

Clinical Significance of Inferior Right Hepatic Vein

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Abstract Liver resection is the golden-standard treatment for hepatocellular carcinoma. The extent of liver resection is a balance between complete removal of tumor and the maximum preservation of tumor-free hepatic parenchyma. Bisegmentectomy 7-8 can be an alternative choice to more extensive liver resections if a thick inferior right hepatic vein (IRHV) occurs. This review briefly describes the conception of inferior right hepatic vein (IRHV) and its significant role in live hepatectomy and other clinical practice.

Keywords: hepatic vein, inferior right hepatic vein, hepatectomy, Living donor liver transplantation, anatomy

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1. Introduction

The right, middle and left hepatic veins are three major draining blood vessels for the liver as we know, but there are still a great many small vessels, which are called accessory, or short hepatic veins by most authors. When divided into two groups according to the side they entering into the inferior vana cava (IVC), the left side veins are usually called caudal hepatic veins, while the right side ones are frequently referred to as inferior right hepatic vein (IRHVs). IRHVs are separated into superior, medial, inferior teams by the position at which the IRHVs enter the IVC, respectively named as the superior, medial

or inferior right hepatic vein of all the IRHVS, the inferior right hepatic vein (IRHV) is usually of the biggest size, which makes it important in hepatic surgeries such as hepatectomy and liver transplantation (Figure 1). IRHV injury occasionally results in torrential, life-threatening hemorrhage or chronic atrophy, and acute necrosis of draining segments and the region during hepatectomy due to its junction with the inferior vena cava. This review briefly describes the conception of inferior right hepatic vein and its significant role in living donor liver transplantation [1,2] and hepatectomy [3]. We are going to talk about the conception of IRHVs, ways to find and the significance of IRHVs in surgery field.

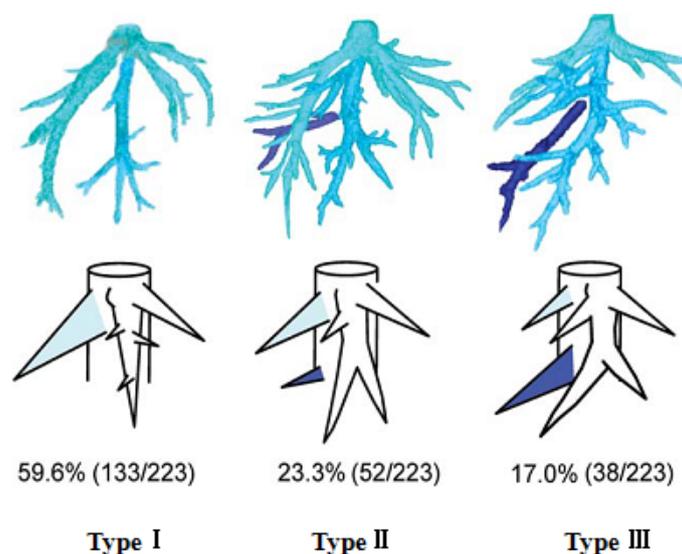


Figure 1. These pictures show classification of the hepatic vein by the RHV and IRHV sizes: in type I, the IRHV was absent; in type II, the IRHV was smaller than the RHV; and in type III, the IRHV was greater than or equal to the RHV in size

2. Concept of IRHV

Accessory hepatic veins do exist in addition to the three major hepatic veins according to a large number of anatomical materials and clinical studies. The IRHV we

mentioned is the thickest of these, which act as the main draining vessel of postinferior area of right liver. The position which these dorsal hepatic veins entering the inferior vena cava was named the third portal hilum by Xia in 1950.

