Perivascular connective tissue sheath and portal tracts in mammals

Patarashvili L.¹ Tsomaia K.¹,² Kakabadze M.² Kordzaia D.¹,² Chanukvadze I.³

Abstract

Introduction: Many hepatic pathologies associated with the ductular reaction, changes of biliary mucosal glands, inflammation with leukocyte infiltration, etc. involve the liver portal tracts. The number of investigations indicates the role of portal tracts in the liver regeneration, innervation of the hepatic parenchyma; also, the portal tracts are important for surgeries aiming to treat the biliary atresia or conduct the liver graft transplantation.

To clarify the role of the portal tracts in development of various hepatic disorders, as well as successful implementation new interventions using the elements of a portal complex, requires translational investigations in different animals and therefore the studies of their portal tracts architecture for this purpose.

Method: We studied the architecture of the portal tracts of humans, canines and rats with the following comparative analysis.

The methods of macerating preparations, corrosion casts of tubular structures, histology (histotopography, histochemistry, immunohistochemistry) were used.

Conclusion: It was revealed that the overall architecture of the human, dog and rat portal tracts and the location of the elements in them is alike: the portal veins are surrounded by arteries and bile ducts, which are localized more peripherally – bordering liver parenchyma. However, in the animals the arterial-fibrous and biliary fibrous layers, which are the typical structures in humans, are less clearly developed. Humans’ and dogs’ bile ducts are supplied with mucous glands, while in rats, these structures are replaced by a periportal biliary plexus. This fact should be related to the absence of gallbladder and therefore, to the different conditions of bile drainage. (TCM-GMJ March 2019; 4(1):P4-P7)

Keywords: Connective tissue sheet; Portal tract; Mammals;

Introduction

Pathologies such as cirrhosis and bile congestion are directly reflected on morphology of liver portal tract (1). The ductular reaction (2,3), inflammation with leukocyte infiltration (4), activity of biliary mucosal glands, as well as links between biliary and lymphatic channels (5,6,7,1) are developed in the area of portal complex surrounded by perivascular fibrous sheath derived from Glisson’s Capsule. The role of portal tracts in the liver regeneration (8), as well as in ensuring innervation of the hepatic parenchyma (9) causes great interest. The knowledge of the architectonics of the portal tracts is important in terms of intervention due to biliary atresia (4) or for successful transplantation of the liver grafts (10). The portocaval connective tissue links, discovered by us (11) increased the interest towards the research of morphology of portal tracts and particularly after revealing that these portocaval connective tissue links might influence on the development of various hepatobiliary pathologies (e.g. formation of hepatic vein thrombosis in case of cholangitis) or may be used for the formation of intrahepatic portocaval shunts (5,12,1). However, the clarification the role of portal tracts in pathogenesis of the various diseases, as well as introduction of new interventions based on the usage of their elements needs conducting additional translational researches in various experimental models. This, in its turn, requires the study of the peculiarities of portal tracts in different animals, both under normal as well as pathological conditions.

We aimed to conduct the comparative analysis of morphology of the portal tracts of humans, canines and rats.

Materials and methods

The following was used for research: a) The archive material included 58 slices of macerating preparations containing hepatic portal tracts, as well
as 0.5cm slices from the 100µm of the same areas, obtained from the corpses of adults (whose death was not related with liver pathology) of both sexes. The part of the slices was prepared by the combination of various colored ink and gelatin mixture of the portal vein, biliary tract and/or hepatic artery (proportion 1:3) following the preliminary injection (I. Chanukvadze’s archive, at the Chair of Operative Surgery and Topographic Anatomy of Tbilisi State Medical University); b) The archive material, included corrosive preparations of hepatic tubular structure of 6 adult mongrel (street) dogs of both sexes (Made of latex manufactured by NÁRIT and tissue disruption in 90% H2SO4); as well as up to 0.3cm thick slices from 30µm, prepared from the 5 dogs’ liver fragments, containing portal tracts. The part of the slices was prepared by the combination of various colored ink and gelatin mixture of the portal vein, biliary tract and/or hepatic artery (proportion 1:3) following the preliminary injection (The animals were control animals in the series of studies of the biliary engagement [D. Kordzaia Archive, at the Chair of Operative Surgery and Topographic Anatomy of Tbilisi State Medical University]); g) The slices, from 4µm up to 100µm thick, containing the portal tracts of the livers of 16 rats of both sexes, which died during the implementation of the various operative models of the ongoing scientific research within the ongoing scientific research Aleksandre Natishvili Institute of Morphology of Ivane Javakhishvili Tbilisi State University.

