PARTICIPATION OF THE DUCT OF SEGMENT III IN FORMING THE MEDIAL BRANCH OF THE INTRAHEPATIC BILIARY DUCTS SYSTEM. STUDY ON CORROSION CASTS

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ABSTRACT.
Intrahepatic biliary ducts of the lateral branch is formed by the confluence of segment II and III ducts. The medial branch is either formed of biliary duct from segment IV or by the confluence of 2-3 ducts, and the right medial division of hepatic parenchyma has several segments. This material provides a reference to special anatomic variations in biliary ducts of the right hepatic lobe. A number of 120 hepatic corrosion casts, realized by injection of plastic in vascular-duetal system and subsequent melting of hepatic parenchyma in HCl, were studied for the morphological variations of biliary ducts from segment III. These 2 corrosion casts (1.67%) revealed that biliary duct of segment III form the medial branch and that of segment II form the lateral branch. The duct from segment III crosses the plane of umbilical fissure, and is situated intra portal compared to the umbilical part of left branch of hepatic portal vein, that susceptible to by cut in case of surgeries requiring incision along umbilical fissure. Associated major variations in biliary ducts of right hepatic lobe were found in both these cases (posterior and anterior branch). All these anatomic variations facilitates the drainage through left hepatic duct. The infraportal location of segment duct III (presence of a bridge of parenchyma at the level of REX's recess) can be explained by dysfuction in ontogenic development of left hepatic divisions (Supported by CEEX 175/2006).

KEY WORDS:Biliary Ducts, Segment III, Anatomic Variations

PARTICIPAREA DUCTULUI BILAR AL SEGMENTULUI III HEPATIC LA FORMAREA RAMURII MEDIALE A DUCTELOR BILIARE INTRAHEPATICE. STUDIU PE PREPARATE DE COROZIUNE

REZUMAT:
Ramura laterală a ductelor biliare intrahepatice este formată de confluința ductelor biliare a segmentelor II și III hepatic. Ramura medială este formată de ductul biliar al segmentului IV sau de confluința a 2-3 ducte pe când diviziunea medială dreaptă prezintă câteva segmente. Acest studiu prezintă câteva precizări ale variantelor anatomiche a ductelor biliare ale lobului hepatic drept. Pe cele 120 de preparate de hepatic, realizate prin injectare intravasculo-duetală de plastifiant și apoi supunere a tesutului la acțiunea coroziva a HCl, au fost studiate variatiiile morfologice ale drenajului ductelor biliare ale segmentului III. Cele două preparate, reprezentând 1.67% din totalul preparatelor studiate, au arătat ca ductul biliar al segmentului III formează ramura medială, iar cel al segmentului II ramura laterală. În trayectoria lui spre ramura medială ductul biliar al segmentului III traversează planul fisurii umbilicale fiind situat infraportal comparativ cu fatura umbilicală a venei porte. Aceasta dispoziție o face susceptibilă la intervențiile chirurgicale ce impun incizie de-a lungul fisurii umbilicale. Variatiile majore ale ductelor biliare ale lobului hepatic drept au fost semnale de ambele cazuri (ramuri posterioare si anterioare). Toate aceste variante anatomiche determina favorizeaza drenajul prin ductul biliar hepatic stang. Localizarea infraportală a ductului segmentului III (prezenta unei portiuni de parenchim la nivelul recessului REX) poate fi explicată printr-o disfuncție de dezvoltare ontogenetica la nivelul diviziunii hepatice stangii. (CEEX 175/2006)

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INTRODUCTION

The system of intra-hepatic biliary ducts has a segmental disposition, being associated to the trajectory of the elements from the divergent part of the portal at the level of the hepatic parenchyma (together with branches of the proper hepatic artery). The right hepatic duct is formed by confluence of the anterior branch with the posterior branch; in the last part of its trajectory merges the right duct of the caudate lobe. The left hepatic lobe is formed by confluence of the medial and the lateral branch; in the last part of its trajectory merges the left duct of the caudate lobe. The two hepatic ducts (right and left) form the superior biliary confluent, situated extra parenchymal at about 1-2 cm inferior to the hepatic hilum. From this level starts the common hepatic duct (situated on the right aspect of the anterior face of hepatic portal vein’s trunk (1, 2, 3, 4).

