

**MAIN AND ACCESSORY RETROHEPATIC INFERIOR VENA CAVA OPENINGS -
CASE REPORTS****Dr. Dragica Jurkovikj***

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ABSTRACT

Two sciences that have been simultaneously developed are surgical anatomy and anatomical surgery complementing each other. In this context, having in mind the clinical importance of retrohepatic inferior vena cava with its tributaries during many interventional or resective procedures in liver surgery gave us the idea to present these case reports. On 11 cadaveric liver specimens from adults the retrohepatic inferior vena cava was opened longitudinally and then all hepatic vein openings were observed. The hepatic venous outflow was mainly through 2 or 3 large openings into upper part of retrohepatic inferior vena cava involving direct flowing of left superior vein into inferior vena cava. But, in addition to these, on the medium and lower thirds there were openings of medium or small-sized hepatic veins that directly entered the retrohepatic inferior vena cava. Among them there were caudate lobe vein and caudate process vein openings on the left side of the midline, accessory middle right hepatic vein and inferior right hepatic vein openings on the right side of midline and at the anterior wall short hepatic vein openings.

KEYWORDS: Liver, anatomy, dissection, retrohepatic inferior vena cava, hepatic vein openings.**INTRODUCTION**

Two sciences that have been simultaneously developed are surgical anatomy and anatomical surgery complementing each other. In this context, some anatomical and clinical investigations during the last 40 years related to openings into Retro-Hepatic Inferior Vena Cava (RHIVC) have been reported. As more remarkable were the studies done by Chang et al. (1989),^[1] Camargo et al. (1996),^[2] Couinaud (1999),^[3] Hata et al. (1999),^[4] Cecchis et al. (2000),^[5] Takemura et al. (2010),^[6] Shilal and Tuli (2015),^[7] Tani et al. (2016).^[8] Having in mind the clinical importance of the mentioned subject gave us the idea to present this anatomical study.

CASE REPORTS

To perform this study 11 cadaveric liver specimens from human adults were used. The RHIVC by careful dissection was opened longitudinally along the right margin of the posterior wall. The entire length of RHIVC was divided into 3 parts: upper, middle and lower thirds. All hepatic vein openings were observed mainly along the anterior wall of RHIVC, then to the right and to the left sides of the midline and on the opened posterior wall. According to their number the openings were classified as single, double, triple etc. Based on their relative

diameter the openings were divided into 3 types: large, medium and small. A probe was placed into the large and medium openings to determine which part of liver parenchyma was drained.

Case no. I: A total of 6 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC a single large opening of the Right Hepatic Vein (RHV) with semioval valve and a double i.e. common oval opening of the Middle Hepatic Vein (MHV) with Left Hepatic Vein (LHV), Fig.1

■ On the middle third of RHIVC, to the left side of the midline, 1 small and 1 medium oval openings of the Caudate Lobe Veins (CLVs), Fig.1

▼ On the lower third of RHIVC, to the right side of the midline, a single medium opening of the Inferior Right Hepatic Vein (IRHV) with semioval valve and to the left side of the midline a single small oval opening of the Caudate Process Vein (CPV), Fig.1.

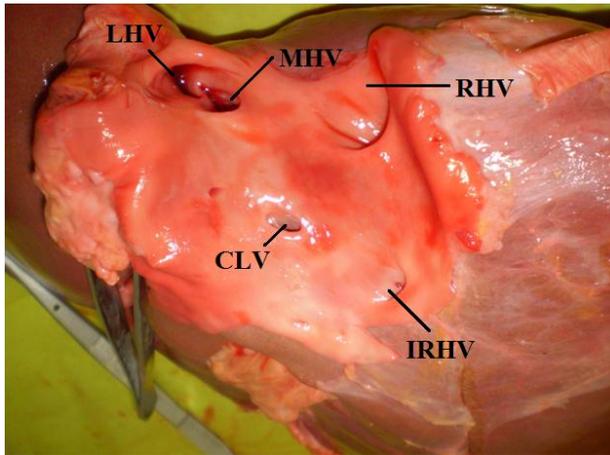


Figure 1: Case no. I: longitudinally opened RHIVC showing a common MHV with LHV opening and an accessory IRHV.

