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Surgical Strategies for Locally Advanced Hepatocellular Carcinoma

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1. Introduction

Patients with advanced liver tumors extending into the portal vein or hepatic vein exhibit extremely poor prognosis after undergoing several nonsurgical therapeutic modalities, including transcatheter arterial chemoembolization (TACE) and radiofrequency ablation (RFA). Aggressive surgical treatments have been recommended in selected patients with advanced liver tumors accompanied with intravascular tumor thrombus (1). Complete surgical resection of the advanced liver tumors with tumor thrombus extending to the inferior vena cava (IVC) is beneficial for patients since it prevents the risk of pulmonary embolisms and prolongs long-term prognosis. However, IVC involvement increases the surgical risk and has been considered as a limiting factor for the curative resection of advanced tumors. The difficulty of surgery varies according to the tumor type and the region of the IVC involved; especially, the resection of tumors invading the junction of hepatic veins and the IVC is challenging. When the tumor thrombi extend above the diaphragm, cardiopulmonary bypass (CPB) is often suggested (2). Traditionally, it is necessary to perform sternotomy or thoracotomy for intrathoracic IVC isolation and to achieve adequate tumor-free margin and prevent emboli formation from the tumor thrombi (3). However, the set-up time for CPB exceeds 30 minutes (4) and the procedure of sternotomy needs additional 20 minutes or so, including the time required for closing the sternum wound. Furthermore, the complications and risks of CPB are similar to those observed in certain types of heart surgery (5). Moreover, the postoperative pain and wound adhesion caused by sternotomy and coagulopathy, and the central nervous complications inherent to the CPB and circulatory arrest have prompted the search for an alternative technique (6, 7).

Therefore, many surgeons continue to perform this aggressive surgery but try to avoid median sternotomy and CPB (8-11). This chapter introduces surgical approaches to loop the supradiaphragmatic IVC by avoiding sternotomy and thoracotomy (Figure 1).

Miyazaki et al. (8) first reported an approach to reach intrapericardial IVC through the abdominal cavity without sternotomy (Fig 1a). They suggested that after dissecting the coronary and triangular ligaments and mobilizing the bilateral hepatic lobes, the bilateral diaphragm just below the pericardial cavity can be transversely incised. The bottom of the

pericardium is consecutively incised, and the intrapericardial cavity is reached. While the left lobe of the liver is retracted caudally, long-curved vascular forceps are inserted into the intrapericardial cavity, and the IVC is encircled just below the confluence into the atrium.

