

ANATOMY OF THE INTRAHEPATIC RAMIFICATION OF THE INTERMEDIATE AND LEFT HEPATIC VEINS IN HUMANS*

José Roberto Ortale, Carolina Bonet, Patrícia Fernanda Frediani Prado and Andrea Mariotto

Faculty of Medicine, Pontifical Catholic University of Campinas, Campinas, SP, Brazil.

ABSTRACT

The intermediate and left hepatic veins and their tributaries were studied by anatomical dissection of 40 adult human cadaver livers which had been fixed in formalin solution. The intermediate and left hepatic veins and their tributaries showed four types of terminations. In types A, B, and C, the intermediate and left hepatic veins showed a common trunk in 31/40 or 77.5% of cases, that flowed into the inferior vena cava. Whereas in type A terminations (14/31 cases) the common trunk had no direct tributaries, in type B terminations (12/31 cases) the trunk received a tributary, and in type C terminations (5/31 cases), the common trunk and the left superior vein opened separately into the inferior vena cava. The diameter of the common trunk was 17.5 ± 4.3 mm and its length, 7.1 ± 2.8 mm. In type D terminations (9/40 or 22.5% of cases), the intermediate and left hepatic veins ended separately in the inferior vena cava. The diameter of the intermediate and left hepatic veins in 40 cases was 10.0 ± 2.5 mm and 10.7 ± 2.4 mm, respectively. The frequency and diameter of their tributaries were: right posterior medial vein - present in 25/40 or 62.5% of cases with a diameter of 5.5 ± 1.5 mm, left posterior medial vein - present in 22/40 or 55% of cases with a diameter of 4.6 ± 1.9 mm, left medial vein - present in 33/40 or 82.5% of cases with a diameter of 5.2 ± 1.6 mm, and left superior vein - present in 21/40 or 52.5% of cases with a diameter of 4.9 ± 2.1 mm.

Key words: Hepatic lobe, left liver, morphology, segmental division

INTRODUCTION

In this study, the liver segments were numbered according to Couinaud [3] and named according to the Federative Committee on Anatomical Terminology [6]. In this classification, the left liver included the left lateral division (the posterior lateral or S_2 segment and anterior lateral or S_3 segment) and the left medial division (the left medial segment, S_4). The left liver was drained by the intermediate and left hepatic veins, but the intermediate hepatic vein also drained part of the right medial division (the right posterior medial or S_8 and the right anterior medial or S_5 segments) and part of the right anterior lateral segment, S_6 , according to Hata *et al.* [10]. The most frequently found arrangement was either the intermediate hepatic and left hepatic veins presenting a common trunk IH-LH prior to opening into the inferior vena cava, or an anatomic variation of this. Both veins may empty separately into the inferior vena cava [2,11,13,17].

These authors studied the length of the common trunk IH-LH and the distance from the right posterior medial segmental vein, left medial vein and left superior vein to the common trunk IH-LH and to the inferior vena cava. Nakamura and Tsuzuki [13] described a classification based on the ramifications of intermediate and left hepatic veins located less than 1 cm from the inferior vena cava. This distance was considered the minimum space needed to control the vein. Wind *et al.* [17] provided an anatomo-clinical classification of the ramifications of the intermediate and left hepatic veins, based on the absence or presence of a common trunk IH-LH and on the existence of branches which emptied less than 1 cm from the opening of the common trunk or directly into the inferior vena cava. Honda *et al.* [11] established that a distance of 2.5 cm from the inferior vena cava was necessary to allow ligation of the left hepatic vein for left lateral segmentectomy or left lobectomy in living related hepatic transplantation.

The aim of this paper was to analyze the patterns of ramification of the intermediate and left hepatic veins in order to provide anatomical evidence that could support the transection of the left liver or its lateral division during surgery.

Correspondence to: Dr. José Roberto Ortale
Centro de Ciências da Vida, Pontifícia Universidade Católica de Campinas, Campus II, Av. John Boyd Dunlop, s/nº, CP 1111, Jd. Ipaussurama, CEP 13059-900, Campinas, SP, Brasil. Tel: (55) (19) 3729-8466, Telfax: (55) (19) 3279-8517, E-mail: ortalejr@uol.com.br

*This paper is dedicated to the memory of our colleague Prof. João Adolfo Caldas Navarro.

MATERIAL AND METHODS

Forty human adult disease-free livers, fixed in 10% formalin and preserved in 5% formalin, were studied. The livers originated from the Legal Medicine Institute in Campinas and from the Laboratory of Anatomy of the Pontifical Catholic University of Campinas. The intermediate and left hepatic veins and their tributaries, together with the portal branches were dissected following removal of the hepatic artery branches and bile ducts. The portal branches were identified according to the direction and location of their ramifications, based on Couinaud's hepatic segmentation. The three segments, left posterior lateral (S_2), left anterior lateral (S_3) and left medial (S_4), were identified. Since the intermediate hepatic vein also drained part of the right liver, its dissection was extended whenever necessary.

