

Interrelationship of Hepatic Veins with Separate Components of Portal Triad

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DOI: 10.52340/GBMN.2023.01.01.45

ABSTRACT

Background: The structure of the intermediate tissue between the components of the portal triad and the hepatic veins, within the zone of the portocaval connective tissue connections, depends on which of the elements of the triad is close to the hepatic vein because the connective tissue surrounding each of the elements of the triad has its characteristic specificity. Within the framework of the portocaval connective tissue connection, the interrelationship of the hepatic veins with the elements of the portal triad varies.

Objectives: The goal of this study is to determine the direct connection of individual components of the portal triad with the hepatic veins.

Methods: Histotopographic and histological preparations from the archival materials of the Department of Clinical Anatomy and Operative Surgery were used for the investigation. The tissue samples material was prepared from 45 livers of adults of both sexes. In addition, the documented archival samples of the preparations, which had been prepared with the macro-microscopic classical preparation method from the liver of adults whose cause of death was unrelated to liver pathology, were also used.

Results: In some zones of the intersection of the portal tract and the hepatic vein, their connective tissue sheath appears to create a nodular form, in the thickness of which the hepatic veins establish a direct relationship with the components of the portal triad. The components of the portal and caval systems are united by a common connective tissue compartment.

Conclusions: In the portocaval complex of the liver, the hepatic vein is connected to the components of the hepatic portal triad (portal vein, branches of proper hepatic artery, bile ducts) as the fourth element of this triad. All of them are surrounded by a perivascular fibrous capsule, which may contribute to spreading the inflammatory processes from the bile ducts to the hepatic veins.

Keywords: Bile ducts; hepatic artery; hepatic veins; portal triad; portal vein.

BACKGROUND

The success of any surgical intervention on the liver and bile ducts depends on a thorough knowledge of their anatomy. The study of the topography of the portal triad of the liver is of great practical importance for developing surgical hepatology.

In recent years, along with the rapid development of laparoscopic liver surgery, Laennec's capsule has become the subject of anatomical research. This capsule was first discovered by the French doctor - Rene T. H. Laennec - in 1802, but for 200 years since then, not enough attention has been paid to it. Laennec's capsule is a fibrous membrane that is included in the structure of the liver stroma, which covers the hepatic veins and appears to be an independent structure. According to some authors, the presence of Laennec's capsule between the peripheral veins of the liver is controversial. Despite the development of radiological studies, Laennec's capsule is still a poorly studied structure of the human liver.^{1,2}

The capsule of Laennec covers the entire surface of the liver, passes through the porta hepatis and around the pedicle of the capsule of Glisson and the hepatic veins, enters the liver parenchyma, and separates the portal tracts

and hepatic veins from each other. A narrow fissure separates these two fibrous capsules (Glisson's and Laennec's); their structure consists of type I and III collagen fibers.^{1,2} The authors have described Laennec's capsule, which merges with the hepatic veins, although nothing is said about a connection between the capsule and the hepatic veins.

At the end of the 70s of the last centuries, Professor I. Chanukvadze's research results changed the opinion about the relationship between the portal tracts and the hepatic veins, which are included in the "soft skeleton" of the liver. It was through his research that it was determined that the portal tracts and the hepatic veins form various types of connective tissue connections at the places of mutual intersection.^{3,4}

In places of direct contact with the hepatic vein, the perivascular fibrous capsule does not usually surround the portal tract. However, it passes over on the vein wall, merges with its connective tissue sheath, and forms a common covering for both systems.^{5,6}

Thus, intrahepatic portocaval connective tissue fibrous connections can be considered anatomical components of



the liver, and further study of the fibrous connections will help to develop surgical approaches for the treatment of various liver pathologies.

METHODS

During the investigation, a corrosive method of anatomical study was carried out, which ensures the preservation of the impression of the lumen of the blood vessels and ducts and lets us see an accurate picture of the spatial relationship of these tubular elements.

To examine the bile and lymphatic ducts of the portal triad, bile duct preparations were used, which were stained with India ink–gelatin injection.

During the study, total histotopographical and histological preparations were used, which were obtained from the main portal canals; the integrity of the fibrous and loose connective tissue sheath of the elements of the portal triad was preserved.

