Using Human Intrahepatic Bile Duct System Corrosion Casts in Training of the Medical Students and Residents

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The bile duct system has two distinct components: one intrahepatic and another extrahepatic. Both components are subject to large anatomical variability. Knowledge of intraparenchimatous bile duct system distribution is particularly useful for planning and performing major surgical resection and liver transplantation. For this reason, the training of students and medical residents must use liver corrosion casts. On the 130 pieces of hepatic corrosion casts, a percentage of 80.75% of cases have modal typology, homologated by Terminologia Anatomica (1998). On a percentage of 19.25% of the studied cases were found major variations of the intrahepatic bile duct system (classified into four morphological types). In 16.15% of cases, the posterior branch in his passage to the left hepatic duct intersects the main portal fissure. Medial and lateral branches showed no major variations on the studied material. Use of human intrahepatic bile duct system corrosion casts with major anatomical variations, can compensate for lack of clinical material in training of medical students and residents.

Keywords: corrosion casts, intrahepatic bile duct system, major variations, training.

The bile duct system has two distinct components: one intrahepatic and another extrahepatic. Knowledge of relevant anatomy of this system is essential to the safety of any operative procedure at this level [1]. Intrahepatic component contains on the one hand, the anterior branch and the posterior branch that formed by confluence the right hepatic duct, and on the other branch of the medial and the lateral branch that form by confluence the left hepatic duct. In the last part of the hepatic ducts are draining the right/left caudate lobe ducts [2, 3]. The confluence of the two hepatic ducts (right and left), forming the superior biliary confluent, level of common hepatic duct origin. The extrahepatic component contains the main part of the common hepatic duct, the cystic duct, the gall bladder bile duct (ductus choledocus) [1, 2, 4].

The intrahepatic bile duct system is associated with the intrahepatic elements of the hepatic portal vein and hepatic artery proper (component of the celiac trunk) [3 - 5], that have a segmental distribution [2, 3, 7, 9, 11, 12].

In the liver segmentation fissures, based on the distribution of the afferent pedicle elements, are located in the hepatic veins (elements of the efferent pedicle of the liver) [13] that drain in retrohepatic part of the inferior vena cava [13, 14].

Early reports [15] reveal that the anatomical variations of the hepatic artery proper is associated with the classic intrahepatic distribution of the portal hepatic in only 11% of cases, while the anatomical variations of the intrahepatic bile ducts system is associated with the classic intrahepatic distribution of the portal hepatic in 19% of cases.

Although currently the anatomical variations of the afferent liver pedicle elements (including intrahepatic bile duct system) is much easier to highlight the radioimagistic procedures, the study of the corrosion casts is much better in training of the medical students and residents. This study highlights the major anatomical variations of the intrahepatic bile duct system on corrosion casts.

Experimental part

In the present study, one used 130 human intrahepatic bile duct system corrosion casts achieved in the Department of Anatomy of the "Victor Babes" University of Medicine and Pharmacy, Timisoara. The corrosion pieces were prepared in the period 1997-2012. Liver pieces were harvested from human cadavers who had no history of liver disease. Injection of the liver vasculo-ductal systems liver was performed with Technovit 7143 plastic compound (Heraeus Kulzer GmbH, Wehrheim, Germany) (product based on methacrylate copolymers). To induce corrosion of the liver parenchyma, technical hydrochloric acid was used. All procedures for harvesting the liver pieces and making of corrosion casts were approved by the Ethics Committee of the "Victor Babes" University of Medicine and Pharmacy, Timisoara. The studied liver vasculo-ductal corrosion casts were photographed (Nikon D3, Tokyo, Japan, AF-S Nikkor Lens f/1.4G) and classified according to the present type of major biliary anatomic variation.

Results and discussions

In 123 pieces (94.60%) of human intrahepatic bile duct system corrosion cast highlight in their structure the four

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branches (anterior, posterior, lateral and medial) that drain bile from the parenchyma of four liver divisions. In 7 cases (5.40%) the anterior branch is absent and bile ducts of segments V and VIII drains directly into the superior biliary confluent. Depending on the confluence modality of these branches and the formation of hepatic ducts (right, left and common), we revealed five morphological types: a modal type (type I) on 105 corrosion casts (80.75% of cases) and four morphological types (types II-V) with major anatomical variations corrosion on 25 corrosion casts (19.25% of cases).