Case no. II: A total of 19 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC 3 single large openings, of the RHV with semioval valve and oval openings of the MHV and LHV

■ On the middle third of RHIVC, at the anterior wall 5 small openings; to the left side of the midline 1 medium oval opening of the CLV with semioval valve and on the left wall 3 small CLV openings

▼ On the lower third of RHIVC, at the anterior wall 5 small openings and to the right side of the midline a single medium opening of the IRHV with semioval valve and 1 small CPV opening with rounded valve.

Case no. III: A total of 30 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC 3 single large openings, of the RHV with semioval valve, oval of the LHV and rounded of the MHV

■ On the middle third of RHIVC, at the anterior wall 8 small openings; to the left side of the midline 1 medium oval CLV opening and to the right side of the midline 2 small openings and 1 small Middle Right Hepatic Vein (MRHV) opening with semioval valve; at the posterior wall 6 small openings

▼ On the lower third of RHIVC, at the anterior wall 6 small openings and 1 medium oval CPV opening with semioval valve; to the left side of the midline 1 small CPV opening and to the right side of the midline 1 medium IRHV opening with semioval valve.

Case no. IV: A total of 8 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC 3 single large openings, of the RHV with semioval valve, oval of the LHV and rounded of the MHV

■ On the middle third of RHIVC, to the left side of the midline 1 medium oval CLV opening with semioval valve and 1 small oval CLV opening

▼ On the lower third of RHIVC, to the right side of the midline 1 small opening of the IRHV with semioval valve and at the anterior wall 2 small openings.

Case no. V: A total of 4 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC a single large opening of the RHV with semioval valve and a double i.e. common oval opening of the MHV with LHV, Fig.2

■ On the middle third of RHIVC, to the left side of the midline 1 medium rounded CLV opening, Fig.2

▼ On the lower third of RHIVC, to the right side of the midline 1 medium IRHV opening encircled with valve, Fig.2.

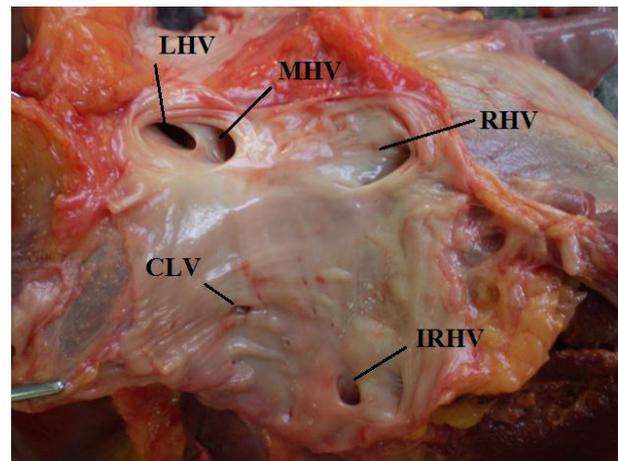


Figure 2: Case no. V: longitudinally opened RHIVC showing a common MHV with LHV opening and an accessory IRHV.

Case no. VI: A total of 28 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC a single large opening of the RHV with semioval valve, a double i.e. common oval opening of the MHV with LHV and 2 small openings of veins draining the fatty tissue located in the fissure of venous ligament, Fig.3

■ On the middle third of RHIVC, at the anterior wall 5 small openings; to the left side of the midline 1 medium CLV opening with semioval valve and to the right side of the midline 5 small openings, Fig.3

▼ On the lower third of RHIVC, at the anterior wall 9 small openings; to the left side of the midline 1 small CPV opening and to the right side of the midline 1 medium MRHV opening with semioval valve and 2 small IRHV openings with semioval valves, Fig.3.