RESULTS

Within the portocaval connective tissue connections, the relation of the hepatic veins with the elements of the portal triad is varied. Within the area of the components of the portal triad connections, the bile duct (78%) more often attaches to the hepatic vein. Moreover, more rarely, the bile duct attaches to the portal vein (49.4%) or the hepatic artery (24.4%) with its corresponding branch.

The direct relationship between the hepatic vein and the bile duct within the area of the portocaval connective tissue connections is a common phenomenon.

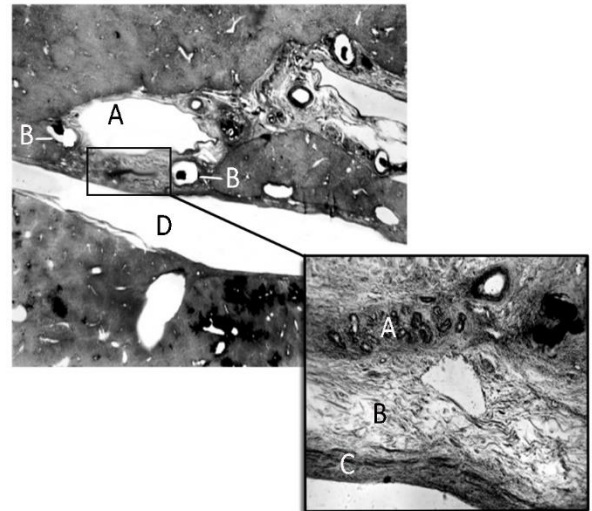
When the distance between the hepatic vein and the portal triad is 0.3-0.5 mm, the connective tissue sheath of the bile duct directly and tightly adheres to the hepatic vein. Thin bile ducts are up to 1 mm in diameter, and mucous bile glands course through the connective tissue between the bile duct and the hepatic vein and reach the wall of the hepatic vein (Fig.1).

As a result of filling the bile ducts with a mascara–gelatin mixture, the injected ducts in the area of the portocaval nodular connection push the hepatic veins, causing the narrowing of their lumen (Fig.2).

In 15% of the cases, the portal vein was directed to the hepatic vein within the zone of the portocaval connective tissue connection (Fig.3). Such a relationship is more a characteristic of the porta of segment III, where the hepatic vein usually adheres to the portal tract from below. In the case of close connections between the portal and hepatic veins, the connective tissue space is filled with connective tissue.

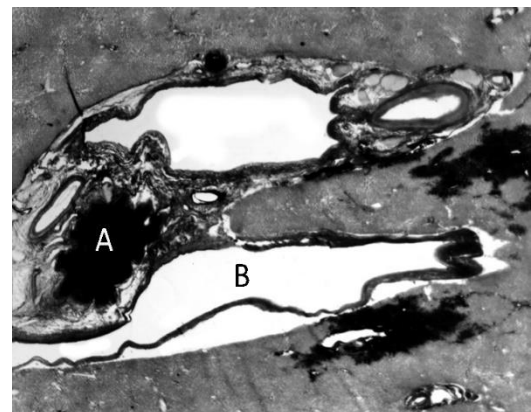
Within the area of the portocaval fibrous connective tissue connection, the arteries relatively rarely (24.4%) adhere to the hepatic vein compared to other elements of the portal triad.

FIGURE 1. Histotopography of superficial form of portocaval nodular connection. M.72y



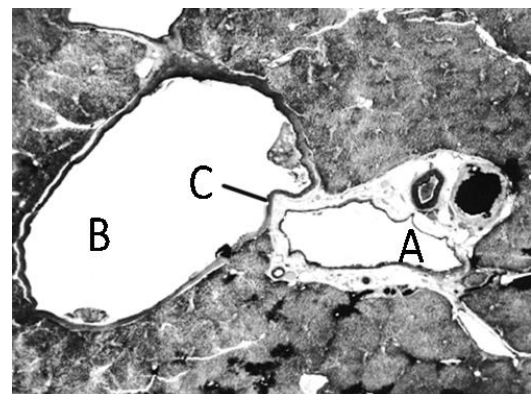
Explanations: A. Portal vein; B. Bile ducts; C. Mucosal bile ducts; D. Hepatic vein stained by Van Gizon.

