ORIGINAL ARTICLE

Morphometric Study of Hepatic Veins: Application in Hepatic Imaging and Surgery

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Abstract

Knowledge of the surgical anatomy of the hepatic veins is indispensable for extensive hepatectomy, transplantation of the liver and the treatment of hepatic trauma with avulsion of the hepatic veins. A total of 60 cadaveric livers, used were included in the present study. Common trunk formed by union of left and middle hepatic veins was found in 28/60 (46.66%) specimens. Common trunk formed by union of left hepatic vein and right and left radicals of middle hepatic veins was found in 7/60 (11.66%).In 25/60 (41.66%) specimens there was separate opening for left, middle and right hepatic veins. The average diameter of ostium and new ostium of the common trunk was 13.52±3.50 and 16.35±3.30 (mean±SD) respectively. The average length of the common trunk was fond to be 6.49±2.70 (mean±SD). The average diameter of right hepatic vein, middle hepatic vein and left hepatic vein was 10.98±2.60, 8.82±2.54 and 8.20±1.87 (mean±SD). Preoperative delineation of this complex venous anatomy is very important. It provides vital information in the preoperative evaluation needed before performing a liver surgery.

***Keywords**: Common Trunk, Hepatic Veins, Ostium*

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Introduction

Venous blood of the liver drains to the inferior vena cava (IVC) via the hepatic veins.[1]Usually a total of three hepatic veins leave the liver though numerical variations is not uncommon.[2,3,4,5] Sometimes there is a single right hepatic vein while left and intermediate hepatic veins join to form a common trunk.[2,3] Liver resection surgery, associated with significant perioperative mortality and morbidity, is technically challenging (Korea, 2005). [6]

Recent advances in resectional therapy of hepatic neoplasm, in portal systemic shunt surgery, angiography and angiotherapy of splanchnic arterial and venous systems, demand detailed knowledge of the vascular anatomy of the liver.[7]

Knowledge of the surgical anatomy of the hepatic veins and inferior vena cava is indispensable for extensive hepatectomy, transplantation of the liver and the treatment of hepatic trauma with avulsion of the hepatic veins. Usually catastrophe occurs at the hepatic veins and inferior vena cava in the form of massive bleeding or air embolism due to laceration of the veins. In performing a hepatic resection, it is preferable to ligate the hepatic vein prior to transaction of the liver. This will prevent the pushing of cancer cells into the hepatic veins and will reduce bleeding. Despite its significance in clinical surgery, only a few reports regarding the surgical anatomy of the hepatic veins and inferior vena cava are available.[8]

Hepatic veins before draining into inferior vena cava may join to form a common trunk. An anastomosis between the common trunk of the receiver and cranial portion of the inferior vena cava of the donor is one of the techniques for restoration of hepatocaval continuity in

orthotopic liver transplantation. This technique avoids dissection of the retrohepatic vena cava and total caval clamping.[9]

The range of diameter of these vessels is significant because if a particular vessel is of a very small caliber, then the other vessels take over its territory. Prior knowledge of such a fact would enable the surgeon to take precautions during surgery. [10]

The present study would be helpful to derive the normative dimensions of the vessels in the Indian population and to label abnormal vessels by imaging methods prior to surgery.

Materials and Methods

A total of 60 cadaveric livers (fixed by the 10% formalin) used for dissections for undergraduate teaching were included in the present study. The livers which were free of pathological conditions macroscopically were included. Livers along with hepatic segment of inferior vena cava were removed from cadavers by cutting all of the peritoneal attachments of the liver and the structures at the porta hepatis. In present study, the method of manual dissection was used for tracing the vascular structures. The structures were thus seen as they would have been visualized during an actual operative procedure. The plane forceps were used to tease away the liver parenchyma and to expose the vessels.

The liver was dissected along the plane of the three major hepatic veins and these veins were exposed. These vessels were traced from their confluence into the inferior vena cava. The pattern of drainage of three major hepatic veins and their radicals were looked for. Presence or absence of the common trunk was observed. If present (Fig. 1, 2, 3), circumference of the ostium common trunk was measured near the site of its attachment with inferior vena cava. Circumference of new ostium of the common trunk was measured near its formation. Its length i.e., the distance from new ostium up to its attachment with the inferior vena cava, was measured. The circumference of the right, middle and left hepatic vein was measured. Diameter of these vessels was derived from circumference with the formula $2\pi r$. Percentage, mean, standard deviation, and range of the observed values were derived.