3. The Incidence

The incidence of IRHVs still remains controversial. On the basis of autopsies, the incidence reported by Uchida K [4] is 61.4%, by Huang YD is 84%, by Wang Hai-quan is 83.3%, and Liu Shu-wei is 88%, while on the basis of image tools the incidence is quite different, usually less than autopsy ones, for example Makuuchi reported the incidence of IRHV as 10%, Cheng Yu-fan reported 18%, Zhang Yan [5] reported 28.33% via color duopler ultrasound. With the help of CT, the incidence is 27.27% by Li Yu-kun [6], 28.33% by Wang Li [7] and 30% by Zhang Yan [5]. Li Jie [8] reported that utilizing two-dimensional ultrasound, the incidence of IRHV is 24%. Ji woong Hwang [9] reported that the incidence of IRHV was higher under the situation of no exposure of RHV. The incidence counted by using cadavers is more prevalent in the incidence counted by image tools. This may have occurred because as Radtke A [10] reported only veins with a diameter of 2mm or larger can be depicted on CT scans, but In the cadeciv team maybe all levers of diameter are counted including even the diameter of a pin. More reasons should be explored.

4. The Diameter and Extrahepatic Length of IRHVs

The diameter is about 4.3 ± 0.12 mm reported by Wang Hai-quan [11] and Li Jie. B.trotovsek [12] reported that the mean diameter of IRHVs was 7.0 ± 2.1 mm with a maximum value of 13mm. Ji woong Hwang [9] reported that the mean diameter of IRHVs was 6.2 ± 2.7 mm (range, 1.9-13.7mm). However, or technical reasons, the diameter of the hepatic vein which can be used in venous reconstructions needs to be large [13] (ie >5 mm). Extrahepatic length means the distance between the IRHV and the IVC, it ranks from 3.44 to 7.84 cm, on an average of 5.328 ± 1.142 cm [6]. The length between the IRHV and the RHV is also counted as 3.3 to 6.7cm, on an average of 4.9 ± 1.1 cm [11]. This makes it possible to reserve the tumor area as large as we can in order to reduce the rate of recurring.

5. Drainage Area

According to the nomenclature of Couinaud, the superior right hepatic vein mainly drains the superior part of segment VII and the medial right hepatic vein drains the middle part of segment VII, which is adjacent to the hepatic bare area and the inferior vena cava [14]. The IRHVs with narrow diameter drain a small region of the hepatic parenchyma. The thicker IRHVs mainly drain segment 6 and the inferior part of segment 7, while thinner IRHVs drain the inferior part of segment 5 [15]. In another research, more than 21% of patients have a large inferior right hepatic vein (IRHV), which is believed to drain the inferior segments of the right hemiliver [16]. Recently, however, POONAM SHILAL [17] proposed that because of the variety of the branching pattern of the right hepatic vein (RHV) and appearance of the inferior right hepatic vein, the tape of drainage in the posterior segment of liver express otherness. So hepatic surgeon must master the knowledge of this diversity to ensure the precise of the surgery.

6. Ways to Find

The image tools make it possible for the surgeons to get better practice both preoperatively and intraoperatively. In recent years, 3-dimensional (3D) computed tomography (CT) scans (Figure 2) and color duopler ultrasonography have assisted doctors in preoperative surgical planning. as we mentioned previously, the positive rate between the two tools is of no significant difference. In patients with obstruction of the bile ducts, one important sonographic criterion called the parallel channel sign is usually found, which the portal venous branch and the dilated bile ducts are seen parallel to each other. A thick IRHV and the posterior portal venous branch are also parallel to each other, however. It is not a sign of obstruction of the bile duct, so Machuuchi [18] named it as "pseudo-parallel-duct sign". It is improtant to distinguish the so-called "parallel sign" to avoid unnecessary percutaneous transhepatic cholangio-drainage (PTCD). [8] Li Jie proposed that compared with obstruction of the bile ducts, two blood flow signal can be observed assisted with color duopler ultrasonography to prove the presence of a thick IRHV. By using CT, we can also calculate the liver drainage volume of the IRHV using its diameter alone, which enables liver surgeons to determine how to manage these hepatic veins. [19] By using these tools before operation, doctor's confidence gained.