FIGURE 2. Area of portocaval nodular connection. M.56y



Explanations: A. Bile duct dilated after mascara gelatin injection; B. Hepatic vein, lumen is narrowed at the level of contact to the bile duct.

FIGURE 3. Histotopography of portocaval connective tissue connection. M.68y

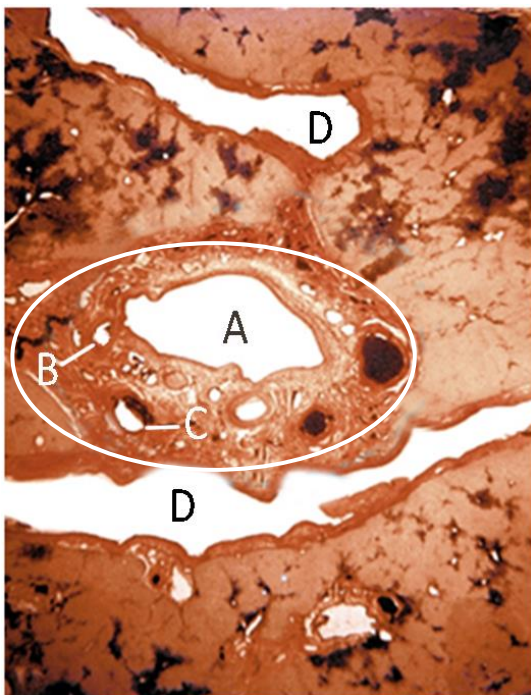


Explanations: A. Portal vein; B. Hepatic vein; C. Space between portal and hepatic veins.

DISCUSSION

A direct relationship between the hepatic vein and the bile duct within the area of the portocaval connective tissue connection is a frequent phenomenon.⁷⁻¹² This is explained by the fact that, firstly, the intrahepatic bile ducts in the portal tract are located most peripherally from the other elements of the portal triad, and secondly, because the sectional and segmental bile ducts are usually located superior to the other elements of the portal triad and, therefore, appear closer to the hepatic veins. In this regard, it is also important that the portal triad often contains several bile ducts of different calibers, one of which is usually directed to the hepatic vein (Fig.4).

FIGURE 4. Relationship of the portal tract and major veins of the liver, III segment.W.61y



Explanations: White circle: portal tract; A. Portal vein; B. Hepatic artery; C. Bile ducts stained via mascara gelatin injection; D. Hepatic vein stained via Van Gizon.

In the case of biliary hypertension, dilated bile ducts can push firmly against the wall of the hepatic vein and thereby significantly affect its drainage function.

The close relationship between the portal and hepatic veins in the area of the portocaval connective tissue connection is of essential practical importance to create intrahepatic portocaval anastomosis because when there is close contact of the portal vein with the hepatic vein in the area of the specifically superficial form of the portocaval connective tissue connection, there appear to be favorable conditions for the creation of an anastomosis between them.¹³⁻¹⁵

Thus, in some areas of the spatial intersection of the main portal tracts and the hepatic veins, the portal tract and

the hepatic vein connective tissue sheath together create a nodular type of fusion formation, in the thickness of which the hepatic veins establish a direct connection with the elements of the portal triads well as the elements of the portal and caval systems in the form of a common connective tissue compartment.¹⁶⁻²¹

The direct interaction of the bile ducts and mucous bile glands with the hepatic veins in the zone of the portocaval connective tissue connection can contribute to spreading the inflammatory processes from the bile ducts to the hepatic veins.

CONCLUSIONS

In the portocaval fibrous connection of the liver, in most cases (78%), the bile duct courses to the wall of the hepatic vein and joins it with the parabolic type of tissue. Within the framework of the hepatic portocaval fibrous tissue, the portal vein is directed to the hepatic vein (15%), and arteries are directed to the hepatic vein (24.4%).

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ACKNOWLEDGMENTS

We want to thank our colleagues as well as the entire laboratory team of the Morphological Institute at Ivane Javakhishvili Tbilisi State University (TSU).

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