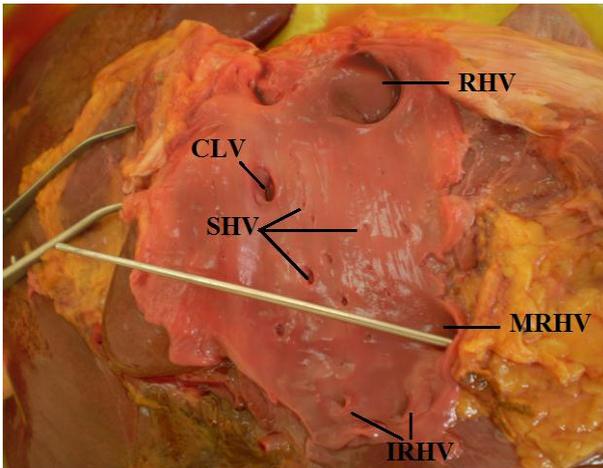


Figure 3: Case no. VI: longitudinally opened RHIVC showing at the anterior wall numerous Small Hepatic Vein (SHV) openings and to the right side of the midline a MRHV opening and below it two small IRHV openings.

Case no. VII: A total of 16 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC a single large opening of the RHV with semioval valve and triple oval opening of the LHV, MHV and one major tributary of the MHV, Fig.4

■ On the middle third of RHIVC, at the anterior wall 5 small openings and 1 medium opening with semioval valve; to the right side of the midline 1 small MRHV opening with semioval valve and to the left side of the midline 1 medium CLV opening with semioval valve and 2 small CLV openings, Fig.4

▼ On the lower third of RHIVC, at the anterior wall 1 small opening with semioval valve; to the right side of the midline 1 small IRHV opening with semioval valve and to the left side of the midline 2 small CPV openings with semioval valves, Fig.4.

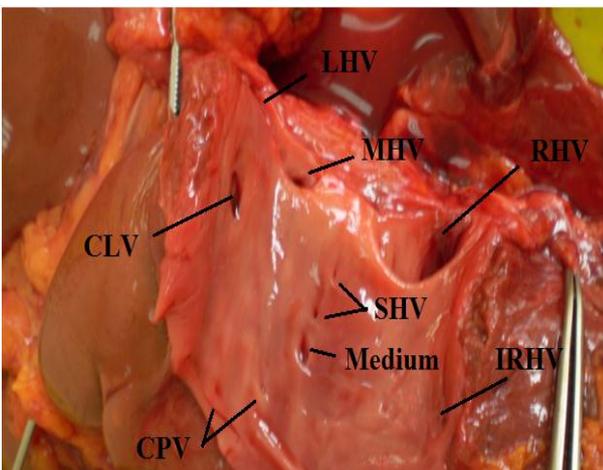


Figure 4: Case no. VII: longitudinally opened RHIVC showing at the anterior wall small and 1 medium-sized SHV openings and to the right side of the midline a IRHV opening.

Case no. VIII: A total of 15 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC a single large opening of the RHV with semioval valve, and double i.e. common oval opening of the MHV with LHV, Fig.5

■ On the middle third of RHIVC, at the anterior wall 4 small openings; to the right side of the midline 1 small MRHV opening with semioval valve and to the left side of the midline 1 medium oval CLV opening and 1 small CLV opening with semioval valve, Fig.5

▼ On the lower third of RHIVC, at the anterior wall 4 small openings and to the right side of the midline 2 small MRHV openings with semioval valves, Fig.5.

