difficulty scoring to guide the approach for surgery (5). However, the caudate lobe poses a unique challenge and its place in the difficulty scoring is not clearly defined. Herein we report our experience in LLR for caudate lobe lesions (*Figure 2*).

Surgical technique

The caudate lobe consists of 3 subsegments represented by the spigelian lobe on the left, the central paracaval portion, and the caudate process on the right (7). For isolated caudate lobe resections and concomitant lesions on the left hemiliver, our preference for positioning is the supine split leg position with the surgeon standing in between. The assistant holding the camera stands on the left side of the patient. The first assistant may be on patient's right side during hilar dissection and on the left during parenchymal transection. For concomitant right hemiliver segments, our preference is for a 45-degree left decubitus position with the surgeon and the assistant holding the camera to be on the patient's left side.

The central venous pressure is maintained at 5 mmHg. Pneumoperitoneum is induced with a direct trocar insertion technique and maintained at 12 mmHg to reduce the risk of gas embolism. We begin with an infraumbilical incision and Hassan technique is used to gain access into the abdomen. Usually four other trocars are placed, two in the right upper and two in the left upper quadrant. With the surgeon standing between the patient's legs, a liver retractor is placed through the most lateral right upper quadrant port. The stomach is retracted to the patient's left using the most lateral left upper quadrant port. A short profile 5 mm left subcostal port, is used to introduce a cotton tape for the Pringle maneuver. The gastrohepatic ligament is opened and attention directed to the porta hepatis.

Where isolated caudate resection was performed, we begin with retraction of the caudate lobe anteriorly and superiorly. The caudate branches of the portal vein and hepatic artery are dissected, double clipped, and divided. We next proceed with a right sided retraction of the caudate lobe, this is to approach the short caudate veins to the vena cava, where are isolated, clipped and divided. Transection of the caudate lobe was usually performed with a combination of ultrasonic dissection and surgical staplers where necessary. The specimen was placed in a surgical bag

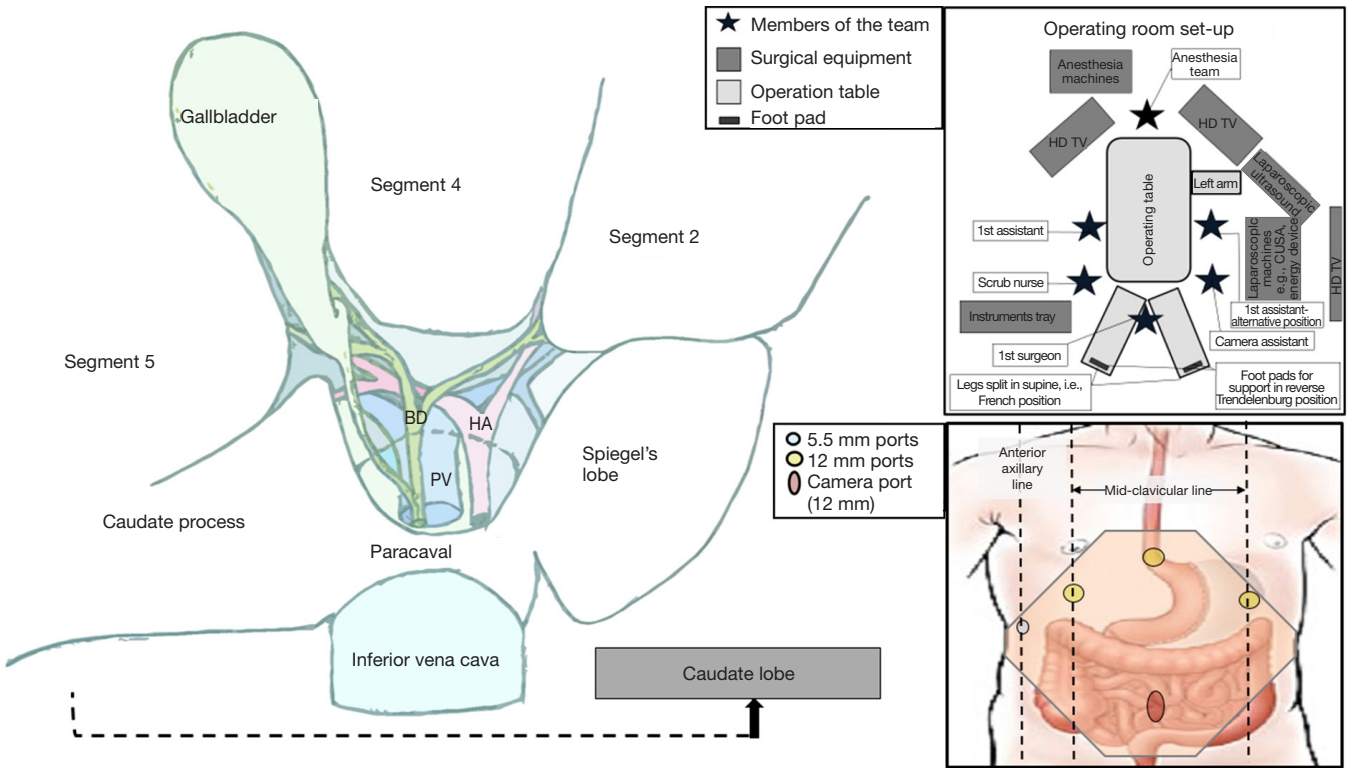

Figure 1 Surgical Anatomy, operating room set up and laparoscopic port placement.

