Totally Laparoscopic Caudate Lobe Resection: Technical Aspects and Literature Review

Enrico Gringeri, MD, PhD, Riccardo Boetto, MD,* Domenico Bassi, MD,* Francesco E. D'Amico, MD,* Marina Polacco, MD,* Maurizio Romano, MD,* Stefania Barbieri, MD,† Paolo Feltracco, MD,† Marcello Spampinato, MD, PhD, FEBS,‡ Giacomo Zanus, MD, PhD,* and Umberto Cillo, MD, FEBS**

Abstract: The particular anatomic location of the hepatic caudate lobe between the hilar plate and inferior vena cava means that it is still considered unsuitable for laparoscopic measures and a difficult site even for conventional surgery. Here we describe the first case to be reported in the literature of caudate lobe resection for a single metastasis from breast adenocarcinoma that was completed using an exclusively laparoscopic procedure and a simplified scheme involving the placement of 4 trocars, without any need for conversion or the Pringle maneuver. The patient was 31 years old with a history of radical right mastectomy and chemotherapy. The patient's postoperative course was uneventful and she was discharged 4 days after the surgery. Twelve months on, she is currently alive and disease free.

Key Words: laparoscopy, metastasis, liver resection

(*Surg Laparosc Endosc Percutan Tech* 2014;24:e233–e236)

Laparoscopic liver resection (LLR) has been steadily growing in the last few years, allowing reduction in hospital stay, faster recovery, and shorter operative time.

The weaknesses in the safety and efficacy of LLR have been gradually overcome thanks partly to a better understanding of the liver's segmental anatomy, and improved preoperative imaging methods and intraoperative anesthesia, but also and more importantly to gains in laparoscopic expertise and better equipment.[1]

The hepatic caudate lobe (CL) has generally not been considered amenable to laparoscopic treatment because its anatomic position between the hilar plate and inferior vena cava (IVC) technically interferes with the application of the usual laparoscopic approach to the treatment of primary and metastatic lesions in this liver segment.

Laparoscopy was once used in the liver surgery only for wedge resections and anterior segmentectomies (liver resection of so-called "laparoscopic segments"). Nowadays, minimally invasive liver resections have come to include the left[2,3] and right,[4,5] and extended[6,7] hepatectomies are now performed routinely, with acceptable morbidity and mortality rates. The 3- and 5-year survival rates reported for laparoscopic treatments of hepatocellular carcinoma and colorectal cancer metastases are much the same as after open surgery.[1]

There have also been reports, albeit very rarely, of isolated laparoscopic resections of the CL. These have usually been part of a series of technically diverse procedures and, apart from a couple of reports, the literature provides virtually no systematic technical descriptions of the procedure used in the CL.

Several approaches have been developed, including exclusively laparoscopic procedures as well as hand-assisted and laparoscopically assisted "hybrid" forms of open surgery.[1,8]

Lesions located in the posterosuperior liver segments (I, VII, VIII, and IVa) are generally considered technically unsuitable for laparoscopic surgery. In comparison with procedures on the anterolateral segments (II, III, V, VI), they take significantly longer to deal with (the respective operative times being 331.4 vs. 258.5 min, $P = 0.009$), and they are more likely to require intraoperative transfusions (47.2% vs. 25%, $P = 0.015$); they are nonetheless technically feasible and safe, with comparable morbidity rates (19.4% vs. 16.3%, NS).[9]

Here, we report on a CL LLR for a single metastasis from breast adenocarcinoma that was completed using an exclusively laparoscopic technique (without any Pringle maneuver) in a very young patient who had previously undergone radical right mastectomy and chemotherapy.

CASE REPORT AND SURGICAL TECHNIQUE

Clinical History

A 31-year-old woman underwent radical right mastectomy for invasive ductal breast adenocarcinoma (G3) and received adjuvant systemic chemotherapy with trastuzumab and tamoxifen for multiple bilateral hepatic metastases identified 2 months after surgery. At follow-up after 1 year she had a complete response, but 4 months later she revealed a single 15 mm lesion in the CL, closely juxtaposed with the IVC (Fig. 1).

The patient's clinical history included a laparotomic appendectomy 19 years earlier.

