

Morphological Variability of the Hepatic Portal Vein Posterior Branch: Study on Corrosion Casts

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The liver segmentation is determined by the distribution of the vascular and ductal hepatic elements; from this, the hepatic portal vein (HPV), the central element of liver afferent pedicle, is the most important. The posterior branch (PB) is serving right lateral division (RLD) of the liver and presents the lowest morphological variability. On a total of 125 pieces of liver corrosion casts, one examined the intraparenchymal distribution of portal PB and the segmentation of RLD. Regarding the intraparenchymal distribution of the branches in the RLD of the liver, we showed four distinct morphological types: Type I (77.6% of cases) in which the PB bifurcate symmetrically in branch of segments VI and branch of segment VII; Type II (8.8% of cases) in which the PB bifurcate in branch of segment VII and an inferior branch, that bifurcate branch of segment VI and branch of segment VIA; Type III (12.8% of cases) in which the PB bifurcate in branch of segment VI and a superior branch, that bifurcate in branch of segment VII and branch of segment VIIA; Type IV (0.8% of cases) in which the PB trifurcate in branch of segment VI, branch of posterior intermediate segments, and branch of segment VII. Knowledge of these morphological types of portal PB is important for clinical and surgical practice.

Keywords: corrosion casts; hepatic portal vein; posterior branch; variability; morphological typologies

Knowing the internal organization of the liver parenchyma, intraparenchymal distribution of the vascular-ductal elements of afferent and efferent pedicles, and therefore knowledge of liver parenchyma segmentation variability, is essential for localisation of focal hepatic pathology before surgical or percutaneous interventions [1, 2].

In the case of the liver and other organs equipped with hilum, which enter or leave vascular and ductal elements [3 - 6], a system of lobes and other divisions (divisions, sectors segments and sub-segments) [7, 8] is described. Size and hence the number of these volumes of parenchyma depends on the size of anatomical elements recognized as “segmental”, or in other words, the level of the vascular or ductal arborisation arbitrarily taken into account [7].

As described in the studies of Couinaud in 1966 [9], the elements of liver pedicles (afferent and efferent) are like the crossed fingers of two hands, and in the same way, in the fissures of one segmentation is located the main pedicle of another segmentation.

A new model is the presentation of liver segments overlaid on right hand model [2, 10], in which with finger tight fist, thumb represents the caudate lobe, located in the rear of the other four fingers of the hand, and the fingers 2-5 represent each a division of hepatic parenchyma. The limit of proximal interphalangeal joint represent the limit between the upper (II, IVA, VIII and VII) and lower segments (III, IVB, VI and VI).

The right lateral division (RLD) of the liver is less subject to morphological segmentation variations. In the literature, the RLD is described as unique segment in the studies of Rex in 1888 [11], Hjorstjö in 1948 [12], Diaconescu in 1963 [13], Platzer and Maurer in 1966 [14], as well in Nomina Anatomica in 1989 [15]. Presence of two distinct segments in the liver RLD was described by Healey et al. in 1953 [16], Couinaud in 1954 [17] and 1957 [18], Reiferscheid in 1957 [19], Ciobanu in 1958 [20] and Lanz and Wachsmuth in 1993 [21].

The present study seeks to highlight the segmentation of the RLD of the liver depending on the intraparenchymal distribution of portal posterior branch on a significant number of liver corrosion casts.

Experimental part

In this study, 125 human hepatic portal vein (HPV) system corrosion casts (focused on the right branch and PB of the HPV) were investigated. The liver corrosion casts were prepared in the Department of Anatomy of the “Victor Babes” University of Medicine and Pharmacy Timisoara, between 1997 and 2012. For an accurate morphological study, the liver pieces were harvested from human subjects who had no history of any medical or surgical liver diseases. Between 1997 and 2005, the injection of the liver vascular-ductal systems was performed with AGO II mass (nitrocellulosic paste); between 2006 and 2012, Technovit 7143 (methacrylate copolymers) was used. The

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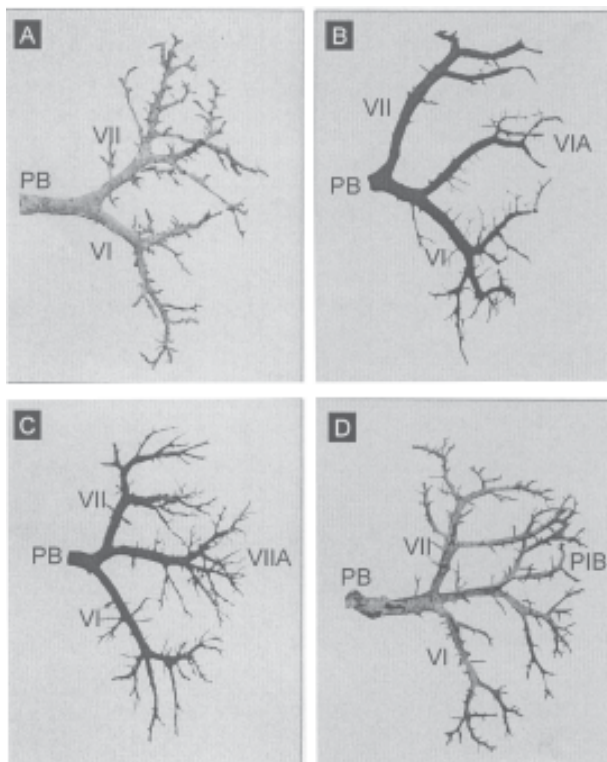


Fig.1. Corrosion cast of portal posterior branch - posterior view. The four distinct morphological types: A - type I, B - type II, C - type III, D - type IV.