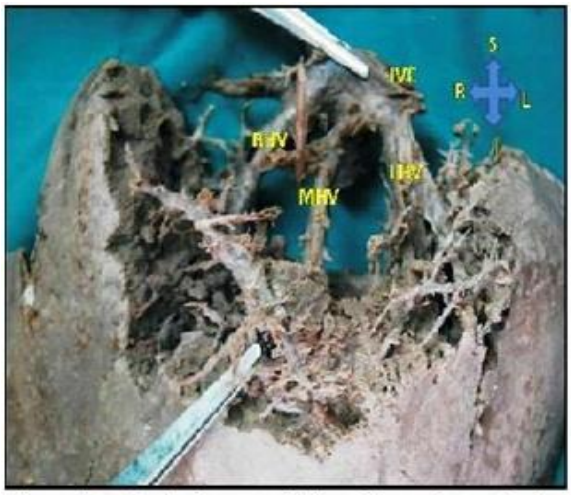
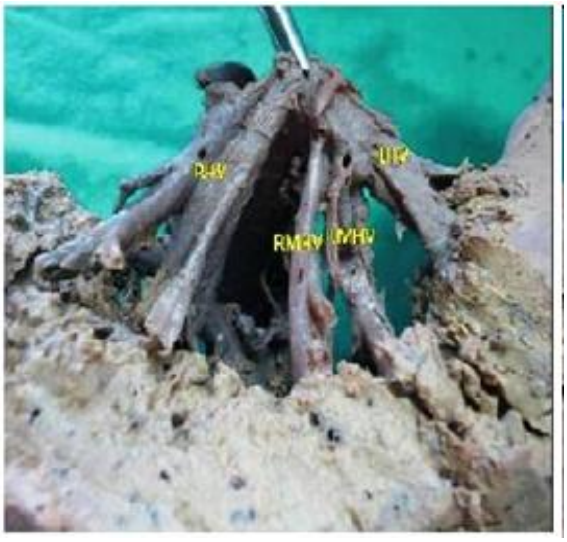


Figure 1: Illustration showing pattern of drainage of three major Hepatic Veins: separate openings for Left, Middle and Right Hepatic Veins. LHV-Left Hepatic Vein MHV- Middle Hepatic Vein, RHV- Right Hepatic Vein

Figure 2: Illustration showing formation of Common Trunk by joining of Middle and Left hepatic Veins. IVC- Inferior Vena Cava, LHV- Left hepatic Vein, MHV- Middle Hepatic Vein, RHV-Right Hepatic Vein, CT- Common Trunk.



Results

Table- 1: Pattern of drainage of three major hepatic veins into the inferior vena cava

Sr. No.	Pattern	No. of Specimens
1	Left common trunk formed by union of left and middle hepatic veins, separate opening for the right hepatic vein	28/60 (46.66%)
2	Separate opening for left, middle and right hepatic veins	25/60 (41.66%)
3	Left common trunk formed by union of left hepatic vein and right and left radicals of middle hepatic veins, separate opening for right hepatic vein	7/60 (11.66%)

Table- 2: Common trunk

	No. of Specimens	Minimum(mm)	Maximum(mm)	Mean (mm)	SD
Diameter of ostium	35	7.64	19.11	13.52	3.50
Diameter of new Ostium	35	9.87	21.66	16.35	3.30
Length	35	3.00	14.00	6.49	2.70

Table- 3: Diameter of the hepatic veins

	No. of Specimens	Minimum(mm)	Maximum(mm)	Mean(mm)	SD
Right Hepatic Vein	60	6.37	17.20	10.98	2.60
Middle Hepatic Vein	53	4.78	17.20	8.82	2.54
Left Hepatic Vein	60	5.10	13.38	8.20	1.87

Discussion

The anatomical knowledge of the large intrahepatic veins is the key in preoperative evaluation of hepatic tumors and in performing liver resection and transplantation procedures (Soyer et al., 1995).[11] Hepatic veins carry the venous blood of the liver and the venous blood that comes with the portal vein to the IVC. Usually numbering three [right, left and intermediate ((middle) hepatic veins], Hepatic veins open into the IVC, which travels in the groove for vena cava on the posterior surface of the liver, beneath the diaphragm.[1]

The three cranial hepatic veins drain independently into inferior vena cava or they join and form common trunk as they approach inferior vena cava. In present study, the common trunk formed by joining of left and middle hepatic veins (Fig. 2) and common trunk formed by union of left hepatic vein and right and left radicals of middle hepatic veins (Fig. 3) was found in 28/60 (46.66%) and 7/60 (11.66%) respectively.