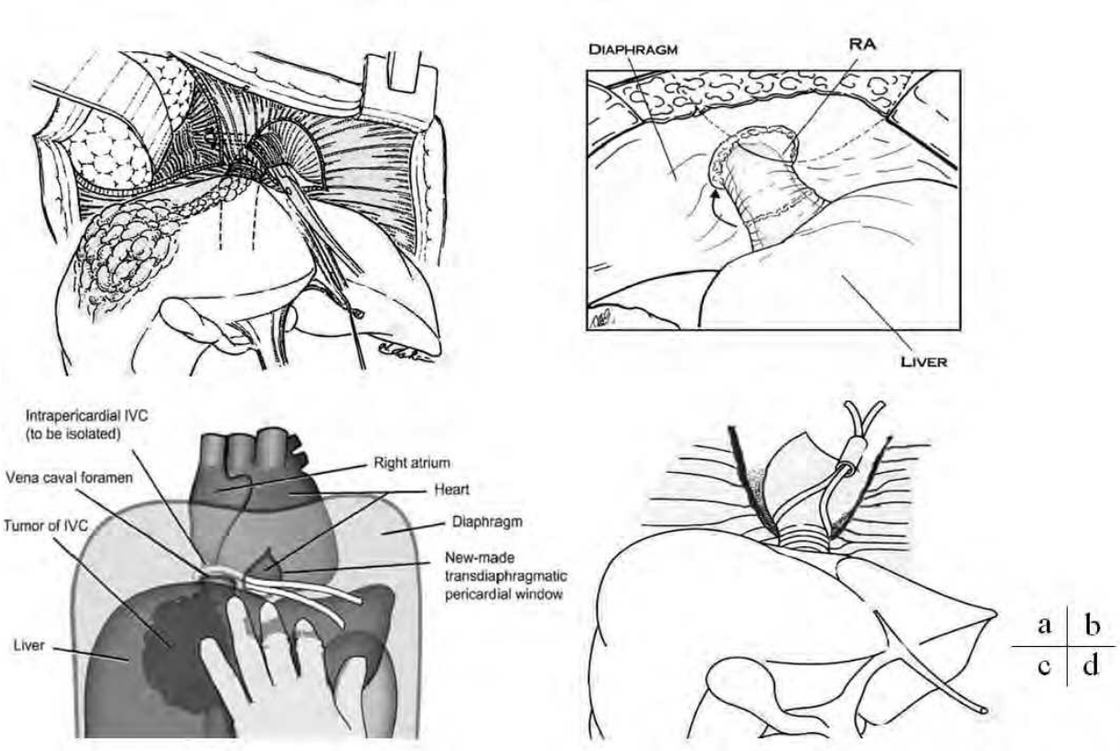

Fig. 1. Approach to the intra-thoracic IVC. (a) Miyazaki's technique: The figure was copied from the original paper (8), with permission from Thieme. (b) Ciancio's technique: The figure was copied from the original paper (9), with permission from Elsevier. (c) Chen's technique: The figure was copied from the original paper (10), with permission from Elsevier. (d) Our technique: The figure was copied from the original paper (11), with permission from Springer.

Ciancio et al. (9) showed the technique to gain access to the supradiaphragmatic IVC by circumferentially dissecting the central diaphragm tendon (Fig 1b, 2). The falciform ligament is divided using a cautery probe, and the incision is continued around each portion of the divided falciform ligament up to the right superior coronary ligament. The left triangular ligament and the central diaphragm tendon are dissected until the supradiaphragmatic, intrapericardial IVC is identified. The dissection should be circumferential so that the intrapericardial IVC can be encircled below or above the confluence into the right atrium.

Chen et al. (10) reported the method of IVC isolation through a transdiaphragmatic pericardial window (Fig 1c, 3). They suggested that the left lateral segment of the liver can be mobilized, and a plane between the liver and the diaphragm developed carefully to create a transdiaphragmatic pericardial window, about 5 × 5 cm. Through this window, the intrapericardial IVC is isolated with an umbilical tape by blunt and sharp dissection.

