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An applied anatomical study of the ostia venae hepaticae and the retrohepatic segment of the inferior vena cava*

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INTRODUCTION

The openings of hepatic veins into the retrohepatic segment of the inferior vena cava (IVC), i.e. the ostia venae hepaticae, are not only structures playing a part in controlling the hepatic circulation (Gibson, 1959), but are also of importance during catheterisation to determine the hepatic and sinusoidal pressures and in selective hepatic venography (Chermet & Bigot, 1980; Wang, 1982). Moreover, they are also relevant to resection of parts of the diseased liver (Dong & Lin, 1978) and the removal of a long segment of the IVC (Nakamura & Tsuzuki, 1981) during liver transplantation. In order to clarify the pattern of drainage of the hepatic veins into the IVC, the calibre, position and region of drainage of the hepatic veins were determined and the morphology of the retrohepatic segment of the IVC was recorded.

MATERIALS AND METHODS

Sixty livers of adult cadavers, free from gross pathological changes, were taken at random for study. The axial direction of the retrohepatic segment, as well as its length, the antero-posterior diameter of the superior opening and the extent of exposure of its posterior wall were determined. If the particular segment was encircled by liver substance, the thickness and height of the latter were also measured. This was followed by opening the posterior wall of the IVC to measure the openings of the hepatic veins. The openings, being mostly oval in shape, were classified as large with the longer diameter over 1 cm, as medium with the longer diameter from 0·5 cm to 1 cm and as small with the longer diameter less than 0·5 cm. The internal wall of the retrohepatic segment of the IVC was divided into sixteen areas which were used to record the sites of the openings of hepatic veins. Finally, probes were inserted along the lower margins of the openings of the hepatic veins to determine the region of drainage and to measure the angles formed by the left, middle and right hepatic veins respectively with the IVC as well as with the sagittal plane.

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Table 1. *Total number of large, medium and small openings, their percentages and average number per liver*

Names of veins	Types of openings of hepatic veins (no. of cases)			
	SLO	ILO	Medium openings	Small openings
Right hepatic (RHV)	58	—	—	—
Middle hepatic (MHV)	7	—	—	—
Left hepatic (LHV)	7	—	—	—
Joined MHV and LHV	53	—	—	—
Right postero-inferior	—	17	26	—
Caudate	—	7	46	—
Right postero-superior	—	6	15	—
Right superior	—	1	5	—
Right postero-lateral	—	1	6	—
Right postero-intermediate	—	—	1	—
Total of openings	125	32	99	236*
Percentage	31·91		20·12	47·97
Average per liver	2·62		1·65	3·93

* Since it is difficult to distinguish different veins with small openings, only a mean total of the latter is given.

Table 2. *The combination pattern of SLO*

Combination patterns	Patterns of opening (cases)		
	Triple-type	Double-type	Single-type
Right hepatic vein + joined MHV and LHV	—	52	—
Separate openings of left, middle and right hepatic veins	6	—	—
Left hepatic vein + middle hepatic vein, without right hepatic vein	—	1	—
Joined MHV + LHV, without right hepatic vein	—	—	1
Total number of cases	6	53	1
Percentage	10·00	88·33	1·67

RESULTS

Retrohepatic segment of IVC

The average length of the retrohepatic segment was 7·1 cm; the direction of the axis was vertical in 5 cases (8·33%) and obliquely upwards towards the left in 10 cases (16·67%). It was curved towards the left in 45 cases (75·00%). The IVC was totally enclosed by liver substance in 4 cases (6·67%). The posterior wall of the tunnel in these cases was an average of 0·5 cm in thickness, with a mean height of 2·5 cm. Those segments of the IVC that were incompletely embedded in liver substance amounted to 93·33%. The width of the posterior wall exposed was 1·2 cm on average.

The right to left diameter of the upper opening of the segment was large, the antero-posterior diameter being 1·8 cm.

Table 3. *The diameters of the openings of hepatic veins and their relevant measurements*

Openings of hepatic veins	Longer diameter (cm)	Shorter diameter (cm)	Angle between vein and sagittal plane (degrees)	Angle between vein and wall of IVC (degrees)
Large openings:	1·6	0·9	—	—
SLO				
Right hepatic	1·8	1·0	41·9	28·2
Middle hepatic	1·0	0·6	24·4	34·1
Left hepatic	0·9	0·7	33·3	42·1
Joined MHV and LHV	1·6	1·1	48·6(LHV) 27·8(MHV)	54·1(LHV) 36·8(MHV)
ILO	1·3	0·6	—	—
Medium openings:	0·7	0·4	—	—
Right postero-inferior	0·7	0·4	—	—
Caudate	0·7	0·4	—	—
Right postero-superior	0·6	0·4	—	—
Right superior	0·6	0·4	—	—
Right postero-lateral	0·7	0·3	—	—
Right postero-intermediate	0·6	0·4	—	—
Small openings	—	—	—	—

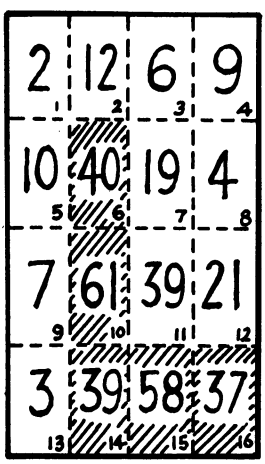

Fig. 1. Number of ILO, medium and small openings. In Figs. 1–4 the openings of the hepatic veins are indicated on the inner surface of the retrohepatic segment of the IVC which has been divided into 16 areas.