Dissection started on the visceral surface of the liver and accompanied the ramification of the hepatic veins as far as possible. A window was then opened in the diaphragmatic surface and dissection was continued until the branches dissected from the visceral surface were encountered.

The tributaries of the intermediate hepatic and left hepatic veins, i.e., right posterior medial vein, left posterior medial vein, left medial vein and left superior vein, were analyzed to within 2.5 cm from the inferior vena cava because 1.0 cm is the minimum length allowing control of the hepatic vein [13] and 2.5 cm is the critical area for left segmentectomy or left lobectomy [11].

The diameters of the intermediate and left hepatic veins and their tributaries were measured at the point where the veins ended. The following distances were also recorded: 1) from the inferior vena cava to the confluence of the intermediate hepatic and left hepatic veins with a common trunk IH-LH, 2) and 3) from the inferior vena cava to the right posterior medial vein and left posterior medial vein, respectively, and 4) and 5) from the confluence of IH-LH to the left medial vein and left superior vein, respectively. Measurements 2 and 3 were taken from the diaphragmatic surface and all others from the visceral surface of the liver, always at the superior contour of the vein (Fig. 1). The diameters of the venous branches were measured with a digital pachymeter and are reported as minimum, maximum and mean $\pm$ SD. A schematic representation of each specimen was made and some were photographed.

RESULTS

In all 40 cases, the intermediate hepatic and left hepatic veins drained the left liver. The intermediate hepatic vein drained the left medial segment (S_4) and part of the medial division of the right liver (S_5 and S_8); in 4 cases (10%) this vein also drained part of the right anterior lateral segment (S_6). The left hepatic vein drained the lateral division of the left liver (S_2 and S_3). In 31 cases (77.5%), the intermediate hepatic (IH) and left hepatic (LH) veins presented a common trunk IH-LH that emptied into the inferior vena cava. In 9 cases (22.5%), the intermediate hepatic and left hepatic veins ended separately in the inferior vena cava. The length of the common trunk

IH-LH in 31 cases in which it was present ranged from 2.8 - 16.0 mm (7.1 ± 2.8 mm). The posterior wall of the retrohepatic segment of the inferior vena cava was cut longitudinally and the distance from the ostia of the common trunk IH-LH and the right hepatic vein ranged from 0.9 - 20.3 mm (11.0 ± 3.5 mm).

The tributaries of the intermediate and left hepatic veins were: the right posterior medial, left posterior medial, left medial and left superior medial veins. The right posterior medial vein drained part of the corresponding segment (S_8) and it was present in 25 cases (62.5%). In 10 cases, it also drained the superior part of the left medial segment. In 19 cases, it ended mainly (12 cases) in the intermediate hepatic vein (Fig. 2a-

Figures 1- 5. Abbreviations: VC, inferior vena cava; IH, LH, intermediate and left hepatic veins; common trunk IH-LH, common trunk of the intermediate and left hepatic veins; LS, left superior vein; LM, left medial vein; LP, left posterior medial vein; RP, right posterior medial vein.

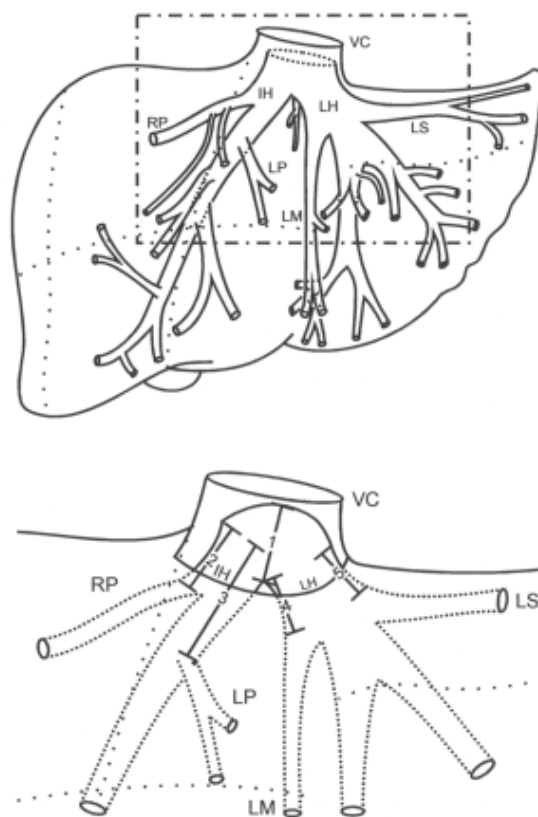


Figure 1 Schematic presentation of the following hepatic veins: intermediate hepatic, left hepatic, right posterior medial, left posterior medial, left medial and left superior. Representation of distances: 1 - from the inferior vena cava (VC) to the confluence of the intermediate and left hepatic veins; 2 and 3 - from the inferior vena cava to the right posterior medial vein and the left posterior medial vein, respectively; 4 and 5 - from the confluence of the intermediate and left hepatic veins to the left medial vein and the left superior vein, respectively.

d), which formed a common trunk IH-LH with the left hepatic vein and in 6 cases, it ended in the common trunk IH-LH (Fig. 2e,f). The distance from the right posterior medial vein to the inferior vena cava ranged from 4.6 to 23.8 mm (11.0 ± 5.2 mm).