Figure 2. These results of CT show the relationship between tumor (marked by A) and IRHV (marked by B or C) clearly, which prove that CT is a valuable imaging technology for preoperative test of hepatectomy, especially for those involve right hepatic lobe

During hepatectomy, intraoperative ultrasonography is customarily used to determine the location of a tumor and the relationship between it and the vessels, including the IRHV, portal and hepatic veins, as well as to decide on the extent of resection and to confirm the dissection plane. Norihiro [20] reported that the IRHV can be visualized by intraoperative ultrasound (IOUS), but it can be easily avoided by direct visual inspection from the caudal side behind the liver. Color Doppler ultrasonography is used to visualize the flow in the vessels easily [21], so it is for the IRHV.

A preoperative search for a prominent inferior right hepatic vein by ultrasound, computerised tomography, or even magnetic resonance imaging should be considered.

7. Clinical significance of IRHV studies

7.1. Liver Resection

Liver resection is the most effective curative treatment for primary hepatocellular carcinoma and resectable colorectal liver metastases. The extent of liver resection is a tricky balance between complete removal and preservation of parenchyma as much as possible. For most patients with a normal liver function, when a tumor infiltrated the Right hepatic vein (RHV), the whole right liver is usually resected. But according to Klaus Steinbrück [22], it is significant to reserve the parenchymal areas, especially for patients with impaired liver function and this is common in patients with cirrhosis and hepatocellular carcinoma (HCC). Reserches have showed that future remnant liver volume less than 30% is related to a high rate of postoperative complications, especially liver failure. Torzilli G [23] raise a novel view, The radical but conservative philosophy, it aims to think the liver surgery and develop new techniques to reserve more liver parenchyma. For patients with colorectal liver metastasis, liver resection is the gold-standard treatment with a less than 5% mortality and long survivors. However, two-thirds of the those patients will finally develop into a recurrence, 30% of which are intrahepatic. in this case, repeated hepatectomy is a possible choice, what is more, the second liver resection has a similar short and longterm survival as in the first hepatectomy. And a third resection in patients which has a good results. Therefore, this necessitates us to preserve hepatic parenchyma as much as possible.

In past several decades, plenty of technologies has applied to clinic, such as portal vein ligation, two-stage hepatectomy, portal vein embolization(PVE)and the Associating Liver Partition and Portal vein ligation for staged hepatectomy (the APPLS), to reduce the frequency of the major hepatectomy [24]. All these attempts aim to get bigger FRL in order to prevent postoperative liver failure and thus improving short and longterm survival, especially the PVE. But the side effects of PVE should not be underrated. So an IRHV-preserving liver section is of great importance.

The clinical significance of these studies on IRHVs varies. (1) The posteroinferior area of the right lobe can be preserved along with the hypertrophic IRHV even if the entire main right hepatic vein is resected during segmentectomy of VII and VIII with right hepatic vein

resection for patients with primary liver cancer. (2) It is also of good use in liver transplantation. (3) It is very helpful for clinical study and treatment of Budd-Chiari syndrome. (4) when the RHV must be resection, the appearance of an IRHV is a useful variation for the section of the RHV without harming the drainage of inferior segments.