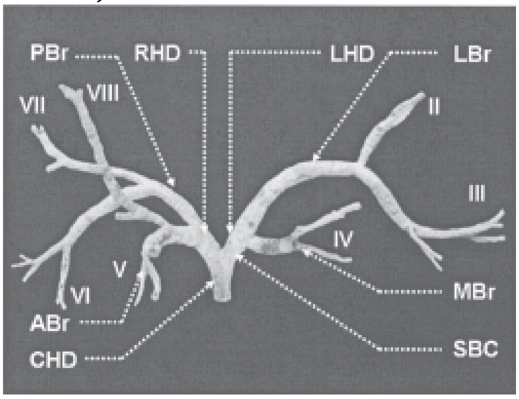

Fig.1. Corrosion cast of intrahepatic bile ducts system. Anterior view. Modal type (Type I). ABr - anterior branch, PBr - posterior branch, LBr - lateral branch, MBr - medial branch, RHD - right hepatic duct, LHD - left hepatic duct, SBC superior biliary confluent, CHD - common hepatic duct, II-VIII - segmental branch

The analysis of five morphological types reveals the following characteristics:

Type I (modal type - 105 corrosion casts, 80.75% of cases), in which the confluence of anterior and posterior branches form the right hepatic duct; the confluence of lateral and medial branches form the left hepatic duct; the two hepatic ducts (right and left) form the common hepatic duct at the level of superior biliary confluent (fig.1).

Type II (3 corrosion casts, 2.30% of cases), in which the anterior branch is absent, and the biliary ducts of segment V and segment VIII drain in the superior biliary confluent with the posterior branch (fig.2A).

Type III (4 corrosion casts, 3.10% of cases), in which the anterior branch is absent, and the biliary ducts of segment V and segment VIII drain in the superior biliary confluent; the posterior branch drain in the left hepatic duct at the level of the supreme biliary confluent (fig.2B).

Type IV (17 corrosion casts, 13.05% of cases), in which the anterior branch drain the superior biliary confluent with the left hepatic duct; the posterior branch drain in the left hepatic duct at the level of the supreme biliary confluent (fig.2C).

Type V (1 corrosion cast, 0.80% of cases), in which the posterior branch drain the superior biliary confluent with the left hepatic duct; the interior branch drain in the left hepatic duct at the level of the supreme biliary confluent (fig.2D).

Intrahepatic bile ducts differentiate into the 8th week of embryonic life. They appear between epithelial hepatic cords without the proper wall, but even their lumen, is temporarily closed by epithelial cells, and subsequently barely channeled [15]. The intrahepatic bile ducts appear under the influence of mesenchyme located along the hepatic portal vein ramifications. In the 12th week of embryonic life (the third month) begins bile secretion that draining in the primitive intestine [16]. Bile pigments are developed in the IVth month, and the typical bile is secreted from the Vth month. The proliferating endodermal cells give rise to interlacing cords of hepatocytes and to the epithelial lining of the intrahepatic part of the biliary apparatus [16]. The intraparenchimatous bile duct system elements are associated with the path of the intrahepatic hepatic portal vein branches. In the sixth week, the vesicular bud, located in gastrohepatic ligament, form his lumen. In the second month of embryonic life, the gallbladder comes into relation with the liver. The gallbladder and the cystic duct have the lumen temporarily obliterated by epithelial cell proliferation. Subsequently there is a recanalization of them. The closeness and the contacting of primordium of the gallbladder and cystic duct, with the hepatic parenchymal mass occurs the connection between the intrahepatic bile ducts and the extrahepatic bile ducts.

A normal embryological development leads to right hepatic duct placement in the right portal fissure plane, and the left hepatic duct placement in the plane of the left portal fissure. Also, the superior biliary confluence is placed in the main portal fissure plan.