Given the young age and good response to CT in the presence of a single nodule, we opted for a mininvasive LLR.

Anatomic Considerations

As a rule, the first hepatic segment (S1) is divided into 3 portions according to Kumon's classification, that is, Spiegel's lobe, the caudate process, and the paracaval portion. Spiegel's lobe lies underneath the lesser omentum to the left of the IVC, the paracaval portion in front of the intrahepatic portion of the IVC

Received for publication May 6, 2013; accepted July 11, 2013.
From the *General Surgery and Organ Transplantation, Hepatobiliary Surgery and Liver Transplant Unit; †Department of Anesthesiology, Azienda Università di Padova, Padova; and ‡Department of Surgery, HPB and Advanced Minimally Invasive Surgery, Policlinico di Abano Terme, Italy.
The authors declare no conflicts of interest.
Reprints: Riccardo Boetto, MD, General Surgery and Organ Transplantation, Hepatobiliary Surgery and Liver Transplant Unit, Azienda Università di Padova; Via Giustiniani, 2-35128, Padova, Italy (e-mail: rboetto@hotmail.com).

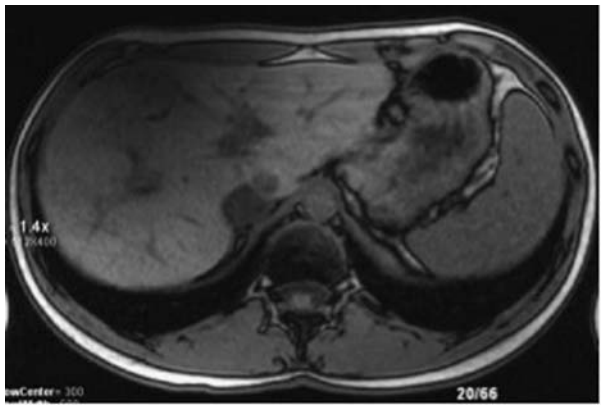

FIGURE 1. RMN T2 sequence with evidence of 15 mm hyperintense lesion in the caudate lobe.

with the right and middle hepatic veins surrounding it, and the caudate process extends between the IVC and the portal vein.[10]

Vascular inflow to S1 comes from primary Glissonian branches originating from the right and left portal veins; the hilar bifurcation branch supplies the paracaval portion and Spiegel's lobe (29%) to the left and the caudate process (21%) on the right.

The arteries normally comprise multiple small branches arising from the left and right hepatic arteries: single branches from the right and left hepatic arteries are seen in only 35% and 12% of cases, respectively, whereas both the arterial branches assure vascularization in 53% of individuals.

One or 2 thick veins (2 to 3 mm in diameter), usually called the "caudate veins," and several thin veins jointly drain the CL, some of them also serving as drainage for Spiegel's lobe, whereas others contribute to draining the paracaval portion of S1 and/or S4, S7, and S8. The thicker veins enter the IVC, the thinner lead into the IVC or the middle and/or right hepatic vein.[11,12]

Around half of the 2 to 4 ducts from the CL merge with the posterior sectorial hepatic duct (B6 and B7) originating from S6 and S7, and they usually follow an epiportal course. The other ducts coming from the S1 lead into the left hepatic duct, which is formed by B2, B3, and B4 coming together.[13]

Surgical Procedure

Three approaches to the CL have commonly been described: left, right, and transparenchymal. The left approach is frequently used in laparoscopic surgery; the right is recommended in case of caudate process tumors; the anterior transparenchymal approach is theoretically suggested for laparoscopy, mainly for right hepatectomy, but S1 is not always perfectly well exposed when this method is used.

In our experience, patients due to undergo surgery through a left approach are placed in a supine decubitus position (30 degrees anti-Trendelenburg) with their legs apart so that the surgeon can stand between them, with the surgeon's assistant and the other surgeon holding the camera, respectively, at the patient's right and left side.

Pneumoperitoneum (14 mm Hg) was induced and a supraumbilical 12 mm optical trocar (30 degrees) was inserted using the open technique, and then 15 and 5 mm operative trocars were positioned under direct vision along the left and right mid-clavicular lines, respectively, 5 cm above the transverse umbilical line; another 5 mm trocar was inserted into the epigastrium for the purposes of retracting the inferior surface of the liver to ensure adequate exposure of the CL and IVC (Fig. 2). The patient's central venous pressure was maintained >5 mm Hg.