The left posterior medial vein drained the posterior part of the left medial segment (S_4) and was present in 22 cases (55%). In 19 cases, it ended in the intermediate hepatic vein (Fig. 2c,d), which in 14 cases presented a common trunk IH-LH with the left hepatic vein and in 5 cases opened directly into the inferior vena cava (Table 1). The distance from the opening of the left posterior medial vein to the inferior vena cava ranged from 3.0 - 21.6 mm (12.2 ± 5.4 mm).

The left medial vein seen in 33 cases (82.5%) drained the lateral division of the left liver and may also have drained the adjacent region of the medial division of the left liver. In 26 of these cases, there was a common trunk IH-LH and in 21 cases the left medial vein opened into the left hepatic vein and in 5 cases into the intermediate hepatic vein. In these 26 cases which presented a common trunk, the distance from the left medial vein to the confluence IH-LH ranged from 1.0 - 19.1 mm (9.9 ± 4.6 mm) and this distance plus the length of the common trunk ranged from 7.8 to 24.3 mm (16.8 ± 5.1 mm). In six cases there was no common trunk IH-LH and the left me-

dial vein opened in four cases into the left hepatic vein and in two cases into the intermediate hepatic vein. In these six cases, the distance from the left medial vein to the inferior vena cava ranged from 3.4 to 24.4 mm (13.7 ± 6.9 mm). In one case, the left medial vein opened directly into the inferior vena cava.

The left superior vein drained the superior part of the anterior lateral segment (S_3) and was present in 21 cases (52.5%). In 10 cases, it opened into the left hepatic vein (Fig. 2e,f), which opened into the common trunk IH-LH. In these 10 cases, the distance from the left superior vein to the confluence IH-LH ranged from 1.3 - 17.9 mm (12.6 ± 5.6 mm) and this distance plus the length of the common trunk ranged from 8.2 - 24.5 mm (19.6 ± 5.3 mm). In six cases, the left superior vein opened into the common trunk IH-LH (Fig. 2a,b) in five cases and flowed into the left hepatic vein in one case; the latter vein ended directly in the inferior vena cava. In these six cases, the distance from the left superior vein to the inferior vena cava ranged from 4.2 - 8.2 mm (5.2 ± 1.5 mm). In 5 cases, the left superior vein opened separately into the inferior vena cava (Fig. 2c,d).

The ramifications of the intermediate hepatic vein and the left hepatic vein within 2.5 cm from the inferior vena cava were classified in four types. The explanation of types A-D is encountered in the figures 3-5.

Table 1. Anatomical classification of the intermediate and left hepatic veins.

Type	Veins opening into the inferior vena cava (IVC)	n	%	Diameter (mm)		Common trunk IH-LH	
				IH	LH	Diameter (mm)	Length (mm)
A	Only the common trunk IH-LH, which had no tributary less than 2.5 cm from the IVC	14	35.0	6.2-15.3 (10.9 $\pm$ 2.2)	7.2-14.0 (10.1 $\pm$ 1.9)	12.0-25.5 (17.2 $\pm$ 3.6)	2.8-8.5 (5.9 $\pm$ 1.7)
B	Only the common trunk IH-LH, which received one tributary less than 2.5 cm from the IVC	12	30.0	4.5-14.0 (8.8 $\pm$ 2.7)	6.6-15.3 (10.9 $\pm$ 2.7)	11.1-26.6 (18.2 $\pm$ 5.0)	5.2-16.0 (8.6 $\pm$ 3.4)
C	Common trunk IH-LH and the left superior vein	5	12.5	6.9-11.5 (9.6 $\pm$ 1.7)	7.6-13.2 (10.0 $\pm$ 2.4)	11.0-24.1 (16.8 $\pm$ 4.5)	4.0-10.1 (7.0 $\pm$ 2.1)
D	Intermediate and left hepatic veins, separately	9	22.5	7.2-15.3 (10.4 $\pm$ 2.6)	7.8-14.0 (11.4 $\pm$ 2.3)	—	—
Total		40	100	4.5-15.3 (10.0 $\pm$ 2.5)	6.6-15.3 (10.7 $\pm$ 2.4)	*11.0-26.6 (17.5 $\pm$ 4.3)	*2.8-16.0 (7.1 $\pm$ 2.8)

IH and LH - intermediate hepatic and left hepatic veins, respectively; Common trunk IH-LH - common trunk of the intermediate and left hepatic veins.

