Isolated caudate lobe resection for hepatocellular carcinoma

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Summary  Isolated resection of the caudate lobe for hepatocellular carcinoma (HCC), indicated for cases associated with liver cirrhosis, usually challenges surgeons. To understand the anatomical relationship and feeding vessels of the tumor is important before a surgical plan. The approach depends upon the location and the size of the tumor and the liver function. For tumors in the paracaval portion, how to secure the inflow control and outflow control is needed. Theoretically, the outcome of HCC of the caudate lobe is worse than that for carcinoma (cancer) in other segments. However, a comparable outcome may be obtained in some patients.

KEYWORDS  caudate lobe; hepatocellular carcinoma; resection

1. Introduction

Resection remains the mainstay treatment for hepatocellular carcinoma (HCC). For HCC in the caudate lobe, the resection can be performed as an extension of other types of hepatectomy or as an isolated caudate resection. However, for cases of HCC associated with liver cirrhosis, isolated resection is preferred. The caudate lobe has often been considered the forbidden zone of hepatic operation, located posterior to the porta hepatis and the major hepatic veins but anterior and partially circumferential to the inferior vena cava (IVC). The approach to such HCCs with isolated resection is technically demanding and usually a challenge to surgeons.

2. Anatomical implications of the caudate lobe

The caudate lobe may be divided into three parts: the Spiegel lobe (SP), the caudate process (CP), and the paracaval portion (PC). The SP is defined as the portion under the lesser omentum and the left-side portion of the IVC. The CP is defined as the dorsal portion of the portal trunk. Margins of SP and the CP can be recognized by indentations that correspond to the ligamentum venosum and to...
the right posterior branch of the glissonian sheath. The PC is located just anterior to the IVC; its superior border is the posterior aspect of the right and middle hepatic veins, and the inferior border is the hepatic hilus. Its ventral margin is defined by the middle and right hepatic veins in the parenchyma. The main challenge is its deep location lacking landmarks indicating its right margins. The caudate lobe has 5 surfaces: the dorsal, left and hilar-free surfaces, and the right and ventral border planes. Some surgeons use counterstaining and tattooing techniques during liver transection to identify the caudate boundary.

Of the liver segments, the caudate lobe is the only part that is in contact with the IVC (Fig. 1). The posterior sector is embryonically and anatomically independent of the right and left of the liver and the main portal fissure. Couinaud found that the relationship of the main portal fissure to the caudate lobe predicts the location of the supplying portal branches.²

3. Variation of feeding vessels of HCC in the caudate lobe

Multiple caudate arteries arising from the right, left, and middle hepatic arteries are frequently connected to each other. When HCCs develop, the feeding arteries will differ.

If the HCC is in the SP, the feeding branches mainly arise from the proximal portion of the right and/or left hepatic artery. As the SP protrudes from the liver, a large tumor is frequently fed by extrhepatic collaterals. An HCC in the CP is mainly fed by the caudate artery derived from the right hepatic artery, and partly from the left. An HCC in the PC is usually fed by the caudate artery derived from the right hepatic artery, sometimes from the proper hepatic artery.

For postresection recurrent tumors, the feeding vessels change. Extrhepatic arteries are the main blood supply for those in the SP and the right inferior phrenic artery for those in the CP.⁶

4. The main points of caudate lobe resection

Isolated resection of the caudate lobe involves three major points: (1) control of the inflow supply from the portal vein and hepatic artery; (2) dissection, ligature, and division of the retrohepatic veins; and (3) parenchymal section to divide and remove the tumor from the base of other liver segments.

4.1. How to approach the caudate lobe

The access to the caudate lobe should be determined on the basis of the location and the size of the tumor, hepatic function, and the presence of scarring from previous resection. For local resection of tumors located in the SP or CP, a left or right approach is recommended.

For caudate lobectomy, there are different approaches, such as posterior (caudal, dorsal), or an anterior, transhepatic (Table 1).²⁻⁴,⁹⁻²⁵ It may be impossible to obtain full mobilization with the posterior approach if the tumor is large and the liver is rigid from cirrhosis. Extrahepatic control of hepatic veins is advisable if the tumor is large and/or close to the entrance of the hepatic veins into the IVC. A combination with a transhepatic approach is helpful.