The presence of a lesion in segments VII-VIII infiltrating the right hepatic vein is usually an indication for right hepatectomy. Usually the whole right lobe is resected together with the RHV. However, this procedure occasionally requires resection of enough nontumorous liver parenchyma, which may at sometimes, cause small for size syndrome. Extended or create a risk of postoperative liver failure. So we should preserve as much liver parenchyma as we can. But if a thick inferior right hepatic vein is seen, a bisegmentectomy VII-VIII can be performed In patients with a thick IRHV [25], thus the right posteroinferior area can be preserved. After Makuuchi M [27] and the partners described 4 new hepatectomy procedures for resection of the right hepatic vein and preservation of the inferior right hepatic vein, the importance of the IRHV was recognized, and aggressive surgical procedures involving preservation of the IRHV were reported [21,26,27]. Chen Xiaoping [28] reported that due to the presence of thick IRHV, tentative blocking the RHV is feasible without liver parenchyma congestion or necrosis. Muratore A and colleagues reported that Texler ML [29] and his co-workers reported a patient with involvement of segments 2, 4 and 8 by metastatic colorectal cancer. The patient had a large inferior right hepatic vein, and so was able to undergo an extended left hemihepatectomy with ligation of all superior hepatic veins and Subsequent quality of life was maintained. Hirai I [30] described a patient with three metastatic nodules in segment 7 and 8, a invaded RHV and a tumor-apsed MHV. She underwent hepatectomy of segments 7 and 8 and part of segment 4, along with resection of the RHV and MHV, without reconstruction.it all comes down to the reason that she had a large IRHV. It has been shown that hepatectomy with resection of the RHV and without venous reconstruction is possible if the patient has an inferior right hepatic vein. Besides, Fumiya Sato [31] hold that the extent of RHV exposed on the transected plane is closely related to the type of the IRHV, so more attention should be attached to the IRHV during the hepatic trisectionectomy. Machado [32] stated that among patients operated the resection of RHV, on account of the segment V drainage of IRHV, the congestion of the remnant liver hardly occurs. Ji Woong Hwang [9] considered that the presence of IRHV is a anatomical landmark on the right anterior sectionectomy and right posterior sectionectomy rather than the RHV. Chunging Jiang [33] reported that associating with intraoperative ultrasonograph and meticulous perioperative care, the short-term outcome of IRHV-preserving liver resections is satisfactory, especially for hepatocellular carcinoma patients with significant fibrosis or cirrhosis. however, Machado MA [34] reported that bisegmentectomy 7-8 did not result in segmental outflow block even in the absence of a thick inferior right hepatic vein, they successfully performed this technique in four consecutive patients without immediate or long-term venous or venous related complications. And the absence of this vein should not be

a straightforward indication for right hepatectomy in cases where a liver-sparing procedure such as bisegmentectomy 7-8 can be safely employed. Therefore they argued the technique should be performed more often than reported. We think it need to be confirmed by larger samples.

7.2. Living Donor Liver Transplantation (LDLT)

Living donor liver transplantation (LDLT) is an alternative to deceased donor liver transplantation for the treatment of patients with end-stage liverdisease [35]. However, its application in adult recipients has been complicated by the problems associated with an atypical variations of hepatic vasculatures [36] and insufficient graft volume caused by venous outflow obstructions [37]. This is particularly true when the right lobe is selected for transplantation. Liver atrophy or almost no liver regeneration has been noted in congested areas. Large congested areas can also result in infarction and lead to septicshock. Because such congestion occasionally induces hepatic failure (particularly in patients with impaired liver function), reconstruction of the major hepatic veins is required. Complications caused by potentially congested areas can be prevented if an adequate volume is provided by venous reconstruction. According to the traditional view, because of the reverse or obstruction of the IRHV, the value of reconstruction of IRHV has been underestimate [38]. However, recently survey prove the significant role of IRHV in venous reconstruction. Pan Guangdong [39] reported that for the presence of thick IRHV, reconstruction of IRHV have the potential to ensure the quality of graft. H.Kamei [40] reported in a case that reconstruction of IRHV should be carried out except the RHV and MHV for patients with situs inversus. Besides, as we mentioned previously, CT and color doppler ultrasound also should be used to make the operation well prepared. If a large IRHV(usually bigger than 5mm or thicker than the RHV) is found in the donor liver, venous reconstruction need to be done between the IRHV and the major hepatic vein of recipient liver to avoid congestion or atrophy. If it was revealed in the recipient liver, we should preserve it to make the transplantation easier.

8. Discussion

A thick IRHV can change the style of the operation and preserve more hepatic prenchtmal than usual, prevent patients from suffering postoperative liver failure, giving patients more opportunity for repeated liver sections. The IRHV plays a great role in hepatic surgeries, such as living donor liver transplantation and hepatectomy. The incidence should be deeply explored, more findings needed to confirm the important use in LDLT.

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