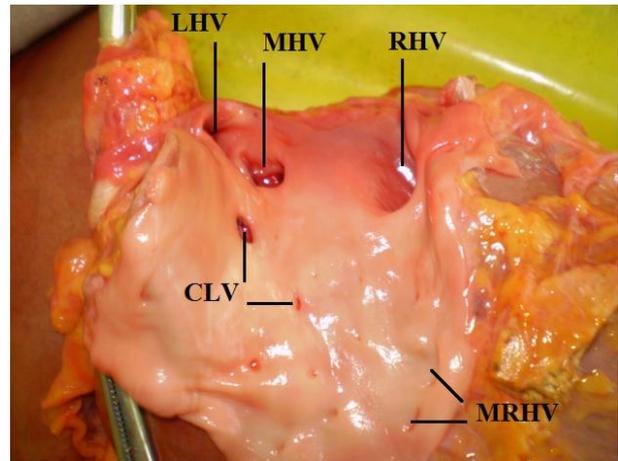


Figure 5: Case no. VIII: longitudinally opened RHIVC showing at the anterior wall numerous SHV openings and to the right side of the midline small MRHV openings.

Case no. IX: A total of 10 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC a single large opening of the RHV with semioval valve, and double i.e. common oval opening of the MHV with LHV

■ On the middle third of RHIVC, at the anterior wall 5 small openings; to the left side of the midline 1 medium oval CLV opening

▼ On the lower third of RHIVC, at the anterior wall 2 small CPV openings from which 1 was with semioval valve.

Case no. X: A total of 24 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC three single large openings, of the RHV with semioval valve, double rounded opening of the MHV with LHV and a single large oval opening of the Left Superior Vein (LSV), a major tributary of the LHV and at the anterior wall 2 small openings, Fig.6

■ On the middle third of RHIVC, at the anterior wall 8 small openings and 1 medium oval opening with semioval valve; to the left side of the midline 1 medium oval opening of the CLV, Fig.6

▼ On the lower third of RHIVC, at the anterior wall 8 small openings and to the right side of the midline 1 medium IRHV opening with semioval valve, Fig.6.

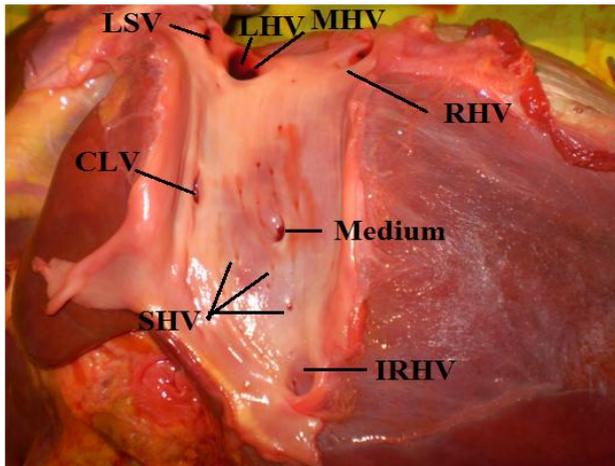


Figure 6: Case no. X: longitudinally opened RHIVC showing direct entering of LSV into IVC left to the common MHV with LHV opening ; at the anterior wall numerous small and 1 medium-sized SHV openings and to the right side of the midline a medium-sized IRHV opening.

Case no. XI: A total of 15 openings of the hepatic veins were observed:

▲ On the upper third of RHIVC three single large openings, of the RHV large oval, double rounded opening of the MHV with LHV and a single small opening of the Left Superior Vein (LSV), a major tributary of the LHV

■ On the middle third of RHIVC, at the anterior wall 1 small opening; to the left side of the midline 1 small opening of the CLV

▼ On the lower third of RHIVC, at the anterior wall 5 small openings and 1 small CPV opening; to the left side of the midline 2 small CPV openings and to the right side of the midline 1 superficial MRHV opening and 1 profound IRHV opening.

DISCUSSION

On the presented small series of adult human cadaveric liver specimens some interesting openings into RHIVC were observed. Having in mind their clinical importance during many interventional or resective procedures involving hepatic veins and especially RHIVC and tributaries that directly enter the Inferior Vena Cava (IVC) was found useful to report these cases.