Figure 2 Laparoscopic isolated caudate resection and laparoscopic caudate with left hepatectomy (6).
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and extracted through the umbilical port.

Where a combined left hemi-hepatectomy is performed, we use the anterior approach and only begin the caudate mobilization from the vena cava after the parenchyma transection of the hemiliver is completed. This approach facilitates access to the caudate process and good exposure of the IVC.

Clinical data

From January 2010 to January 2017, 6 consecutive patients underwent laparoscopic caudate lobectomy for hepatocellular carcinoma (HCC), colorectal liver metastases and fibrocystic lesion of the liver. Diagnoses and features of the lesions (i.e., tumor number and size) were obtained from the pathology records. The postoperative variables taken into consideration included complications and mortality up to 90 days post operation. Clinical and follow-up data of the 6 patients presented in *Table 1*. There were no postoperative complications and the patients were discharged well after a median stay of 4 days.

Discussion

Laparoscopic resection of caudate lobe is an uncommon procedure because of the complexity of the surgical dissection of the area and early involvement of IVC and hilar structures by invasive lesions of the caudate lobe (8). Although open caudate lobectomy was increasingly reported recent literature, laparoscopic approach of the caudate lobe is still cautiously navigated. The latest international

Table 1 Clinical and pathological data of the patients who underwent laparoscopic caudate lobe resection.

Age	Sex	Diagnosis	Tumour size	Margin (mm)	Surgery	Operative time (min)	Pringles	Blood loss (mL)	Post operative stay (days)	Post operative complication
58	M	HCC	38 mm; poorly differentiated grade 3	1.0	Caudate resection	205	No	50	3	Nil
52	M	HCC	30 mm; moderately differentiated grade 2	3.0	Caudate resection	270	No	500	4	Nil
61	M	Colorectal Liver Metastases	30 mm and 18mm; colorectal liver metastases	5.0	Left Hepatectomy and caudate resection	505	No	200	4	Nil
58	M	HCC	18 mm; moderately differentiated grade 2	2.5	Caudate resection	125	20 min	50	4	Nil
60	F	Fibropolycystic disease of liver	35 mm	5.0	Left Hepatectomy and caudate resection	400	No	300	5	Nil
72	M	Multifocal HCC	Segment 7: 28 mm poorly differentiated grade 3; Caudate: 7 mm poorly differentiated grade 3	1.0	Segment 7 and caudate lobe resection	400	No	200	4	Nil

M, male; F, female; HCC, hepatocellular carcinoma.

consensus meeting in Morioka 2014 concluded with laparoscopic surgery being the standard of care for minor liver resections with laparoscopic major liver resection still in the explorative phase (3).

Traditionally, three common approaches of caudate lobe resection have been described: left, right, and anterior transparenchymal (9). The right approach is typically indicated for large lesions located in the caudate process and for resections in combined with right hepatectomies. This approach is technically arduous laparoscopically as it requires a complete mobilisation of the right lobe to the left side to expose the caudate hepatic veins.

The anterior transparenchymal approach is feasible in laparoscopic surgery, especially for concomitant hemi hepatectomies. This allows transparenchymal resection through the middle of the liver and when combined with suspension of the transection line, the modified Belghiti "hanging maneuver", exposes the IVC and hence makes the approach to the caudate lobe more straight forward (10). The left sided approach for isolated caudate lobe resections is our choice of approach as the major vascular structures to the caudate are more easily seen on the left and sequential dissection and retraction enables more comprehensive control of the vascular structures and eventual access to the parenchymal transection of the caudate process (11-13).

The most hazardous technical challenges of laparoscopic caudate resection are first, the dissection of the anterior part of the IVC off the caudate lobe, more so in the case of large lesions; and the second is the parenchyma transection of the caudate process of which most part of it is a blind dissection. We utilize the paracaval plane as defined by landmarks of firstly, the bifurcation of the right portal vein, and the of the gall bladder fossa (*Figure 1*). We routinely prepare the pringle's tourniquet and use an ultrasonic dissector and ultrasonic surgical aspirator for parenchyma transection. Bleeding arising from small vessels is treated using endoscopic clips, whereas suturing controls major vascular tears.

These 6 reported cases were favorable because the lesions were small and did not involve the IVC, all these factors predisposes to the success of a minimally invasive surgical approach. Furthermore, the success of the laparoscopic approach is in part to the improved visualization that the laparoscopic approach offers to this visually restricted area. However, this advantage may be lost when dealing with large bulky tumors that are difficult to retract laparoscopically or those that involve the inferior vena cava or the porta hepatis, which demands expeditious control of

these vascular structures in emergent situations.

In conclusion, laparoscopic resection of well-selected caudate lobe lesions is feasible and will bring about the perioperative benefits of minimally invasive surgery. We believe that the main challenge of a laparoscopic liver resection lies in the achieving a good exposure to perform a safe resection, and therefore the difficult location of the caudate lobe does not represent a contraindication. Nevertheless, these resections should be performed only in selected cases and by highly experienced laparoscopic and hepatobiliary surgeons.

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