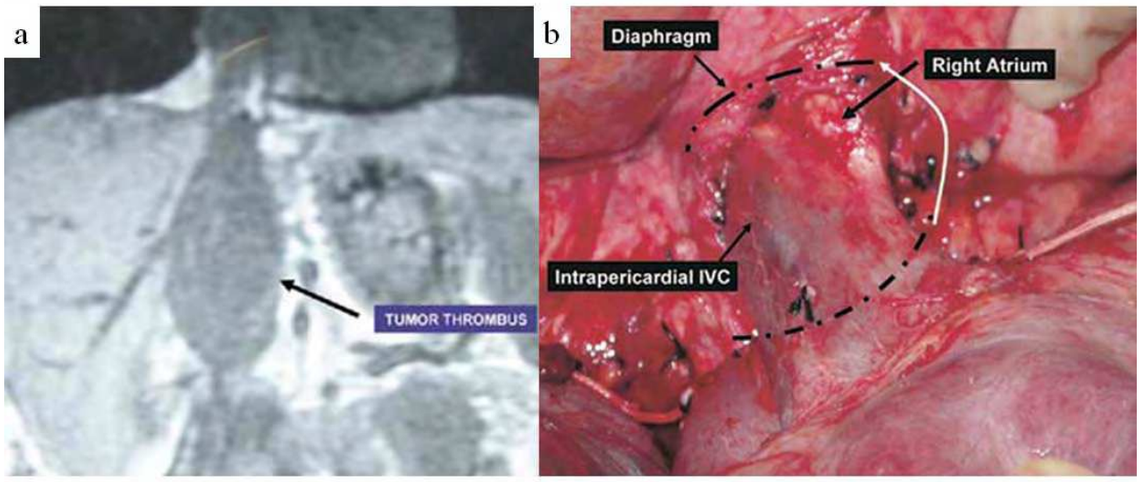

Fig. 2. Ciancio's technique (9). (a) Magnetic resonance imaging of RCC. Arrow indicates tumor thrombus in IVC extending above diaphragm into right atrium. (b) Diaphragm dissected off suprahepatic IVC. Intrapericardial IVC and right atrium exposed through abdominal cavity.

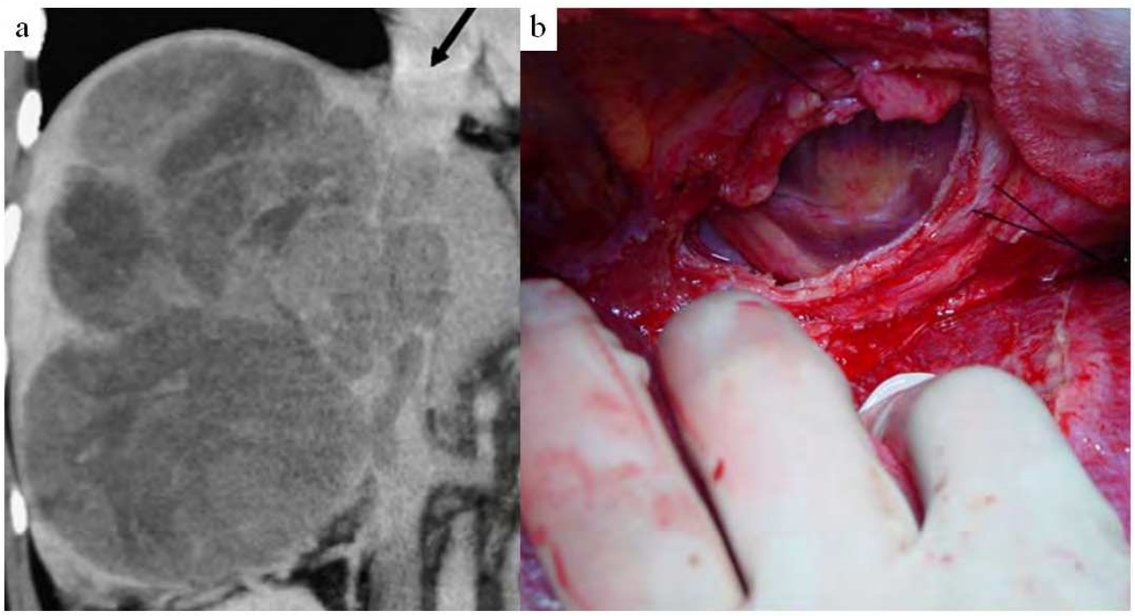

Fig. 3. Chen's technique (10). (a) Computed tomography image of an adrenocortical carcinoma. The arrow indicates the tumor thrombus extending to the junction of the hepatic vein and the inferior vena cava. (b) Transdiaphragmatic pericardial window approach for intrapericardial isolation of the inferior vena cava.

With regard to the adverse events of cutting the pericardium, there are intraoperative and postoperative problems. Intraoperatively, opening the pericardium increases the right ventricular end-diastolic and end-systolic volumes, resulting in diminished right ventricular ejection fraction (12). Postoperatively, there have been many case reports suggesting that pericardial effusion, constrictive and/or purulent pericarditis, and cardiac tamponade develop after cardiac or noncardiac surgery (13, 14).

Our technique is simpler, easier to perform, and less invasive, as compared to these approaches because it does not involve opening of the thoracic cavity and cutting of the pericardium (Fig 1d). We focused on the line of the fusion of pericardium to diaphragm (LFPD) (8), which is connected between the pericardium and diaphragm but can be easily disconnected (Fig. 4).