The openings of the hepatic veins

Altogether 492 openings were observed, averaging 8·2 per liver (Table 1). There were two types of large openings: one type was found at the upper end of the groove for the IVC, and showed openings that were either separate or common to the left (LHV), middle (MHV) and right (RHV) hepatic veins. These were named the superior large openings (SLO). There were 125 SLO in 60 cases (25·41 %), belonging mostly to the type of double-opening (Table 2). The other type was named the inferior large opening (ILO), situated below the plane of the SLO in the middle and lower parts of the segment. There were 24 cases (40·00 %) in which 32 ILO were found, of which more than half were openings of the right postero-inferior vein (Table 1).

There were 51 cases (85·00%) with medium openings, most of which were those of the caudate veins (Table 1). Next were those of the right postero-inferior veins, right postero-superior veins, right postero-lateral veins, right superior veins and right postero-intermediate veins.

Small openings occurred in 50 cases (83·33%) with an average of 3·93 per liver.

The ILO and medium openings occurred in 57 cases so that 95% of the livers observed had such openings.

The calibres and relevant measurements of the openings of hepatic veins are presented in Table 3.

The longer diameters of large openings were generally over 1 cm, except for those of the left hepatic veins, which varied around 1 cm. The angles between the large hepatic veins and the wall of the IVC, as well as between the veins and the sagittal plane, are shown in Table 3. The sites of the openings of the hepatic veins are depicted in Figure 4.

DISCUSSION

Types of openings of hepatic veins

The openings of hepatic veins are divided into large, medium and small. The longer diameters of the large openings average 1·3 cm. The large openings, like the medium and small openings may be found in the upper, middle or lower parts of the retrohepatic segment of the IVC so that it is not true to say that the large openings are present in the upper part of the segment and the small ones in the lower part. The presence of SLO as well as ILO is of significance in liver surgery and during hepatic pressure measurement or venography.

The SLO of a single liver may be classified into four types, i.e. single-opening, double-opening, triple-opening and, occasionally, quadruple-opening (Guo, 1981). In this study, 88·33% of the openings belong to the double-opening type, which, itself, shows two patterns: one consists of openings of the right hepatic vein and combined middle and left hepatic veins and the other including the openings of left and middle hepatic veins in the absence of the opening of the right hepatic vein. In view of the presence of other patterns, it is suggested that the SLO of the double-opening type should be called the left and right ostium respectively. This was, indeed, the nomenclature used by Gibson (1959), according to whom the diameter of the left ostium is about 13 mm and that of the right about 15 mm. In the present study, the left ostia, i.e. openings of the combined MHV and LHV, have a longer diameter of 1·6 cm, those of the right ostia, i.e. openings of the right hepatic veins, being 1·8 cm. The former amount to 86·67%, approaching what Nakamura & Tsuzuki (1981) reported, i.e. 84·34%.

Positions of the openings of hepatic veins

Superior large openings (SLO) occur on the upper one quarter of the retrohepatic segment of the IVC. Approximately two thirds (64·03%) of the openings of other hepatic veins (ILO, medium and small openings) occur on the left anterior wall of the retrohepatic segment of the IVC as well as in its lower one quarter (Areas 2, 6, 10, 14, 15 and 16 in Fig. 1). Of the ILO, 59·38% are located on the lower one quarter of the right half of the retrohepatic segment (Areas 15 and 16 in Fig. 2) while 71·72% of medium openings occur on the middle two fourths of the left anterior wall and the lower one fourth of the right half of the retrohepatic segment (Areas 6, 10, 15 and 16

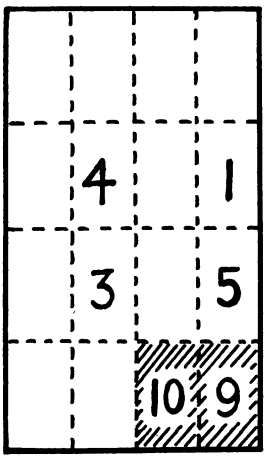

Fig. 2. Distribution and number of ILO.

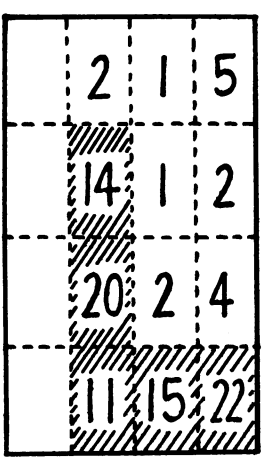

Fig. 3. Distribution and number of medium openings.

in Fig. 3). Thus, the left anterior wall and the lower quarter of the right half of the wall of the retrohepatic segment of the IVC may be considered as the regions where openings of hepatic veins are particularly likely to be found.