After pneumoperitoneum induction, the peritoneal cavity is explored to rule out any extrahepatic disease; an intraoperative liver ultrasound is performed on the CL before and carefully dissecting the hepatoduodenal ligament with the aid of a cautery hook (while checking for left hepatic accessory arteries), confirming the

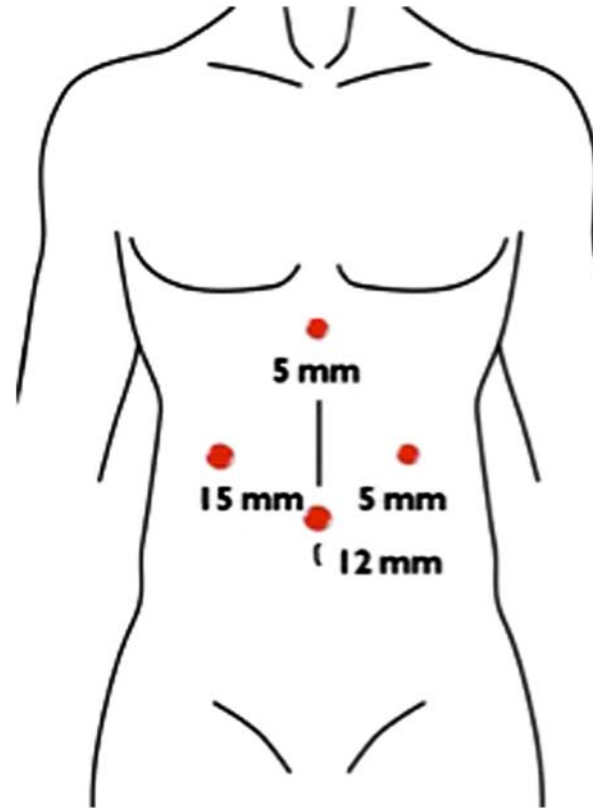

FIGURE 2. Trocars placement scheme.

presence of a hypoechoic 12.5 mm lesion not directly involving the IVC.

The left lobe was not mobilized; the liver was raised with the aid of a 5 mm laparoscopic liver retractor to allow for the Glissonian pedicle to be severed, followed by hook cauterization of the peritoneal reflection of the IVC, gently grasping Spiegel's lobe on the left (Fig. 3). Blunt IVC dissection continued to expose the hepatic accessory veins, which were ligated with the Hem-o-Lok system (Teleflex Medical, Research Triangle Park, NC) (Fig. 4).

After completely releasing Spiegel's lobe from the IVC, a clip was placed on the dorsal portal accessory veins of the Glissonian pedicle. The authors judge it safer to mobilize the lobe first to gain a better control of the Glissonian area, even though this means interrupting the venous outflow.

Parenchymal transection was performed cephalad using radiofrequency forceps (Ligasure Atlas, US Headquarters Covidien, Mansfield, MA) and a bipolar cautery associated with an intermittent drip irrigation with water until the CL resection had been completed (Fig. 5). The resection surface (Fig. 6) was checked carefully for biliary leaks and bleeding was controlled with the bipolar cautery and drip irrigation. The specimen was placed in a laparoscopic bag (Endo Catch, US Headquarters Covidien) and retrieved through the 12 mm supraumbilical port. A small suction drain was inserted positioned at the resection site through the right 15 mm trocar.

As in our routine surgical practice for open and mini-invasive liver surgery, no Pringle maneuver was applied during the parenchymal transection.