The mentioned slices were studied by using binocular magnifying glass or light microscope (Micros [Austria]), by the hematoxylin-eosin, Van Gieson method (Weyhert picro-fuchsin) and after painting with Masson Trichrome (additionally, part of the slices was painted by reticulin - for revealing reticular fibers); The mucicarmine stain was applied for revealing mucosal biliary glands. Part of the preparations were marked by cytokeratin (CK19, CK7, AE1/AE3), stem cells (OV6), smooth muscle actin(SMA, NCAM) markers.

As a result of histological studies (including histotopographic) of the preparations, the typical description of human liver portals has been developed, which covered all the structures located at this site, their interpositioning and interconnection.

The abovementioned was followed by studying the dog and rat portal tracts and identification of the structures within them, taking into account the description of the human liver portal tract.

We have conducted tabular comparison of the obtained data similarly to what was performed by W. A. Beresford and D J. M. Henninger (13), to reveal the similarities and differences between the livers of vertebrates.

Results and discussion

Results of the research are presented in the table N1. The table contains general description of portal tracts of humans, dogs and rats and at the same time it gives part of the digital photos and schemes of these portal tracts for illustration.

Conclusion

The overall architecture of the human, dog and rat portal tracts and the location of the elements in them is alike: the portal veins are surrounded by arteries, followed by bile ducts. The nerves and lymphatic vessels are “scattered” in the portal area. In addition, the smaller the dimensions of the liver and therefore its tubular structures are, the thinner the fibrous sheath of the portal veins, hepatic arteries and bile ducts is. Also, the arterial-fibrous and biliary fibrous layers are less clearly developed and do not organize the circular sheath. Human and dog bile ducts are supplied with mucous glands, while in rats, these structures are replaced by a perilportal biliary plexus. This fact, as well as presence in ”larger dozes” of the smooth muscular fibers in these ducts, should be related to the absence of gallbladder and therefore, to the different conditions of bile drainage.

Acknowledgement

This work was supported by Shota Rustaveli National Science Foundation (SRNSF) [DP2016_22, New Interdisciplinarity Interdisciplinary Structured PhD Programme “Translational Biomedicine” (Direction – “Hepatology”)].

References

The portal complex of humans is represented by three consecutively arranged circular sheaths: fibrous-portal, fibrous-arterial and fibrous-biliary layers - enveloped within a fibrous sheath of the whole portal tract, -a peri-vascular fibrous sheath representing the intraparenchymal derivative of Glisson’s capsule, together with the collagen, reticular and elastic fibers, as well as smooth muscle fibers, are distinguished in the composition of all mentioned layers and the walls of the branches of bile duct portal vein and hepatic artery, though in different correlation they represented relatively to a less extent in the vein and duct walls, while they create quite well expressed layer in the artery walls (14,15). The fibrous-biliary layer is located most peripherally. It is represented by long smooth and short caliber ducts, intra- and extramural mucosal biliary glands and parenchymal glands. Portal vein and hepatic artery, though in different correlation they represented relatively to a less extent in the vein and duct walls, while they create quite well expressed layer in the artery walls (14,15). The fibrous-biliary layer is located most peripherally. It is represented by long smooth and short caliber ducts, intra- and extramural mucosal biliary glands and parenchymal glands. Portal vein and hepatic artery, though in different correlation they represented relatively to a less extent in the vein and duct walls, while they create quite well expressed layer in the artery walls (14,15).


The structure of the canine portal tract is principally identical to the structure of human portal tracts. At the same time, the fibrous layer of the portal veins, hepatic arteries and bile ducts is thinner. The bile ducts and arteries in the tract maintain such topography, as noted in the human portal tracts. Although, in contrast to them, the arterial, biliary and fibrous biliary layers are less clearly defined, as well as whole circular sheath. The structure of the rat portal tracts repeat the structure of human and dog portal tracts, although rats do not contain mucous and biliary fibrous layers, which are not identified unlike them, as the whole circular sheath. The location of the nerve fibers in the portal tract more or less repeat their topography in human and dog portal tracts. However, as confirmed, in contrast to them, do not provide fibers inside the liver lobules (9).