Research Article

Ramification pattern and morphometry of major hepatic veins of liver by silicone cast method: Its clinical relevance to liver surgeries

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Received: August 07, 2020; **Accepted:** October 14, 2020

ABSTRACT

Background: Liver being the largest organ in the body receives blood supply from hepatic artery (25%) and portal vein (75%) and drained by three major hepatic veins opening into inferior vena cava. The dimensions of hepatic veins are quite essential during portosystemic shunting procedure and radiological interventions. The presence of variants of major hepatic veins is of prime importance to evaluate donor and recipient in living donor liver transplantation. **Objectives:** The objectives of the study were (1) to evaluate the ramification pattern and morphometry of major hepatic veins of liver by cast method and (2) to study the clinical implications of the hepatic vein variations. **Materials and Methods**: Forty liver specimens (22 males and 18 females) aged between 30 and 60 years were obtained from the Department of Forensic Medicine of JSS Medical College and Mysore Medical College. The silicone gel was injected into vena cava and pushed thoroughly into the ostia of hepatic veins. The drainage patterns of hepatic veins were noted and measurement of hepatic veins was done using thread and measuring scale. **Results:** The present study ramification pattern of middle and left hepatic veins showed Type 1 pattern in 24 specimens (58%), Type 2 in 12 specimens (40%), and Type 3 in 5 specimens (12%). There was a significant difference with $P < 0.05$ in all the parameters among males and females except the length and diameter of common trunk. **Conclusion**: Thorough knowledge of hepatic vein variants and its morphometry is essential during imaging procedures, anatomic resection of hepatic veins in hepatocellular carcinoma, liver transplantation, and other liver surgeries.

KEY WORDS: Hepatic Veins; Cast Method; Morphometry; Hepatic Resection; Liver Transplantation

INTRODUCTION

The liver being the largest organ in human body is located in the right hypochondrium and maintains its position through peritoneal reflections and various ligaments.[1] Morphologically liver has been divided into four lobes; right, left, caudate, and quadrate lobes and surgically divided into right and left lobes demarcated by Cantlie's line.[2]

Access this article online	
Website: http://www.ijmsph.com	Quick Response code
DOI: 10.5455/ijmsph.2020.08127202014102020	

The liver is a highly vascular organ, 25–30% supplied by the hepatic artery and 70–75% supplied by portal vein.[3] The major hepatic veins drain the right and left parts of liver and ultimately into inferior vena cava. According to Couinaud's classification, surgically liver is divided into eight segments and numbered in clockwise manner. Segment I directly drains into inferior vena cava, segments II, III, and occasionally segment IV drained by left hepatic vein. The right segments VI and VI and some proportions of segments V and VIII are drained by right hepatic vein. The middle hepatic vein drains tributaries from segments IV, V, and VIII.[4] The middle and

International Journal of Medical Science and Public Health Online 2020. © 2020 Vidya C S, *et al*. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

left hepatic veins usually form common trunk before draining into inferior vena cava. Among three major hepatic veins, the right hepatic vein alters in size, due to variable contribution of middle hepatic vein to the drainage of segments V and VIII and due to the existence of an accessory right hepatic vein.[5] During the right lobe liver resection, tributary of middle hepatic vein draining segment VIII should be take care, injury may cause serious post-operative complications.[6] Pre-operative imaging and surgical planning of liver resection is of prime importance to avoid iatrogenic injuries for successful surgical outcome.[7] In case of interventional procedures, such as transjugular portosystemic shunts and radiofrequency ablation, the hepatic vein variants should be evaluated for patient safety.

Hence, hepatic venous anatomy of donor and recipient in liver transplantation is important which helps in guiding surgical gastroenterologists, laparoscopic surgeons, and interventional radiologists in patients with hepatocellular carcinoma.[8-10]

Very few studies have been reported on hepatic vein variants and its morphometry in Mysore based population. The present study aims to demonstrate the morphology and morphometry of major hepatic veins by cast method which is quite useful to evaluate before hepatobiliary surgeries.

MATERIALS AND METHODS

In the present study, 80 liver specimens (47 males and 33 females) aged between 30 and 60 years were obtained from the Department of Forensic Medicine of JSS Medical College Institutional ethical committee and informed consent from relatives was obtained for the study. Fresh livers with intact inferior vena cava and hepatic veins were retrieved from postmortem examination and thoroughly washed to remove the blood clots. The livers were dehydrated and with the help of silicon gun injector, BOSS Flexsil (silicon sealant) was injected into ostia of hepatic veins. After hardening of the cast material, liver parenchyma was dissolved in 20% HCl solution and the cast obtained was washed in water to remove the remaining debris.[11] The major hepatic veins were identified and any variants were classified as Type 1, Type 2, and Type 3 depending on ramification pattern of major hepatic veins. The length and diameters of hepatic veins were measured using thread and measuring scale Figure 1.

RESULTS

The data obtained were analyzed using SPSS version 22 (licensed to JSS AHER) and descriptive statistics were adopted for male and female specimens. The frequency of variations was calculated in percentages. The descriptive statistics (Mean, SD) were obtained for length and diameter of major hepatic veins. $P < 0.05$ was considered as statistically significant. There was no gender difference in branching pattern and for variations of hepatic veins.

The normal drainage pattern of hepatic veins, that is, left common trunk formed by union of left and middle hepatic veins and separate opening for the right hepatic vein was observed in 48 cases (60%), while the remaining showed variant branching pattern. Segment I drained independently into inferior vena cava, segments II and III drained by left hepatic vein, segment IV drained by middle hepatic vein. Segments V and VIII drained both by the right and left hepatic veins and segments VI and VII by the right hepatic vein, as shown in Figure 2. The length and diameters of major hepatic veins were analyzed using descriptive statistics. There was a significant difference observed in both the parameters ($P < 0.05$), as shown in Table 1.