In type II, the confluence of the posterior branch, with bile ducts of segment V and segment VIII occur later, at

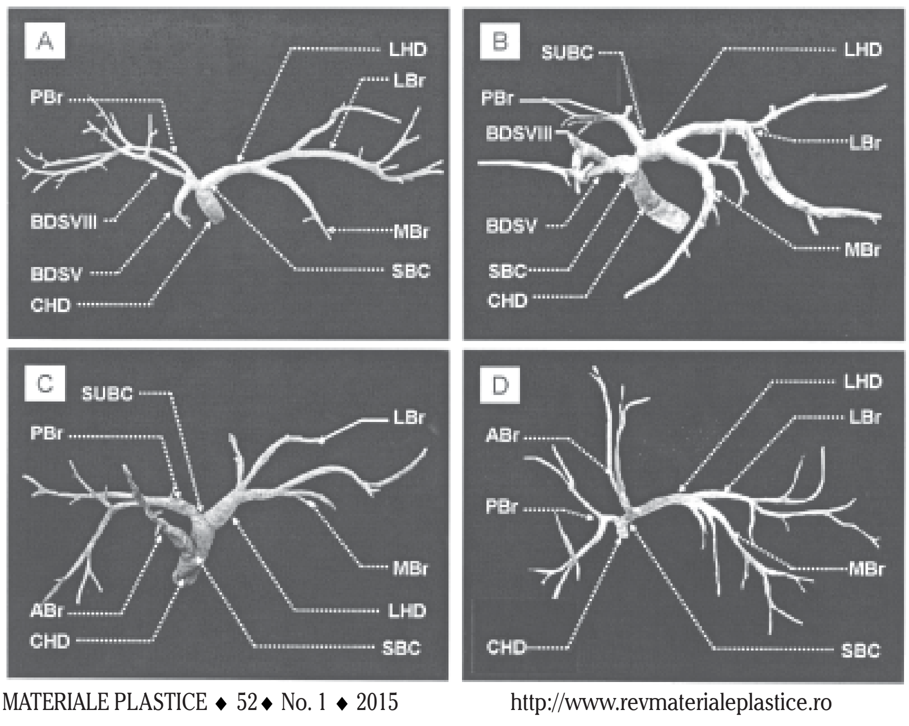

Fig.2. Corrosion casts of intrahepatic bile ducts system. Anterior view. Major anatomical variations.
A - Type II, B - Type III, C - Type IV, D - Type V. ABr - anterior branch, PBr - posterior branch, LBr - lateral branch, MBr - medial branch, BDSV - bile duct of segment V, BDSVIII - bile duct of segment VIII, RHD - right hepatic duct, LHD - left hepatic duct, SUBC supreme biliary confluent, SBC - superior biliary confluent, CHD - common hepatic duct.

the level of the main portal fissure plan (at the level of the primary biliary confluence). In type III and IV, the posterior branch, cross the main portal fissure plan to drain in the last part of the left hepatic duct. In type V, the anterior branch crosses the main portal fissure plan and drains in the last part of the left hepatic duct. These phenomena of intrahepatic bile ducts translation, are only sometimes associated with variations of hepatic portal vein branches.

In case of the anterior sectionectomy it was practiced the resection of segments V and VIII [17, 18, 19]. During this surgery procedure, the posterior branch of the intrahepatic bile ducts system (types III and IV) which crosses the plane of the main portal fissure and drain in the last part of the left hepatic duct may be damaged during surgery. In this situation, uncontrolled biliary drainage of segments VI and VII, can lead to serious postoperative complications. The same complications may occur in the left hepatectomy (with resection of segments II, III and IV). In the right anterior sectionectomy (segments V and VIII) [17, 18, 19] may be damaged also the anterior branch of the intrahepatic bile ducts system, that in type V crosses the main portal fissure plane and drains in the last part of the left hepatic duct (type V).

Intrahepatic bile ducts corrosion casts study is one of the most important ways of training medical students and residents. Although MDCT angiography images are much easier to achieve, given the existence of adequate facilities [20], they do not provide three-dimensional images of the plastination preparations [21, 22, 23] and of the corrosion casts [24, 25].

Conclusions

The modal type of intraparenchimatous distribution of the bile ducts system, homologated by Terminologia Anatomica (1998) was highlighted in a percentage of 80.75% of cases. Major anatomical variations of the intrahepatic bile duct system highlighted in a percentage of 19.25% of cases, were grouped into four morphological types. The most common major variation of the intrahepatic bile ducts system was represented by the drainage of the posterior branch into the distal part of the left hepatic duct (16.15% of cases). The study of intrahepatic bile ducts system corrosion casts can contribute substantially in training of medical students and medical residents.

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