Hepatic veins

The ILO and medium openings observed in this study are the openings of the right postero-inferior veins, caudate veins ('dorsal veins' and 'accessory hepatic vein' of Chermet & Bigot, 1980), right postero-superior veins, right superior veins, right postero-lateral veins and right postero-intermediate veins. Their incidences are respectively 65·00%, 83·33%, 31·67%, 10·00%, 11·67% and 1·67%. They have been reported elsewhere (Chermet & Bigot, 1980; Nakamura & Tsuzuki, 1981; Williams & Warwick, 1980; Elias & Petty, 1952; Goldsmith & Woodburne, 1957; Gupta, Gupta & Gupta, 1981; Kennedy & Medding, 1977) but without specific reference to the sites of their openings or accurate descriptions. The present study reveals that each of the

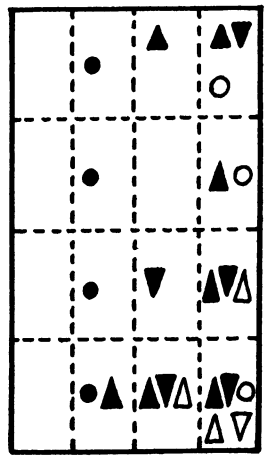

Fig. 4. Points of openings of hepatic veins. ●, caudate veins; ▲, right postero-superior veins; ▼, right postero-inferior veins; ○, right superior veins; △, right postero-lateral veins; ▽, right postero-intermediate veins.

hepatic veins has a main area of drainage in the retrohepatic segment of the IVC (Fig. 4), e.g. 86·05% of the right postero-inferior veins open into the lower quarter of the right half of the wall of the retrohepatic segment while the caudate lobe, being an independent segment (Chermet & Bigot, 1980; Goldsmith & Woodburne, 1957; Bismuth, 1982), has a draining vein of its own; all of the openings, medium or large, occur on the left anterior wall, because the caudate lobe is situated to the left of the retrohepatic segment. Those veins other than the caudate vein mainly open into the lower quarter of the right half of the wall of the retrohepatic segment. The opening of the right postero-inferior vein may be the largest of the ILO, the longer diameter of which may reach 1·85 cm. This approaches closely Nakamura's figure of 1·8 cm. The hepatic veins that drain the right posterior segment of the liver are apt to open independently.

Those hepatic veins with superior large openings have other particular features. Apart from the middle hepatic vein, the upper margins of the openings of the right and left hepatic veins are generally slightly above the level of the superior surface of the liver. This means that the terminal segments of these veins have part of their walls exposed above the substance of the liver. This is inconsistent with the statement that hepatic veins have no extrahepatic course (Romanes, 1981), but agrees with the observations of Nakamura & Tsuzuki (1981). The terminal segment of the left hepatic vein is exposed to a much greater extent than that of other hepatic veins. This is worthy of special attention in liver surgery.

The direction of the axis of the retrohepatic segment is mostly of the left curving type (75·00%) or the left oblique type (16·67%), while the vertical type is relatively uncommon (8·33%). Because of its left curving direction, a cross-section of the superior opening at the upper surface of the liver appears oval rather than round, with its left-to-right diameter greater than its antero-posterior diameter. The average antero-posterior diameter of the superior opening of the retrohepatic segment observed in this study was 1·8 cm. This seems to be smaller than that reported by other workers (Nakamura & Tsuzuki, 1981). who found it to measure 2·5–4·5 cm. This may be due to differences in the method of measurement. The length of the retrohepatic segment of the IVC observed in this study is 7·1 cm, while that reported by other

workers is 8·14 cm (Zhao, Kong, Yang & Ling, 1980). Although a retrohepatic segment completely surrounded by liver substance was only found in 6·67% of cases, the height and thickness of the posterior wall of the tunnel is worth mentioning in relation to liver surgery.

SUMMARY

In sixty normal adult livers the retrohepatic segment of the inferior vena cava was found mostly to assume a curve to the left (75·00%). This segment has a length of 7·1 cm and is totally encircled by liver substance in 6·67% of cases.

Altogether 492 ostia venae hepaticae were studied, averaging 8·2 per liver and classified as large, medium and small. The large ostia are divided into superior (SLO) and inferior (ILO) openings. The SLO are found opening into the upper end of the hepatic segment of the inferior vena cava, frequently with part of the venous walls exposed outside the liver. The ILO and medium ostia are present in 95% of the livers, appearing mainly on the lower quarter of the right half of the wall of the retrohepatic segment of the inferior vena cava as well as on the left anterior wall of that segment. The ILO may serve as the exit for several hepatic veins and they may be multiple. Their significance in respect of liver surgery is discussed.

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