RESULTS

The surgical procedure was completed laparoscopically with no intraoprative complications, nor any need to convert to open surgery or provide blood transfusions; the

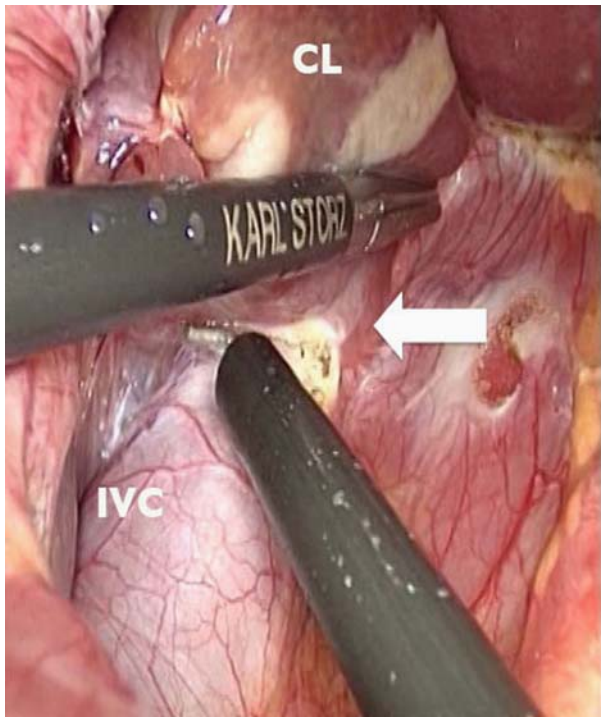

FIGURE 3. Dissection of IVC peritoneal reflection. White arrow shows peritoneal reflection dissection line. CL indicates caudate lobe with neoplasia; IVC; inferior vena cava.

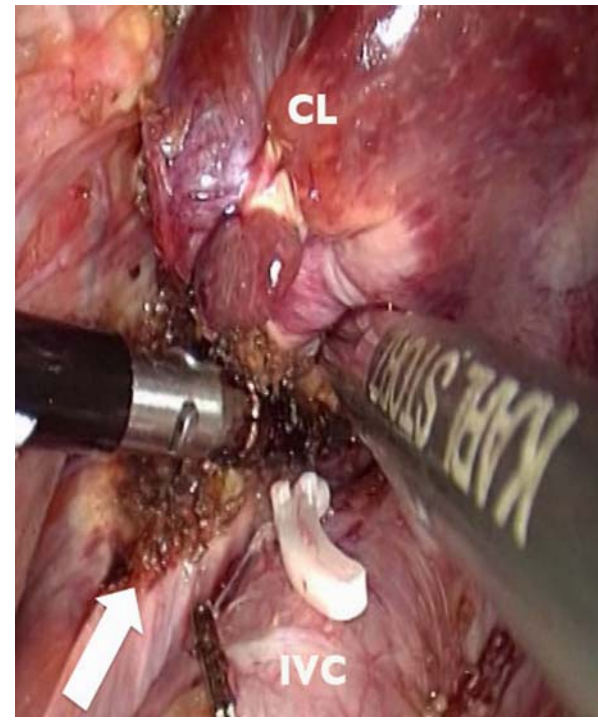

FIGURE 5. Parenchymal transection with radiofrequency forcep. White arrow shows parenchymal transection line. CL indicates caudate lobe; IVC; inferior vena cava.

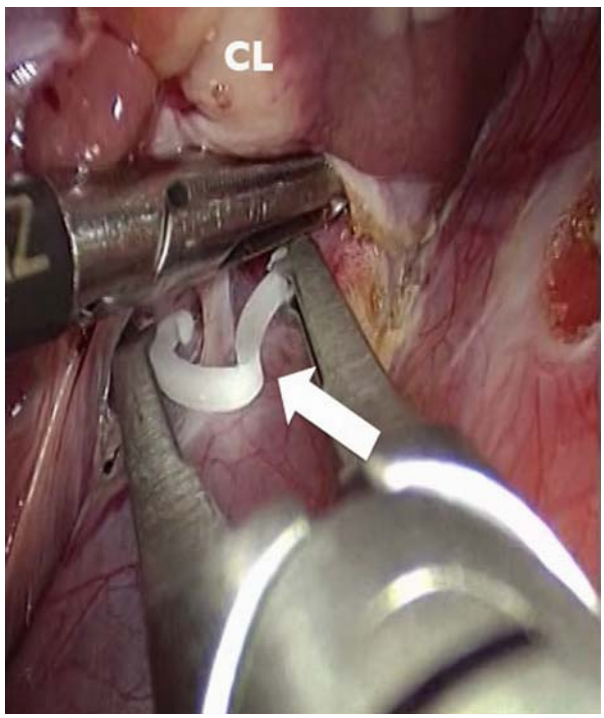

FIGURE 4. Hepatic accessory vein clipping. White arrow shows accessory vein. CL indicates caudate lobe.