As noted by Gupta et al., 1981,^[9] the major hepatic veins (left, middle and right) drained the correspondingly named segments. Posterolateral, posterior, postero-inferior and Short Hepatic Veins (SHVs) drained the visceral surface of the right lobe situated to the right of the IVC. The area drained by these veins has been termed paracaval segment. Superior and inferior caudate veins along with caudate process drained the caudate

lobe. This hepatovenous segment has been named caudate segment.

According to Couinaud's^[3] new considerations on liver anatomy, the dorsal sector was closely connected with the retrohepatic portion of the IVC. Two portions can be distinguished: left and right dorsal sectors. Veins of the left dorsal sector (segment I) were numerous and joined the cava at different levels along the left margin. The right dorsal sector veins (segment IX) were quite few and tiny twigs that entered the IVC in the anterior aspect and at the right margin.

In the applied anatomical study done by Chang et al., 1989,^[1] the internal wall of the RHIVC was divided into 16 areas, which were used to record the sites of the openings of hepatic veins. The openings were classified as large, medium and small. There were two types of large openings: the Superior Large Openings (SLO) and the Inferior Large opening (ILO) below the plane of the SLO. The combination pattern of SLO was mainly of double type, then of triple and only one case was of single type.

A higher percent of single type of SLO, followed by double, triple and quadruple types was also found on the cadaveric adult liver specimens reported by Camargo et al., 1996,^[2] using the classification by Chang et al.^[1] The SLO were located in the first row of 16 areas, and the ILO in the other 3 rows.

In the present study at the level of the upper third of RHIVC a single RHV opening with semioval valve was observed in all cases. In addition to it, in 5 cases the second opening was composed of 2 tributaries, the MHV and LHV, while in 1 case the common confluence was composed of 3 tributaries, one main tributary of MHV, MHV and LHV. A single opening of all main hepatic veins (RHV+MHV+LHV) i.e. triple type of openings in 3 cases was found. As more dangerous type for left lobectomy or left hemihepatectomy are the cases in which additional to the single RHV opening and common MHV+LHV opening a second LHV opening was found. Based on its superior position to the main LHV opening this second LHV corresponded to the tributary of the LHV described by Tani et al.^[8] as left superficial vein, a tributary of the LHV or an isolated vein draining cranial portion of segment II into IVC. Similar results were reported by Camargo et al.,^[2] who found 2 quadruple openings among SLO, one in area 1 which consisted of 3 LHV and 1 MHV, and the other in area 2 which consisted of 2 LHV, 1 MHV and 1 RHV. In their investigation the medium, small and minimum openings were located in all rows of the 16 areas.

In order to give a comment on our study results at the level of middle and lower thirds of RHIVC, firstly we will discuss the findings of other authors as well as the proposed terminology.

Hata et al., 1999,^[4] studied the configuration of hepatic veins in the right surgical lobe. They noted that the venous return did not seem to converge into a single particular vein, but was carried away by multiple superior veins: the RHV, MHV, SHVs, and 5 right superior radicles. In the lower region of the right surgical lobe of the liver, RHV, SHVs and MHV showed complementary (compensatory) venous drainage relationships. Sometimes, the term SHV included the proper drainage veins of the caudate lobe (segment 1 and segment 9). However, they defined the SHVs as those hepatic veins running in a posteriorly-located course behind the posterior segmental portal branches and that entered directly the IVC. The thick SHVs often drained the deep parenchyma of segment 6 and/or segment 7, in contrast to the thinner SHVs that consistently drained the superficial (inferior) parenchyma of the liver.

Using different methodology, many investigators have described anatomical variations in the pattern of the right hepatic veins. Cecchis et al., 2000,^[5] using corrosion cast methodology classified superior right hepatic vein into four types and type 4 was linked to the accessory right hepatic veins. The accessory right hepatic veins, an IRHV alone or an IRHV and a MRHV were always present. The calibre of the accessory right hepatic vein never exceeded that of the superior right hepatic vein.