* Number of cases = 31

Table 1 shows the anatomo-clinical classification of the intermediate and left hepatic veins, the diameters of the intermediate hepatic and left hepatic veins,

and the diameter and length of the common trunk. Table 2 shows the mode of opening and diameter of the tributaries of the intermediate hepatic and left hepatic veins in types A-D.

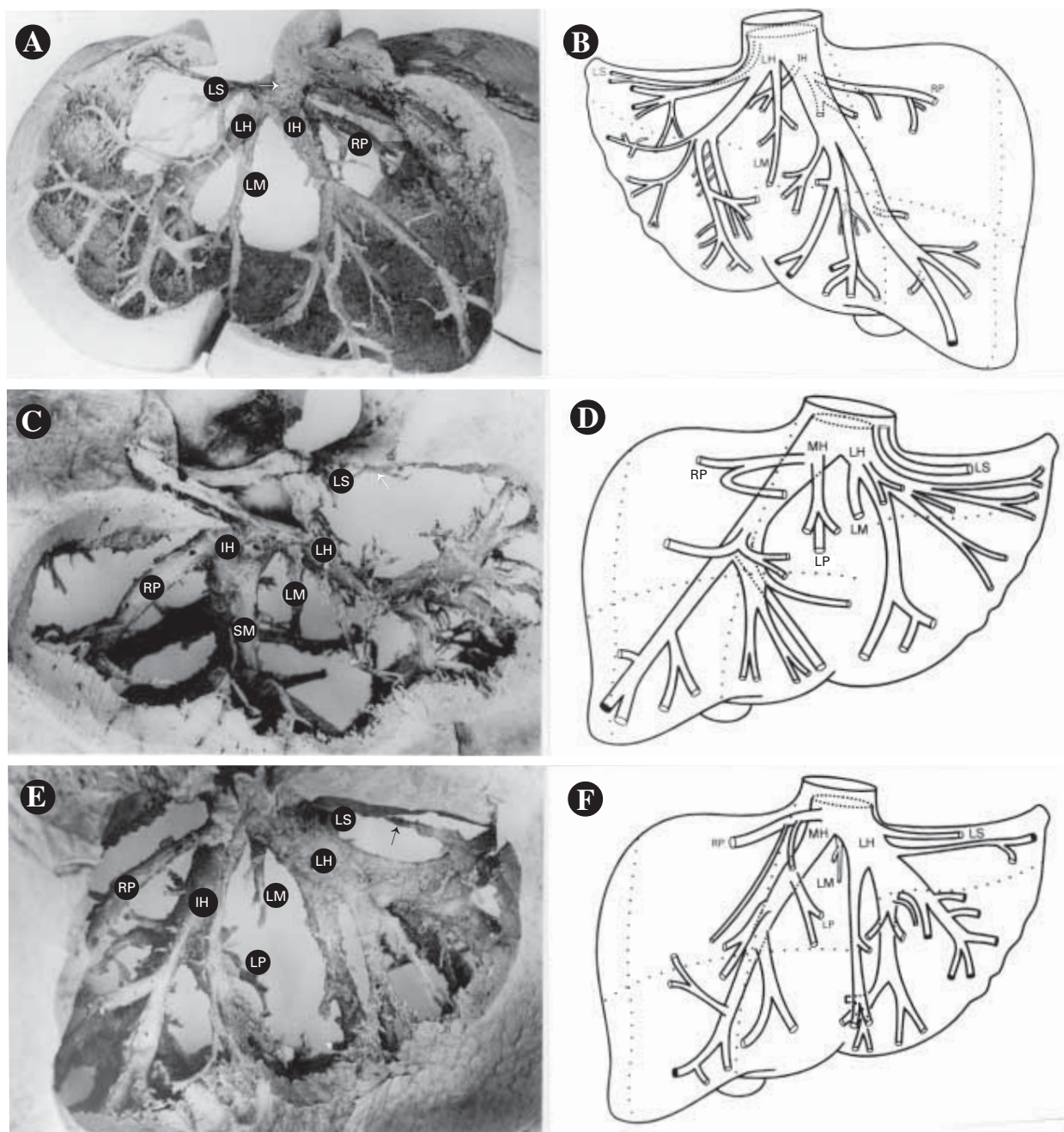


Figure 2. In these three cases the intermediate hepatic and left hepatic veins showed a common trunk IH-LH which emptied into the inferior vena cava. **A, B.** View of the liver from the visceral surface and schematic representation in posterior view. The left superior vein (arrow) emptied into the common trunk of the intermediate and left hepatic veins; the left medial vein emptied into the left hepatic vein and the right posterior medial vein into the intermediate hepatic vein. **C, D.** Upper view of the liver and schematic representation in anterior view. The right posterior medial and the left posterior medial veins opened into the intermediate hepatic vein; the left medial vein opened into the left hepatic vein. The left superior vein (arrow) emptied directly into the inferior vena cava. **E, F.** The right posterior medial vein emptied into the common IH-LH trunk; the left posterior medial vein opened into the intermediate hepatic vein, and the left medial vein as well as the left superior vein (arrow) ended in the left hepatic vein.