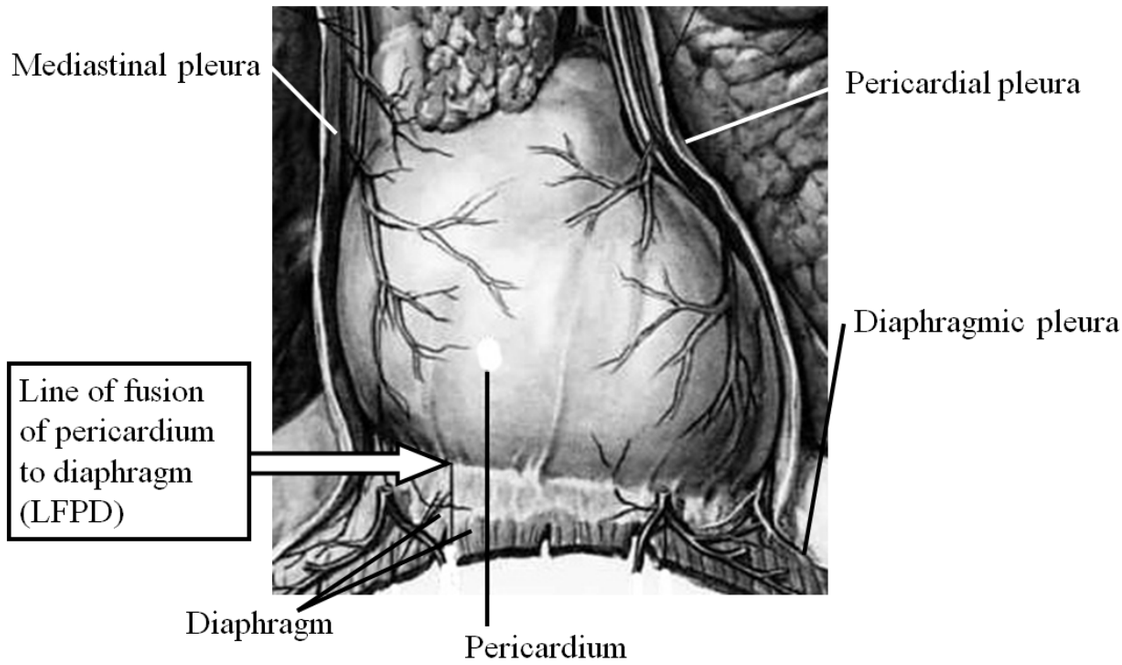

Fig. 4. The anatomy of the line of fusion of pericardium to diaphragm (LFPD)

For advanced hepatocellular carcinoma (HCC) patients (Fig. 5), LFPD was dissected, and the pericardium and diaphragm were completely separated without causing injury to the pericardium. From just below the xiphoid process to the IVC, the diaphragm was vertically dissected using LigaSure® without median sternotomy. Then, the intrathoracic IVC was exposed easily and was encircled with an umbilical tape to prevent emboli formation from the tumor thrombi (Fig. 6). After liver parenchyma transection, total hepatic vascular exclusion (THVE) was achieved by clamping the intrathoracic IVC, the infrahepatic IVC, right hepatic vein, right hepatic artery, and right portal vein. During the THVE, IVC wall

was cut at the root of the left hepatic vein, and then the intracaval tumor thrombus and the left lobe of the liver were removed *en bloc* (Figure 7). The IVC defect was closed by a continuous suture with 5-0 monofilament.