Kokudo et al., 2005,^[10] pointed that the most important complications during liver hanging maneuver was injury to the SHVs and subsequent massive bleeding with an incidence of 4% to 6%. They proposed ultrasonically assisted retrohepatic dissection for a liver hanging maneuver to avoid injury to the SHVs. Typical proper caudate veins located around the midportion of the RHIVC in 42 out of 48 donors with visualized veins were found. Also, a nontypical proper caudate veins draining to the LHV (3 cases) and to the IVC wall very close to the opening of LHV+MHV (3 cases) as dangerous point in retrohepatic dissection were observed.

On ultrasound examination Draghi et al., 2007,^[11] in all cases observed the IVC wall, the openings of the hepatic veins, and the main branch of the portal vein, but intrasegmental vessels (portal, arterial, accessory hepatic venous branches) were partially depicted and in some cases they were not present at all. The minor hepatic veins were propulsive veins that were equipped with valves in the adults.

According to Xing et al., 2007,^[12] in the clinical studies on IRHVs, according to the position of the IRHV entering the IVC, the IRHVs were divided into superior, medial and inferior groups. The thicker IRHVs mainly drained segment VI and the inferior part of segment VII, while thinner IRHVs drained the inferior part of segment V.

Nakayama et al., 2015,^[13] performed a study with an aim to compare the surgical data and postoperative

complications between IRHV-conserving segments 7 to 8 resection and conventional right hemihepatectomy (RH). IRHV-conserving surgery was indicated when the residual liver volume after RH was estimated to be insufficient and extended hepatectomy was judged as having the risk of causing postoperative liver failure including liver tissue fibrosis and fatty degeneration based on intraoperative liver biopsy. In their study, IRHV-conserving liver resection was as simple as conventional RH because the surgical time was short and the blood loss was minimal.

In agreement with the abovementioned reports are the present study results. On the examined material on the middle third of RHIVC the openings were numerous, mainly small-sized, except for CLV openings which were larger i.e. medium-sized, but sometimes there were 1-3 small CLV openings. Their location on the RHIVC walls was more important and very variable. In all cases CLV openings were located on the left side of the midline of RHIVC and in 3 cases were unique openings. In the remaining 8 cases, there were 1-8 small openings at the anterior wall of RHIVC in 6 cases and 1 medium-sized opening with semioval valve in 2 cases. Exclusively only once 6 small openings draining the fatty tissue were found on the posterior wall. In 3 cases on the right side of the midline of RHIVC 1 small MRHV opening with semioval valve was found and in one case there were 5 small openings.

On the lower third of RHIVC small and medium-sized openings were observed. On the anterior wall 1 to 9 small openings were observed in 6 cases only, then in 2 cases one CPV opening was additionally observed and in 1 case only 2 small CPV openings were found. In 2 cases no openings were observed. On the left side of the midline of RHIVC 1-2 small CPV openings were observed only in 5 cases. But, on the right side of the midline of RHIVC except in one case, the medium or small-sized IRHV or MRHV openings alone or both in some cases were found. Unexpectedly, concerning their size they were medium openings at the anterior wall, which were described as tiny twigs that drained right dorsal sector (segment IX).^[3] So, as reported by Chang et al.^[1] the left anterior wall and the lower quarter of the right half of the wall may be considered as the regions where openings of hepatic vein may be found.

CONCLUSION

The hepatic venous outflow is mainly through 2 or 3 large openings into the upper part of RHIVC involving direct flowing of LSV into IVC. But, in addition to these, on the medium and lower thirds there were openings of medium or small-sized hepatic veins that directly entered the RHIVC. Among them, there were CLV and CPV openings on the left side of the midline, accessory MRHV and IRHV openings on the right side of the midline and short hepatic vein openings on the anterior wall.

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