DISCUSSION

The diameters of the intermediate hepatic and left hepatic veins averaged 10.0 ± 2.5 mm and 10.7 ± 2.4 mm, respectively. These values were similar to the 10 mm mentioned by Appel and Loeweneck [1], but slightly higher than the 8.7 ± 1.8 mm and 8.6 ± 2.0 mm, respectively mentioned by Wind *et al.* [17].

The frequency of 77.5% we observed for the confluence of the intermediate hepatic vein with the left hepatic vein to form a common trunk IH-LH was within the range (50% - 95%) reported by others [2,4,11,13-15,17], the diameter of the common trunk IH-LH (17.5 ± 4.3 mm) was nearly identical to that verified by Nakamura and Tsuzuki [13], i.e., $17.0 \pm$

Table 2. Direction of flow and diameter of the tributaries of the intermediate and left hepatic veins within 2.5 cm the inferior vena cava, classified according to the types of terminations (40 cases).

Veins	Type A				Type B					
	Cases	IH/CT	LH/CT	Diameter (mm)	Cases	CT/VC	IH/CT	LH/CT	Diameter (mm)	
Right post. medial	7	7	–	2.8–6.5 (4.9±1.5)	9	6	3	–	3.5–8.2 (5.9±1.6)	
Left post. medial	7	6	1	2.7–10.3 (5.8±2.5)	6	1	5	–	2.3–5.1 (3.4±0.9)	
Left medial	10	2	8	3.1–8.3 (6.1±1.5)	11	–	2	9	3.0–7.7 (4.7±1.3)	
Left superior	7	–	7	4.4–10.2 (6.5±2.1)	8	5	–	3	2.3–8.2 (4.4±1.8)	
Veins	Type C					Type D				
	Cases	VC	IH/CT	LH/CT	Diameter (mm)	Cases	VC	IH/VC	LH/VC	Diameter (mm)
Right post. medial	2	–	2	–	6.4–6.7 (6.6±0.2)	7	–	7	–	2.9–7.3 (5.3±1.5)
Left post. medial	3	–	3	–	4.2–6.4 (5.2±0.9)	6	–	6	–	2.5–6.4 (4.0±1.3)
Left medial	5	–	–	5	3.1–6.0 (4.1±1.1)	7	1	2	4	2.7–9.3 (5.7±1.9)
Left superior	5	5	–	–	2.9–4.9 (3.6±0.7)	–	–	–	1	–
TOTAL										
Veins										
	Cases	%	VC	CT/VC	IH/CT	LH/CT	IH/VC	LH/VC	Diameter (mm)	
Right post. medial	25	62.5	–	6	12	–	7	–	2.8–8.2 (5.5±1.5)	
Left post. medial	22	55.0	–	1	14	1	6	–	2.3–10.3 (4.6±1.9)	
Left medial	33	82.5	1	–	4	22	2	4	2.7–9.3 (5.2±1.6)	
Left superior	21	52.5	5	5	–	10	–	1	2.3–10.2 (4.9±2.1)	

VC: inferior vena cava; CT/VC: common trunk between the intermediate hepatic and the left inferior vena cava; IH/CT: intermediate hepatic vein that opened into the common trunk; LH/CT: left hepatic vein that opened into the common trunk; IH/VC: intermediate hepatic vein that opened into the inferior vena cava; LH/VC: left hepatic vein that opened into the inferior vena cava; post.: posterior.