Terminologia Anatomica 1998 (5) doesn’t recognize specific names for the segmental ducts and maintains the names from Nomina Anatomica 1989 (6) for the second order divisions of the intra-hepatic biliary duct system (the anterior, posterior, medial and lateral branch). The lateral branch reaches the parenchyma of the left lateral division. It is normally formed by the duct of segment II and the duct of segment III. The medial branch reaches the parenchyma of the left medial division and it is formed by a single segmental duct (the duct of segment IV) (according to the hepatic segmentation recognized by Terminologia Anatomica 1998 (6).

Most part of the anatomical variants of the intrahepatic biliary ducts system is localized at the level of ducts draining the right divisions of the hepatic parenchyma (medial and lateral) (7). On a small number of our hepatic corrosion casts we analyzed the morphological variants of the biliary ducts for the left divisions of hepatic parenchyma (lateral and medial).

This paper intends to present some particular situations of biliary drainage of the segment III towards the medial branch of the intrahepatic biliary ducts system.

MATERIAL AND METHOD

From an initial study of 120 hepatic corrosion casts we selected all casts that presented morphological variants of the ducts for segments II and III (ducts that normally form the lateral branch – draining the parenchyma of liver’s left lateral division) (14 casts from 120 – 11,67%). From these, we selected and analyzed two corrosion casts in which the duct of segment III participates in formation of the medial branch (draining usually the left medial division – formed by one, two or three segments).

The corrosion casts were made by injecting with plastic of the hepatic vasculo-ductal systems, followed by hepatic parenchyma’s corrosion with hydrochloric acid. For injecting the vasculo-ductal systems we used the AGO II paste (after the method of Nanu, Corondan, Bejan, 1958) (8) and Technovit 7143. The injection was made with the casts immersion until the complete solidification of the plastic. Using this technique, we succeeded to maintain the normal relation between the intrahepatic vasculo-ductal elements. After the complete solidification of the plastic (24 hours for AGO II paste and one hour for Technovit), the casts were subjected to a corrosion of parenchyma with hydrochloric acid for 5-7 days. The corrosion process was interrupted two-three times by placement of casts under stream of water for ½ hour (hydro dissection), in order to remove the remnant parenchyma.

The corrosion casts thus obtained were analyzed regarding the participation of the segment III duct to form the medial branch and the relationship between this duct and the umbilical part of the left branch of portal vein. We tried to find some of the causes of this anatomic variant. We also analyzed the surgical impact of these morphological aspects.

RESULTS

We analyzed two (1.67%) of the 120 hepatic corrosion casts. The duct of segment III, was found to merge to the medial branch (branch that drains the bile of left medial division of liver’s parenchyma).

We analyze separately each of the two selected casts, with all the specific drainage aspects of the segment III ducts, as well as the associated specific aspects presented at the level of the elements composing the left hepatic duct:

Cast no. 1:
- the medial branch is formed by confluence of three segmental ducts (ducts for the segments IVa, IVb and IVC;
- the duct of segment III drains into the first part of the trunk of the medial branch, having an infraportal trajectory (in relation with the umbilical portion of the left branch of the portal hepatic vein);
- the left duct of the caudate lobe drains into the last part of the lateral branch;
• the lateral branch continues the duct of segment II without a precise delimitation;
• the left hepatic duct is formed by confluence of the medial with the lateral branch; the posterior branch drains into the last portion of the left hepatic duct.
(Fig.1, Fig.2)

I right – right duct of segment I; I left – left duct of segment I; II – duct of segment II; IIa – duct of segment IIa (intermediary); III – duct of segment III; IVa – duct of segment IVa; IVb – duct of segment IVb; IVc – duct of segment IVc; ABr – anterior branch; PBr – posterior branch; MBr – medial branch; LBr – lateral branch; LHD – left hepatic duct; CHD – common hepatic duct.

**Fig. 1.** Corrosion cast no. 1. Detail of the anterior aspect, showing the drainage of the segment III duct into the first part of the trunk of the medial branch.

**Fig. 2.** Corrosion cast no. 2. Detail of the anterior aspect, showing the drainage of the segment III duct in the close vicinity of the point of medial branch formation.
Cast no. 2:
- the medial branch, with a very small length (4mm) is formed by the confluence of two segmental ducts (the duct of segment IVc and the duct of segment III);
- the duct of segment III drains into the last part of the segment IVa duct, in the close vicinity of the point of medial branch formation, having an infraportal trajectory (in relation with the umbilical part of the left branch of the portal vein);
- the left duct of the caudate lobe drains into the last portion of the lateral branch;
- the lateral branch is formed by the confluence of the duct of segment II with the duct of segment Ia (the left lateral intermediary segment);
- the left hepatic duct is formed by the confluence of the medial branch with the lateral branch; the anterior branch drains into the last part of the left hepatic duct.