DISCUSSION

In the present study, the most common variation observed was Type II with the absence of common trunk for middle and left hepatic veins and separate opening for the right hepatic vein was observed in 24 cases (30%). Type III (left common trunk formed by union of left hepatic vein and tributaries of middle hepatic vein) was observed in 8 cases (10%).

In the present study, the Type II drainage pattern of hepatic veins was in accordance with Thakre and Bhuiyan which

Figure 1: Measurements of hepatic veins by cast method

Table 1: Mean ±SD for length and diameters of major hepatic veins by cast and CECT scan method (*n*=80)

Parameters	Hepatic veins	Mean±SD	*P*-value
Length (in cm)	Middle hepatic vein	8.659±1.740	0.000**
	Left hepatic vein	9.90±1.170	0.000**
	Right hepatic vein	11.619±2.832	0.000**
Diameter (in cm)	Middle hepatic vein	0.901±0.168	0.000**
	Left hepatic vein	0.796±0.086	0.000**
	Right hepatic vein	1.123±0.729	0.000**

Indicates significant at $P<0.05$, **indicates significant at $P<0.01$

was reported as 11.66%. The study reported Mean ± SD of diameters of the right hepatic vein 10.98 ± 2.60, middle hepatic vein 8.82 ± 2.54, and left hepatic vein 8.20 ± 1.87 which slightly correlated with the present study.[12] Gupta *et al*. studied hepatic vein variations in 95 livers both by cast and radiological methods and reported that in 74 specimens (77.9%), the middle and right hepatovenous segments were separated by a right segmental plane. The major deviation in the relative sizes of the left, middle, and right hepatovenous segments was also observed.[13]

Sharma *et al*. studied on 100 cadavers by dissection method and study revealed that in 96% of cases, common trunk was found and the diameters of the right and left hepatic veins were 0.7 cm and 1.2 cm, respectively.[14] Ortale *et al*. reported that 77.5% of individuals showed common trunk formed by middle and left hepatic veins.[15] Makuuchi *et al*. reported that accessory right inferior hepatic veins directly draining inferior vena cava.[16]

In addition, the segmental venous drainage may also vary with different sectoral veins draining independently into the vena cava instead of draining into the right or the middle hepatic veins. Normally segment VIII and segment V veins drain into the middle hepatic vein and require reconstruction. The lifesaving procedure to prevent esophageal variceal bleeding in portal hypertension and in Budd-Chiari syndrome is transjugular intraportosystemic shunt which involves anastomosis of portal and hepatic vein.[17] The wide diameter and short length of major hepatic veins need vascular suturing during anastomosis. The anastomosis of common trunk of middle and left hepatic veins of the receiver liver and the cranial portion of inferior vena cava of the donor liver are one restoration technique of hepatocaval continuity in orthotopic liver transplantation. Hence, accurate knowledge of the hepatic venous anatomy of the liver is essential before planning not only a liver transplant operation but also any liver surgery. As detailed above, precise knowledge of major hepatic veins will help the surgeon to plan, modify as needed, and execute a complex surgery in a safe manner.

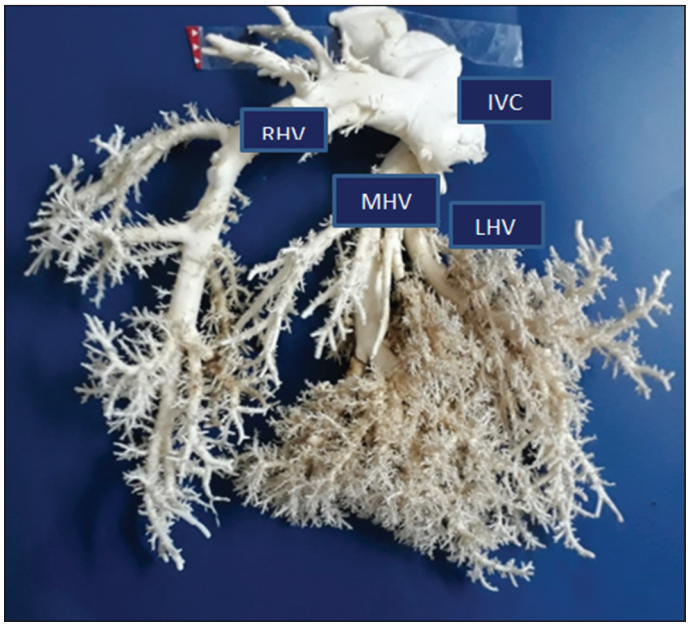

Figure 2: Ramification pattern of hepatic veins by cast method

Cast method allows visualization of three-dimensional organization of course, diameter, branches, and possible variants of vessels which is prerequisite for surgeons and radiologists.[18] The present study of variations and morphometry of hepatic veins is unique as we have adopted silicone gel method where in all the segmental veins can be visualized in detail. The measurements of diameters of veins are quite feasible compared to dissection method. The major limitation of the study is time consuming for the preparation of venous cast.

CONCLUSION

In hepatocellular carcinoma, liver resection is the first line of treatment. Adequate knowledge of normal vascular anatomy and any variation in its branching pattern will help in correct interpretation of radiological reports and planning of hepatobiliary surgeries. The cast method simulates computed tomography angiography and provides accurate information of existing vascular variants and morphometry of vessels which cannot be delineated by dissection method.

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How to cite this article: Vidya CS, Manjunatha B, Kumar MRS, Ravindranath R. Ramification pattern and morphometry of major hepatic veins of liver by silicone cast method: Its clinical relevance to liver surgeries. Int J Med Sci Public Health 2020;9(9):544-547.

Source of Support: Nil, **Conflicts of Interest:** None declared.