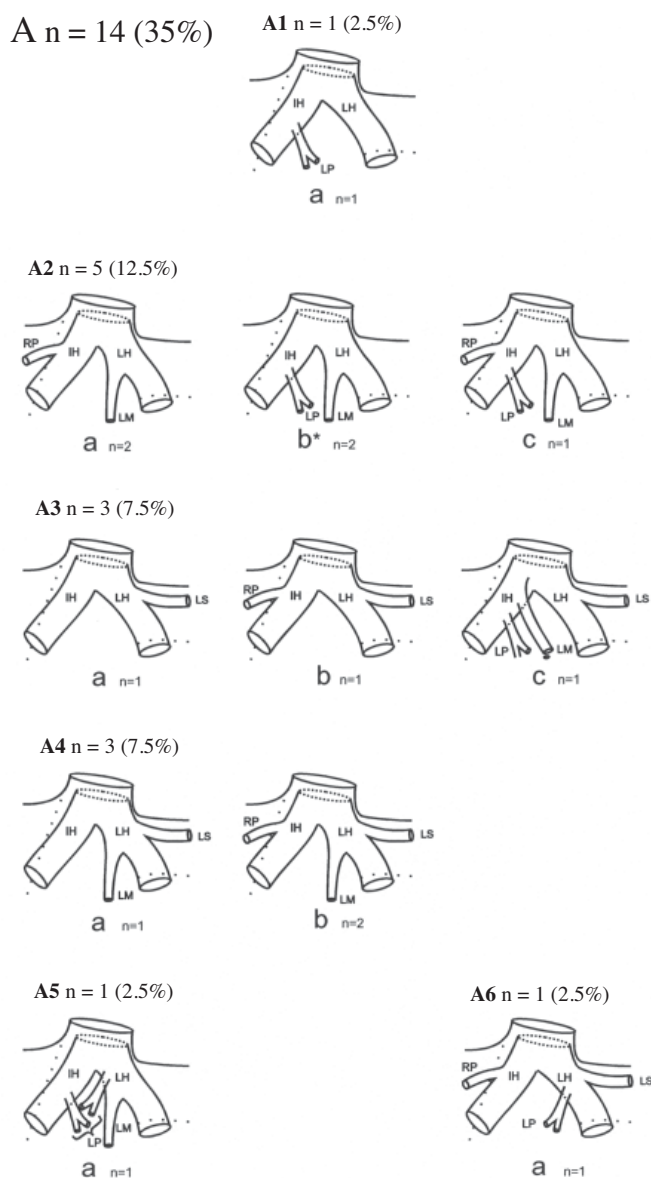


Figure 3. Anatomical classification of the ramifications of the intermediate hepatic vein and the left hepatic vein within 2.5 cm from the inferior vena cava: type A. In this type, the intermediate hepatic and left hepatic veins had a common trunk IH-LH, which ends in the inferior vena cava, without tributaries. No tributaries emptied directly into the inferior vena cava. Type A terminations were subdivided into six subtypes, based on the ramifications of the left hepatic vein: type A1 had no tributaries emptying into the left hepatic vein, and type A2 - contained a bifurcation consisting of the left medial and left hepatic veins; the asterisk in A2b indicates that in one case there were two left posterior medial veins. Type A3 had a bifurcation consisting of the left superior and left hepatic veins; type A4 had a trifurcation consisting of the left medial, left superior and left hepatic veins; type A5 had a trifurcation of the left medial, left posterior medial and left hepatic veins; and type A6 had a trifurcation consisting of the left superior, left posterior medial and left hepatic veins.

5.0 mm. Likewise, the length of the common trunk IH-LH (7.1 ± 2.8 mm) was practically equal to the values recorded by Honda *et al.* [11] but less than those obtained by Cheng *et al.* [2] and Nakamura and Tsuzuki [13]. Honda *et al.* [11] considered 10 mm to be a sufficient length of the common trunk IH-LH for safe division of the left hepatic vein. The length of this trunk was higher than 10 mm in 10% of the cases, although one tributary emptied in the trunk within 10 mm of the inferior vena cava. This frequency was 9.4% in the cases reported by Wind *et al.* [17] and 3.3% in those reported by Honda *et al.* [11].

The frequency of 62.5% for the right posterior medial vein, denominated right anterior superior vein by Nakamura and Tsuzuki [13], was similar to the 64% verified by Wind *et al.* [17] but greater than the 32% verified by Cheng *et al.* [2]. In our cases, the distance from the right posterior medial vein to the inferior vena cava was 11.0 ± 5.2 mm, a little less than the 14.0 ± 10.0 mm mentioned by Nakamura and Tsuzuki [13].

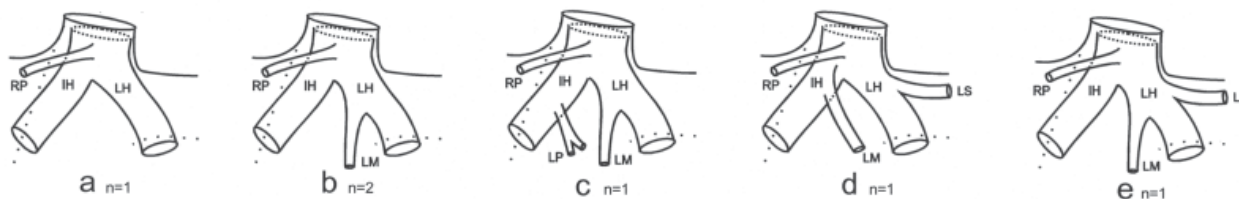
The left posterior medial vein, designated left superior medial vein [13], was present in 22 (55%) of our cases. This vein was different from the right posterior medial vein, since it exclusively drained the posterior region of the medial segment (S_{4a}). The latter vein, which was present in 25 cases, drained only the right posterior medial segment (S_8) in 15 cases and predominantly the S_8 segment, as well as a part of the posterior region of the medial segment (S_{4a}) in 10 cases.