Table-4: Comparison of incidence of common trunk

	Nakamura S, Tsuzui T (1981)	Baird and Britton[12]	Wind et al. (1999)	Scandalkis[12]	Ortale JR et al. (2003)	Cheng YF1 et al. (1996)	Present study
Frequency	70/ 83	-	54/64	-	31/40	140/200	35/60
%	84.33%	96%	84%	60%	77.5%	70%	58.33%

Table-5: Comparison of length of common trunk

	Wind et al. (1999)	Ortale JR et al. (2003)	Nakamura S and Tsuzuki (1981)	Baird and Britton[8]	Present study
Length	3 to 17	7.1±2.8 mm	1.0+0.5cm	0.2 to 2.2 cm	6.49±2.70 mm

In study done by Nakamura S and Tsuzuki, the middle and left hepatic veins presented the common trunk in 70 of the 83 autopsies while in 13, the middle and left hepatic veins were independent. The frequency of a common trunk was also reported by Baird and Britton to be 96 percent in 73 patients. [12]

Wind et al reported the common trunk formed by joining of the middle and left hepatic veins in 54 of 64 (84%) cases. Scandalkis quoted that in about 60% of individuals, the left and middle veins unite to enter the IVC as a single vein. Ortale JR et al. reported common trunk in 31/40 (77.5%) of cases. These circumstances warn us of the vulnerability of the left hepatic vein at the extended right lobectomy and of the middle hepatic vein at the left lobectomy.[12]

In study by Peschaud F1 et al. (2009) biometric analyses were carried out on extraparenchymatous portions of the middle hepatic vein (MHV) and left hepatic vein (LHV) and Common Trunk of 20 fresh cadavers and 10 living subjects, to assess the feasibility of selective clamping without liver mobilization. Fourteen of the 20 cadaveric subjects (70%) had a common trunk between the LHV and the MHV.[13]

Cheng YF1 et al. (1996) studied the anatomic variations of the middle hepatic vein (MHV) and left hepatic vein (LHV) in 200 patients with normal liver function, using ultrasonography to clarify the feasibility of resecting the left lobe or left lateral segment in living subjects for living related hepatic transplantation (LRHT). The MHV and LHV form a common trunk in 70% of cases but drain independently into the inferior vena cava (IVC) in 30%. [14]

In present study the diameter of the ostium, new ostium and length of the common trunk were found to be 13.52±3.50 mm, 16.35±3.30 mm and 6.49±2.70 mm respectively. Wind et al. reported the diameter of ostium, new ostium and length of the common trunk was 13.6±1.9 mm, 23.8±2.3 mm and 3 to 17 mm respectively.[9]

The length of the common trunk was similar to the values reported by Ortale JR et al. (7.1±2.8 mm).[15] Nakamura S and Tsuzuki reported the length of the common trunk to be 1.0+0.5cms. Adson and Goldsmith and Woodburne reported 2 cm and 1 cm respectively. Baird and Britton reported that the length varied from 0.2 to 2.2 cm.[8] Honda et al. considered 10 mm to be a sufficient length of the common trunk formed by joining of the middle and left hepatic veins for safe division of the left hepatic vein.[15]

\Cheng YF1 et al. (1996) fond the distance from the IVC to the confluence of the MHV and LHV ranged from 0 cm to 3.5 cm with an average of 1.5 cm in those cases whose MHV and LHV presented as common trunks.[14]

The common trunk was present in the majority of the cases and the creation of a new ostium by section of middle and left hepatic veins proximal to their junction made it possible to obtain diameter close to that of inferior vena cava at its diaphragmatic passage, Thus it is possible to construct the anastomosis between the cranial extremity of the inferior vena cava of the graft and the common trunk formed by joining left and middle hepatic veins of the receiver in liver transplantation in the adult.[9]

The minimization of blood loss is the main objective during hepatic resection to minimize perioperative mortality and morbidity. Selective clamping of the hepatic veins, combined with pedicle clamping, may make it possible to spare the non-resected territories from ischemia. These clamping procedures are particularly useful in the treatment of hepatic metastases of colorectal cancers, because preoperative chemotherapy may temporarily alter the hepatic parenchyma, increasing its susceptibility to ischemia. During left lobectomy or left hepatectomy, extraparenchymatous control of the left and median hepatic veins (the LHV and MHV, respectively) and of the common trunk (CT) requires exact knowledge of this anatomical region.[13]

The average diameter of the middle (intermediate) hepatic and left hepatic veins was found to be 8.82±2.54 mm and 8.20±1.87 mm respectively. These values were similar to 8.7+1.8 mm and 8.6+2.0 mm, reported by Wind et al.[9] but less than the 10.0±2.5 mm and 10.7±2.4 mm, respectively mentioned by Ortale JR et al.[15]