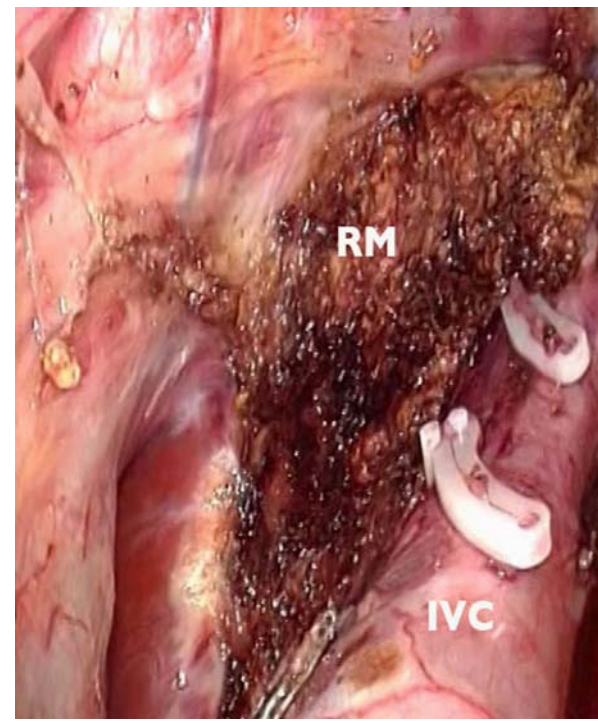

FIGURE 6. Hepatic parenchymal resection margin and IVC isolated after resection. IVC indicates inferior vena cava; RM, resection margin.

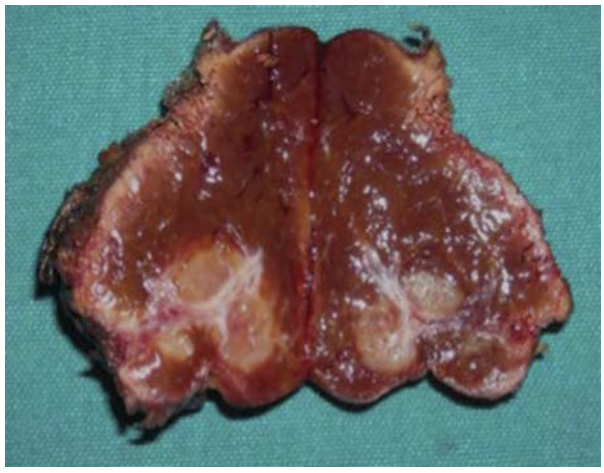

FIGURE 7. Specimen with gross tumour-free margins.

procedure took 140 minutes and the patient's blood loss was < 80 mL.

The postoperative course was uneventful, with a recovery of intestinal transit and deambulation on postoperative day 1; the drainage tube was also removed on postoperative day 1. The patient was discharged on postoperative day 4 with normal liver function tests and having fully recovered her physical functionality.

Pathology confirmed the preoperative diagnosis of adenocarcinoma hepatic metastasis and revealed ample tumor-free resection margins and no vascular invasion (R0 resection, Fig. 7).

The patient is alive and disease free 12 months after the surgery.

CONCLUSIONS AND LITERATURE REVIEW

Using an isolated laparoscopic approach to lesions in the posterosuperior liver segments (S1, S7, S8, and S4a) is associated with significantly longer operative times [(mean 331.4 vs. 258.5 min for laparoscopic treatments in the more readily accessible anterolateral segments II, III, V, and VI ($P = 0.009$)] and a greater likelihood of intraoperative transfusions being needed (47.2% vs. 25%, $P = 0.015$), although it has proved equally feasible and safe, and a recent monocentric series[9] reported comparable morbidity rates (19.4% vs. 16.3%, NS).