The left medial vein was present in 82.5% of our cases and in 50.3% of the cases reported by Honda *et al.* [11]. The distance to the confluence IH-LH or to the inferior vena cava was of 1.0 – 24.4 mm (10.5 ± 5.2 mm), values similar to 1.0 – 23.0 mm (9.2 ± 5.3 mm) reported by Honda *et al.* [11]. In agreement with these authors, 10 mm was a sufficient length for the safe division of the left hepatic vein. These authors reported a length $\leq$ than 10 mm in 29.8% of the livers, compared to value of 42.5% in our cases. The left medial vein ended in the intermediate hepatic vein in 10% of our cases, a percentage slightly higher than the 7% verified by Nakamura and Tsuzuki [13] and Cheng *et al.* [2].

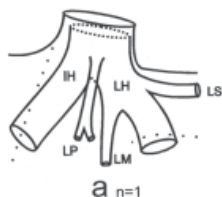
The left superior vein was present in 55% of our cases and in 29.8% of the cases reported by Honda *et al.* [11]. The distance from the left superior vein to the confluence IH-MH or to the inferior vena cava ranged from 1.3 to 17.9 mm (10.6 ± 5.9 mm), values nearly equal to the 1.0 to 21.0 mm (11.3 ± 5.0 mm)

B n = 12 (30%)

B1 n = 6 (15%)



B2 n = 1 (2.5%)



B3 n = 5 (12.5%)

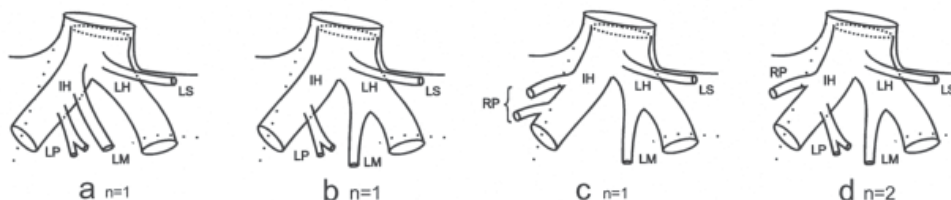


Figure 4. Anatomical classification of the ramifications of the intermediate hepatic vein and the left hepatic vein within 2.5 cm of the inferior vena cava: type B. In this type, the intermediate hepatic and left hepatic veins had a common trunk IH-LH, which had one tributary; no tributary ended directly in the VC. Type B terminations were subdivided into three subtypes, according the vein emptying into the common trunk IH-LH, i.e.: B1 when the tributary of the common trunk was the right posterior medial vein, B2 when this tributary was the left posterior medial vein, and B3 when it was the left superior vein.

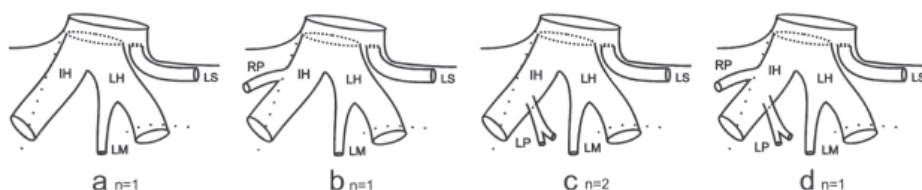
verified by Honda *et al.* [11]. These authors reported a length $\leq$ than 10 mm in 9.9% of the livers, while in our series this percentage was 17.5%. Consequently, the frequency with which this tributary flowed from a distance of > 10 mm from the confluence IH-LH, was significantly higher, and allowed ligation of the left hepatic vein, as previously described [13]. The left superior vein ended directly in the inferior vena cava in 12.5% of our cases, a frequency higher than the 7% mentioned by Nakamura and Tsuzuki [13] and the 1.3% reported by Honda *et al.* [11].

To compare our patterns of the mode of termination of the intermediate and left hepatic veins to those of Honda *et al.* [11], who used ultrasonography, we considered only the left hepatic vein and its tributaries, i.e., the left medial and left superior veins. Of our 40 cases, 21 (52.5%) were type A, 5 (12.5%) were type B, 5 (12.5%) were type C and 9 (22.5%) were type D. The respective values reported by Honda *et al.* [11] for 151 cases were: 109 cases (72.2%), 2 cases (1.3%), 0 cases (0%) and 40 cases (26.5%). Thus,

only in type D, where the intermediate hepatic and left hepatic veins ended separately, were our percentages approximately equal to those of Honda *et al.* [11]. The anatomical differences observed probably reflected the use of different methods. Furthermore, the portography during computerized tomography utilized by some authors [15,16] allows the detection of fine branches if the photographic angle is adequate. According to Franceschini and Ortale [7], direct dissection [13,14] is more reliable for the analysis of anatomical arrangements than indirect methods such as the injection of acrylic resin into the vessels followed by corrosion [5,6,8]. However, as noted by Hata *et al.* [9], the advantages and limitations of each method must be understood.