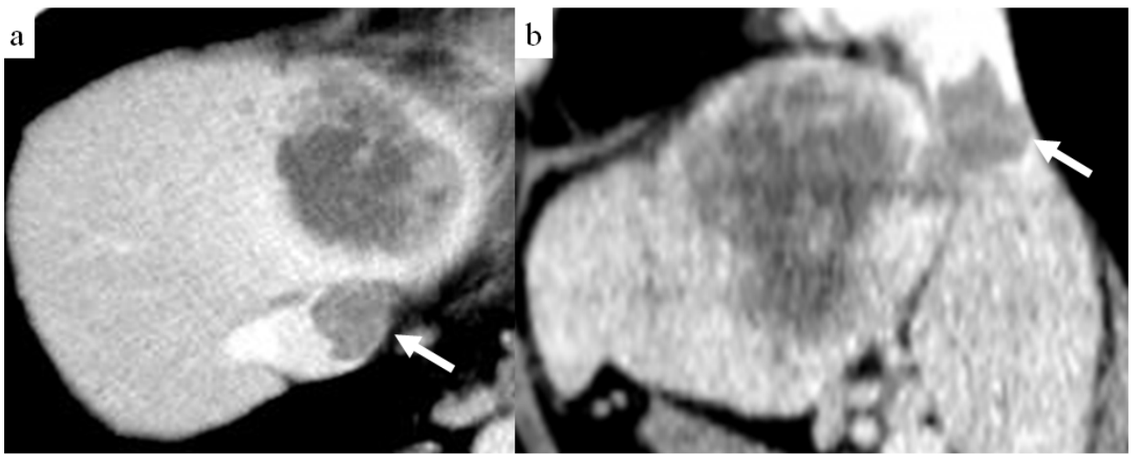

Fig. 5. Computed tomography image of hepatocellular carcinoma. The arrow indicates the tumor thrombus extending to the intra-pericardial inferior vena cava. (a) transverse sections, (b) sagittal section.

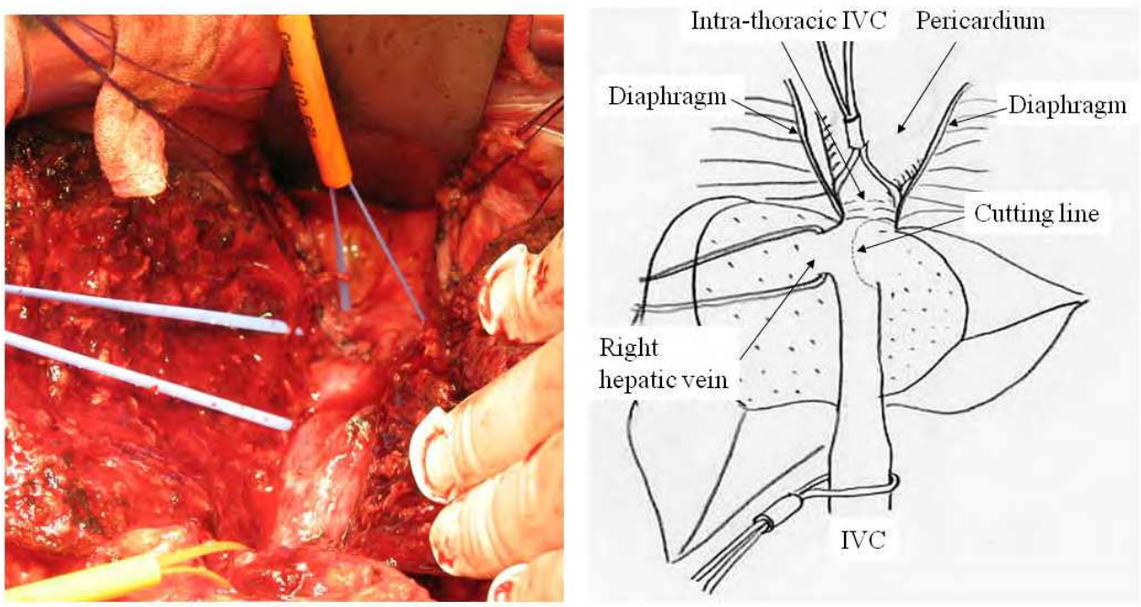

Fig. 6. After detachment of the line of fusion of pericardium to diaphragm (LFPD) and transection of the liver parenchyma, the infrahepatic IVC, right hepatic vein, right hepatic artery and right portal vein were taped.