The challenge of HCC in the PC is greater than that in the SP or CP, especially when the preoperative imagings show a tight adhesion between the HCC and IVC. To obtain a cancer-free margin is the minimal requirement, but a margin of no less than 1 cm is usually not feasible, because the tumor may be in contact with the IVC wall. Based upon the preoperative images alone, Okada et al deemed it difficult to determine whether the IVC was only attached to or invaded by the tumor.²⁶

To assess IVC involvement accurately, mobilization of the caudate lobe is necessary. Kaneko et al used intracaval endovascular ultrasonography to diagnose the invasion on the IVC.²⁷ Hashimoto et al considered that this practice was limited by the expensive cost of the catheter probe, the presence of liver cirrhosis, and the patients’ poor compliance.²⁸ They suggested that the extent of the IVC circumference attached to the tumor compared with the whole IVC circumference and the deformity of the IVC on the CT scan might be useful indicators.²⁸ Some surgeons used a dye injection into portal branches to define the limits of the caudate lobe.¹⁶,²⁴ However, this still could not define the infiltration extent of HCC. Surprisingly, in many cases, the tumor thought to invade the IVC can be dissected free of the IVC in a tumor-free plane. To obtain a relatively bloodless field and to minimize intraoperative hemodynamic instability, some "new" procedures have been reported. In 1990, Lerut et al performed inflow occlusion and packing hemostasis to finish the first case of isolated caudate resection.¹⁰ Yamamoto et al accessed the caudate lobe by separating the liver parenchyma along the interlobar plane.¹¹ Asahara et al used the anterior approach for large HCC originating in the PC.⁹ Colonna et al removed the caudate lobe in noncirrhotic patients by retracting the liver counterclockwise without vascular occlusion.¹³ In selected patients, the IVC can be resected in part or en bloc with the caudate lobe. Short segments of the IVC can be repaired or reconstructed with autogenous grafts; longer segments may

Figure 1 Anatomy of caudate lobe. S₂ and S₃ = Segments II and III; PV = portal vein; IVC = inferior vena cava; arrows = directions of dissection approaches.
require prosthetic grafts. A chronically occluded IVC can be resected without reconstruction because abundant collaterals have usually developed. Recently, various modalities of inflow control with or without outflow control have been introduced, such as total vascular exclusion with or without caval flow preservation, the addition of aortic clamping, the association of hypothermic perfusion, extracorporeal circulation, and the \textit{ex situ} – \textit{in situ} technique \textit{(ex situ} bench surgery of resections and autotransplantation of the remnant).\textsuperscript{12,29} For inflow control, Jeng et al suggested a Pringle maneuver intermittently to avoid a prolonged ischemia in the cirrhotic liver.\textsuperscript{2} For outflow control, they recommended a side clamping of the tumor-attached IVC by a Satinsky clamp to preserve caval flow. This technique is different from hepatic vascular exclusion with caval flow preservation\textsuperscript{30} or segmental hepatic vascular exclusion.\textsuperscript{31} The hemodynamic instability from total clamping of the IVC is thus avoided.

5. Is the surgical outcome of caudate lobe HCC worse than HCC in other locations?

Theoretically, the caudate anatomy may potentiate cancer diffuse throughout the liver because of its proximity to the afferent vasculature and bile ducts. The spread of tumor cells to distant sites could be enhanced by the direct drainage into the IVC or major hepatic veins.

Both the lower tumor-free and cumulative survival and a higher recurrence rate have been emphasized.\textsuperscript{14,32} In addition, the greater operative time and blood loss, the less extent of the surgical margin, and more frequent tumor exposure have been indicated.\textsuperscript{24–32} Recently, however, some authors have reported that the outcome of HCC in the caudate lobe is similar to that in other locations of the liver.\textsuperscript{4,23,24} We are inclined to attribute the discrepancy of outcomes to different locations of HCC in the caudate lobe and to different modes of tumor invasion.

6. Conclusion

Isolated resection of the caudate lobe for HCC can be performed successfully. The approach and the necessity of vascular control have to be well planned, especially when the tumor is located in the PC. An outcome comparable to that for HCC in other locations may be obtained in certain patients.

### References