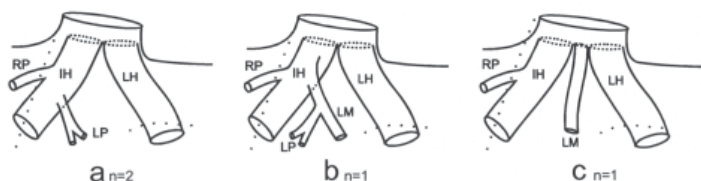
Several authors [5,8,12,16] have mentioned the presence of anastomoses between the hepatic veins or between their tributaries. Although we observed the confluence of the intermediate hepatic and left hepatic veins to form the common trunk IH-LH, we found no anastomoses between their tributaries.

C n = 5 (12.5%)



D n = 9 (22.5%)

D1 n = 4 (10%)



D2 n = 4 (10%)



D3 n = 1 (2.5%)

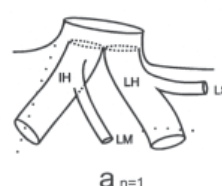


Figure 5. Anatomical classification of the ramifications of the intermediate hepatic and the left hepatic veins within 2.5 cm of the inferior vena cava: types C and D. Type C: the common trunk IH-LH and the left superior vein opened into the inferior vena cava. There were no subtypes, because only the left medial vein ended in the left hepatic vein. Type D: the intermediate hepatic and left hepatic veins opened separately into the inferior vena cava. This subtype was subdivided into three subtypes, according to the tributaries of the left hepatic vein: D1 had no tributary flowing into the left hepatic vein, D2 had a bifurcation consisting of the left medial and left hepatic veins, and D3 consisted of a bifurcation composed of the left superior and left hepatic veins. In one case, the left medial hepatic vein ended directly in the inferior vena cava.

REFERENCES

- Appel M, Loeweneck H (1987) Course and anastomoses of the large hepatic veins to main structures on the liver surface. *Chirurgie* **58**, 243-247.
- Cheng YF, Huang T, Chen CL, Chen TY, Huang CC, Ko SF, Lee TY (1996) Variations of the left and middle hepatic veins: application in living related hepatic transplantation. *J. Clin. Ultrasound* **24**, 11-16.
- Couinaud C (1957) *Le Foie: Études Anatomiques et Chirurgicales*. Masson: Paris.
- Czerniak A, Lotan G, Hiss Y, Shemesh E, Avigadi I, Wolfstein I (1989) The feasibility of in vivo resection of the left lobe of the liver and its use for transplantation. *Transplantation* **48**, 26-32.
- Elias H, Sherrick JC (1969). *Morphology of the Liver*. Academic Press: New York.
- Federative Committee on Anatomical Terminology (1998) *International Anatomical Terminology*. Thieme: Stuttgart.
- Franceschini LJ, Ortale JR (1995) Ramification of the portal veins at the porta hepatis in humans. *Surg. Radiol. Anat.* **17**, 35-39.
- Gupta SC, Gupta CD, Gupta SB (1981) Hepatovenous segments in the human liver. *J. Anat.* **133**, 1-6.
- Hata F, Hirata K, Murakami G, Mukaiya M (1999) Identification of segments VI and VII of the liver based on ramification patterns of the intrahepatic portal and hepatic veins. *Clin. Anat.* **12**, 229-244.
- Hata F, Murakami G, Hirata K, Kitigawa S, Mukaiya M (1999) Configuration of hepatic veins in the right surgical lobe of the human liver with special reference to their complementary territorial relationships. *Okajimas Folia Anat. Jpn.* **76**, 1-16.
- Honda H, Yanaga K, Onitsuka H, Kanero K, Murakami J, Masuda K (1991) Ultrasonographic anatomy of veins draining the left lobe of the liver. *Acta Radiol.* **32**, 479-484.
- Kennedy PA, Madding GF (1977) Surgical anatomy of the liver. *Surg. Clin. North Am.* **57**, 233-245.
- Nakamura S, Tsuzuki T (1981) Surgical anatomy of the hepatic veins and the inferior vena cava. *Surg. Gynec. Obstet.* **152**, 43-50.
- Pérez JMF, Pérez RC, Muro R, Aguila A, Callaba LE (1986) Anatomia quirúrgica del hígado. *Rev. Cub. Cir.* **25**, 390-396.
- Soyer P, Bluemke DA, Choti MA, Fishman EK (1995) Variations in intrahepatic portions of the hepatic and portal veins. *Am. J. Radiol.* **164**, 103-108.
- van Leeuwen MS, Noordzij J, Fernandez MA, Hennipman A, Feldberg MAM, Dillon EH (1994) Portal venous and segmental anatomy of the right hemiliver. *Am. J. Radiol.* **163**, 1395-1404.
- Wind P, Douard R, Cugnenc PH, Chevalier JM (1999) Anatomy of the common trunk of the middle and left hepatic veins: application to liver transplantation. *Surg. Radiol. Anat.* **21**, 17-21.

Received: October 23, 2002

Accepted: January 6, 2003