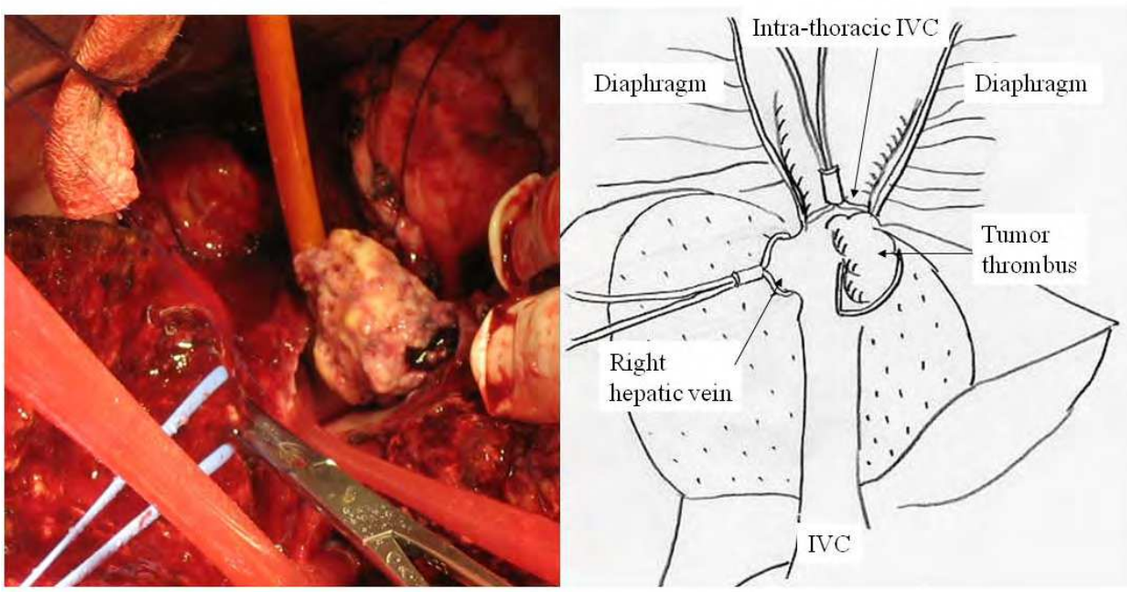

Fig. 7. During the THVE, the wall of the IVC was cut at the root of the left hepatic vein, and tumor thrombus was exposed.

Before applying THVE, we have to assess the preoperative hepatic functional reserve and carefully monitor intraoperative hemodynamic changes (16). Our selection criteria for liver resection are the same as Makuuchi criteria (17): the resection volume of the liver is determined based on total bilirubin and the Indocyanine green retention rate at 15 minutes. However, since THVE runs the risk of ischemic liver damage, these criteria should be determined more strictly.

In conclusion, the technique we have described here appears to be easy and beneficial in the surgical treatment of IVC tumors, since it provides a longer tumor-free margin of the IVC; short operative time; and abolishes the need for sternotomy, CPB, and cutting the pericardium. However, more experience is necessary to validate the benefits of this approach.

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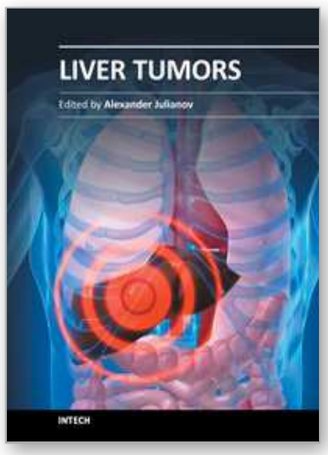

Liver Tumors

Edited by Prof. Alexander Julianov

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This book is oriented towards clinicians and scientists in the field of the management of patients with liver tumors. As many unresolved problems regarding primary and metastatic liver cancer still await investigation, I hope this book can serve as a tiny step on a long way that we need to run on the battlefield of liver tumors.

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