PB - portal posterior branch, VI - branch of segment VI, VIA - branch of segment VIA, VII - branch of segment VII, VIIA - branch of segment VIIA, PIB - posterior intermediate branch.

corrosion process of the liver parenchyma was performed for 5 - 7 days using technical hydrochloric acid in three successive baths, alternating with wash water for quicker elimination of liver parenchyma. All procedures for crop the liver pieces and performing the corrosion casts were approved by the Ethics Committee of the "Victor Babes" University of Medicine and Pharmacy, Timisoara, before harvest time. The liver corrosion casts were photographed by the same distance to the photo camera with focal lens length of 50mm. The studied liver corrosion casts were classified according to the present type of origin level of portal PB and major distribution variation.

Results and discussions

In all 125 pieces of liver corrosion casts was highlighted first the origin of the right and PB of HPV. Three ways of the HPV right branch origin were observed: (i) the bifurcation of the HPV trunk in right branch and left branch (96.8% of cases), from the right branch arises the anterior and PB; (ii) the absence of the right branch as a distinct morphological entity (3.2% of cases), in which it highlights two distinct subtypes: (iia) trifurcation of the HPV trunk in anterior, posterior and left branches (2.4% of cases); (iii) bifurcation of the HPV trunk in PB and anterior branch; the left branch originates from the first part of the anterior branch (1 track 0.8% of cases).

Regarding the intraparenchymal distribution of the portal branches in the RLD of the liver, we showed four distinct morphological types:

- Type I (77.6% of cases) in which the PB bifurcate symmetrically in inferior branch - branch of segments VI and superior branch - branch of segment VII (Fig.1A),

- Type II (8.8% of cases) in which the PB bifurcate in branch of segment VII and an inferior branch, that bifurcate in branch of segment VI and inferior intermediate branch -

branch of segment VIA (posterior lower intermediate segment) (fig.1B),

- Type III (12.8% of cases) in which the PB bifurcate in branch of segment VI and an superior branch, that bifurcate in branch of segment VII and superior intermediate branch - branch of segment VIIA (posterior superior intermediate segment) (fig.1C),

- Type IV (0.8% of cases) in which the PB trifurcate in branches of segments VI, branch of posterior intermediate segment, and branch of segment VII (fig.1D).

In time, taking into consideration as segmental, the III-order branching elements of HPV (branches of the anterior, posterior, medial and lateral), lead to the description of the four segments (overlapping to the four divisions of hepatic parenchyma currently approved) [11 - 15]. Type I in our classification, type approved by Terminologia Anatomica [1998] [13] is also included in some of the proposals liver segmentation [16 - 21]. The two segments described in this typology (segments VIA and VII) are symmetrical and with equal volumes. Types II and III are due to secondary bifurcation of the segment VI or segment VII branches, and with appearance of an additional segment: (i) VIA segment (lower intermediate posterior segment) associated to segment VI; (ii) segment VIIA (upper intermediate posterior segment) associated to segment VII. In all analysed cases on corrosion casts, this intermediate posterior segment (upper or lower) has a significantly lower volume than the other two segments of RLD. Triforking of PB of the HPV and the appearance of three segments in the RLD of the liver (Type IV) is a morphologically type unreported in the literature. The three branches of the posterior segments (segment VI, intermediate posterior segment, and segment VII) have similar volumes.

Based on studies of Couinaud [17, 18], the approval of liver segmentation was performed consecutively by IANC [15] and by FCAT [22] taking into account especially the distribution of HPV branches. Surgical terminology of liver anatomy and liver resections was homologated by Brisbane 2000 terminology [23] established by the world HPB Association. According with Gadzijev [24], the reason of decision to the terminology was that surgical practice showed differences in the morphologic anatomy based division, especially in the left liver. In Brisbane Terminology [23], resection of segments V-VIII is called right hemihepatectomy, or right hepatectomy, and resection of segments VI and VII is called right posterior sectorectomy, right lateral sectorectomy or bisegmentectomy 6, 7. For a single segment resection, the term segmentectomy (segmentectomy VI and segmentectomy VII) is used.

Achievement of right posterior sectorectomy is technically possible regardless of morphological type of branching pattern of the HPV branches. Presence of the major morphological variations of portal PB (Types II, III and IV) technical hampers the segmentectomies achievement. Making chemoembolization of RLD segments becomes difficult in the presence of major anatomical variations of portal PB [25 - 27].

In 2013, Fischer et al. [28] made of a comparison of right posterior sectorectomy with formal right hepatectomy. Under normal anatomical situation, the right posterior sectorectomy (segments VI and VII) leads to a much smaller loss of hepatic parenchyma than in case of right hepatectomy, in similar technical conditions and provided a similar volume of blood loss. The right posterior sectorectomy is associated with less hepatic insufficiency than right hepatectomy. According to these authors, the right posterior sectorectomy should be strongly considered

when it is technically feasible and pays respect to oncological protocols.

Highlighting and consideration of segments at the level of RLD, IVB and IVC allow limited resections at the LMD of the liver. The determinant anatomic element of these segments is represented by morphological aspects of the portal PB.

Conclusions

Study of intraparenchymatous distribution of the HPV branches can be achieved in good conditions on corrosion preparations. The most frequently (77.6% of cases) the RLD of the liver is served by two symmetrical segmental branches (for segment VI and segment VII); sometimes (21.6% of cases) the RLD is served by an segmental branch and one common trunk from arises an segmental branch and an intermediate segmental branches; extremely rare (0.8% of cases), the RLD is served by three segmental branches (for segments VI, posterior intermediate segment, and segment VII). Knowledge of these morphological types of portal PB is important for clinical and surgical practice.

In [29] was studied the HPV system corrosion casts focused on the posterior branch.

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