Nguyen et al[1] briefly reported on 18 cases of isolated laparoscopic CL resection in their World Review of Laparoscopic Liver Resections. A larger series documents 8 cases of isolated laparoscopic CL resection among 300 minimally invasive liver resections, providing no specific details on the patients and procedures involved.[8]

Chen and colleagues recently documented a series of 9 cases. All procedures for these patients with CL tumors (size, 0.9 to 4.5 cm) were accomplished with totally laparoscopic technique except 1 in which additional left hepatectomy was also performed. The average operative time was 254 minutes (range, 210 to 345 min) and estimated blood loss was 202 mL (range, 10 to 1000 mL), and the average length of postoperative hospital stay was 6.9 days (range, 4 to 11 d). There was no reported perioperative complications and patient mortality in this series.[14]

Apart from our own, there are only 12 other cases reported in the literature that are reported in the current literature with a detailed description of the surgical technique and timing, complications, and short-term and long-term patient outcome,[14–17] which are too few to get conclusions in our opinion.

Judging from our experience, only selected cases are amenable to CL LLR and this should be handled by hepatobiliary surgeons with plenty of experience of laparoscopic liver surgery. Future studies will hopefully lead to the validation of this surgical procedure.

REFERENCES

1. Nguyen KT, Gamblin TC, Geller DA. World review of laparoscopic liver resection-2804 patients. *Ann Surg*. 2009; 250:831–841.
2. Huscher CG, Lirici MM, Chiodini S, et al. Current position of advanced laparoscopic surgery of the liver. *J R Coll Surg Edinb*. 1997;42:219–225.
3. Samama G, Chiche L, Brefort JL, et al. Laparoscopic anatomical hepatic resection. Report of four left lobectomies for solid tumors. *Surg Endosc*. 1998;12:76–78.
4. Topal B, Aerts R, Penninckx F. Laparoscopic intrahepatic Glissonian approach for right hepatectomy is safe, simple, and reproducible. *Surg Endosc*. 2007;21:2111.
5. Gayet B, Cavaliere D, Vibert E, et al. Totally laparoscopic right hepatectomy. *Am J Surg*. 2007;194:685–689.
6. Gumbs AA, Bar-Zakai B, Gayet B. Totally laparoscopic extended left hepatectomy. *J Gastrointest Surg*. 2008;12:1152.
7. Gumbs AA, Gayet B. Totally laparoscopic extended right hepatectomy. *Surg Endosc*. 2008;22:2076–2077.
8. Koffron AJ, Auffenberg G, Kung R, et al. Evaluation of 300 minimally invasive liver resections at a single institution: less is more. *Ann Surg*. 2007;246:385–392.
9. Cho JY, Han HS, Yoon YS, et al. Feasibility of laparoscopic liver resection for tumors located in the posterosuperior segments of the liver, with a special reference to overcoming current limitations on tumor location. *Surgery*. 2008;144: 32–38.
10. Kumon M. Anatomy of the caudate lobe with special reference to the portal vein and bile duct. *Acta Hepatol Jpn*. 1985;26: 1193–1199.
11. Kaneko H. Laparoscopic hepatectomy: indications and outcomes. *J Hepatobiliary Pancreat Surg*. 2005;12:438–443.
12. Furuta T, Maeda E, Akai H, et al. Hepatic segments and vasculature: projecting CT anatomy onto angiograms. *Radiographics*. 2009;29:1–22.
13. Murakami G, Hata F. Human liver caudate lobe and liver segment. *Anat Sci Int*. 2002;77:211–224.
14. Chen KH, Jeng KS, Hyang SH, et al. Laparoscopic caudate hepatectomy for cancer—an innovative approach to the no-man's land. *J Gastrointest Surg*. 2013;17:522–526.
15. Dulucq JL, Wintringer P, Stabilini C, et al. Isolated laparoscopic resection of the hepatic caudate lobe: surgical technique and report of 2 cases. *Surg Laparosc Endosc Percut Tech*. 2006;16:32–35.
16. Kokkalera U, Ghellai A, Vandermeer TJ. Laparoscopic hepatic caudate lobectomy. *J Laparoendosc Adv Surg Tech A*. 2007;17:36–38.
17. Kyriakides C, Panagiotopoulos N, Jiao LR. Isolated laparoscopic caudate lobe resection. *Surg Laparosc Endosc Percutan Tech*. 2012;22:e209.