In our study the diameter of the right hepatic vein was found to be 10.98±2.60. Nakamura S and Tsuzuki reported that the internal diameter of the right hepatic veins ranged from 1.0 to 2.5 cm, 1.7+0.5 cm (mean±SD).[12]

The wide diameter and short stump of the right, middle and left hepatic veins require secure

closure by the application of the vascular clamp followed by a running suture with vascular suture. This procedure can obviate danger of slipping of the suture.[8]

The range of diameter of these vessels is significant because if a particular vessel is of a very small caliber, then the other vessels take over its territory. Prior knowledge of such a fact would enable the surgeon to take precautions during surgery e.g., when the right hepatic vein is small, a relatively large dorsal hepatic vein draining the right posterior inferior segment should be handled with special care. This vein should be ligated securely at the time of right posterior segmentectomy and should be carefully preserved at the time of extended left lobectomy.[10]

Conclusion

To conclude, results of the present study demonstrate the details about the morphology and biometric parameters of hepatic veins. The findings of the present study would be helpful in understanding more about venous drainage of the liver, as well as guide the surgeons for performing complicated surgeries such as liver transplantation and resections.

Conflict of Interest: *None declared*
Source of Support: *Nil*
Ethical Permission: *Obtained*

References

1. Borley NR. Hepatobiliary system. In: Standring S, ed. Gray's Anatomy. The Anatomical Basis of the Medicine and Clinical Practice. 39th ed. Edinburgh: Elsevier-Churchill Livingstone; 2005. p. 1213-26.
2. Evcil EH, Malas MA, Desdicioğlu K. Review of 13 fetal cases with hepatic veins opening variously into the inferior vena cava within the diaphragm. Anatomy 2009; 3: 29-34. [CrossRef]
3. Skandalakis JE, Skandalakis LJ, Skandalakis PN, Mirilas P. Hepatic surgical anatomy. Surg Clin N Am 2004;84(2):413–435. [CrossRef] [PubMed]
4. Buhe S, Miyaki T, Saito T, et al. A study of the accessory hepatic vein to segments VI and VII with a morphological reconsideration of the human liver. Surg Radiol Anat 2008; 30: 201-7. [CrossRef] [PubMed]
5. Fan ST, Wong Y. Absent middle hepatic vein in a right liver graft donor. Hepatobiliary Pancreat Dis Int 2008; 7: 430-2. [PubMed]
6. Korea J. Getting started as a hepatobiliary surgeon: lessons learned from the first 100 hepatectomies as a consultant. N Z Med J. 2005;118(1210): U1322. [PubMed]
7. Gupta SC, Gupta CD, Arora AK. Intrahepatic branching patterns of portal vein. A study by corrosion cast. Gastroenterolog. 1977 Apr;72(4 Pt 1):621-624. [PubMed]
8. Inoue T, Kinoshita H, Hirohashi K, Sakai K, Uozumi A. Ramification of the intrahepatic portal vein identified by percutaneous transhepatic portography. World J Surg. 1986 Apr;10(2):287-93. [CrossRef] [PubMed]
9. Wind P, Douard R, Cugnenc PH, Chevallier JM. Anatomy of the common trunk of the middle and left hepatic veins: application to liver transplantation. Surg Radiol Anat. 1999;21(1):17-21. [CrossRef] [PubMed]
10. Gupta SC, Gupta CD, Gupta SB. Hepatovenous segments in the human liver. J Anat. 1981 Aug;133(Pt 1):1-6. [PubMed]
11. Soyer P, Bluemke DA, Choti MA, Fishman EK. 1995. Variations in the intrahepatic portions of the Hepatic and Portal Veins: Findings on Helical CT scans during arterial portography. AJR 164: 103-08. [CrossRef] [PubMed]
12. Nakamura S, Tsuzuki T. Surgical anatomy of the hepatic veins and the inferior vena cava. Surg Gynecol Obstet. 1981 Jan;152(1):43-50. [PubMed]
13. Peschaud F1, Laforest A, Allard MA, El Hajjam M, Nordlinger B. Can the left hepatic vein always be safely selectively clamped during hepatectomy? The contribution of anatomy. Surg Radiol Anat. 2009 Nov;31(9):657-63. [CrossRef] [PubMed]
14. Cheng YF1, Huang TL, Chen CL, Chen TY, Husang CC, Ko SF, Lee TY. Variations of the left and middle hepatic veins: application in living related hepatic transplantation. J Clin Ultrasound. 1996 Jan;24(1):11-6. [CrossRef] [PubMed]
15. Ortale JR, Bosnet C, Prado P, Mariotto A. Anatomy of the intrahepatic ramification of the intermediate and left hepatic veins in humans. Braz. J. morphol. Sci. 2003;20(1):47-54.