DISCUSSIONS

The analysis of the present anatomical variants shows two distinct aspects:
- Segment III in duct is not joining segments II duct into the lateral branch, but it joins the constitutive elements of the medial branch:
  - in the first corrosion cast the merging point of the segment III duct is situated in the first part of the medial branch trunk below the confluence of the three segmental ducts;
  - in the second corrosion cast the merging point of the segment III duct is situated in the last part of the segment IV a duct, above the joining of the late into the medial branch.
- the medial branch is composed by 3 respective 2 biliary ducts at the level of the left medial division of liver's parenchyma.

This particular disposition of the intrahepatic biliary ducts system the segment III duct joins the medial branch that drains the segment or segments IV and the duct of segment II that participates independently in formation of the lateral branch and then in of the left hepatic duct corresponds with the segmentation proposed by Couinaud (9, 10). He stated:
- the segment II forms the left lateral sector, and
- segments III and IV (unique) form the left paramedian sector.

According to Terminologia Anatomica 1998 (5), today it is considered that the umbilical fissure is situated on the visceral part of the liver at the insertion of the falciform ligament. Considering this location it is clear that, in the two particular anatomical situations where the duct of segment III drains into the medial branch of the intrahepatic biliary ducts system, it crosses the plane of the umbilical fissure and could be injured during surgical procedures approaching through this plane.

When the duct of segment III drains into the medial biliary branch is unfavorable from functional point of view, because of the circulatory overload of the medial branch (in the prejudice of the lateral branch – which drains the bile from a single segment of hepatic parenchyma – segment II).

Normally, the bisegmentectomy II+III biliary (left hepatectomy) requires, the dissection and ligature of the lateral branch above its merging into the left hepatic duct (together with the medial branch of the biliary ducts system). The ablation plane is placed in the plane of the umbilical fissure (11) and doesn't imply surgical difficulties if the drainage of the biliary ducts of the left lateral division two segments is done separately. Improvement of the resection technique of the hepatic parenchyma at the level of the umbilical fissure, no matter of the anatomical variations of the vasculo-ductal elements, allowed performing the bisegmentectomy II + III by help of laparoscopic technique (12).

Extended left hepatectomies (left trisegmentectomies) (13, 14, 15) can be performed without special technical difficulties, without influence of the morphologic variations in the biliary system of the segment III, because the ligature of the intrahepatic biliary ducts is done at the level of the left hepatic duct before the merging of the caudate lobe left duct.

The trisegmentectomy IV (15) or the trisegmentectomy type Taj Mahal (S4+S5+S1) (17) implies dissection of the intrahepatic biliary ducts and sparing of the ducts for segments II and III, with bilio-digestive anastomoses and modifications of the surgical technique (19).

The two particular situations presented in this paper, the deviation of the biliary drainage of segment III into the medial branch - were associated with major anatomical variations of the biliary ducts system at the level of the right hepatic parenchyma:
- in the first case, the posterior branch drains into the last portion of the left hepatic duct;
- in the second case, the anterior branch drains into the last part of the left hepatic duct.

In both situations there is an obvious overload of the biliary drainage into the left hepatic duct, in the prejudice of the right hepatic duct (formed in the first case only by the anterior branch, and in the second case by the posterior branch).
An unfavorable situation during surgery of the hepatic parenchyma is representative by the present of this major anatomical variations that makes the drainage of the anterior or posterior branch into the last portion of the left hepatic duct. The excision of left hepatic parenchyma drained by the left hepatic duct maybe accidentally associated with the excision of some parts of the hepatic parenchyma drained by the anterior branch (right medial division) or by the posterior branch (right lateral division) (7).

The trajectory of the ducts for segments II and III is usually superior to the umbilical portion of the left branch of the portal hepatic vein. The two ducts merge into the lateral branch superior to the right aspect of the umbilical part of the portal hepatic vein. The confluence with the medial branch into the left hepatic duct is placed on an inferior plane, but also to the right of the umbilical portion of the portal hepatic vein (in the absence of variations of the portal system).

In 1999, Kitamura and co. (19) presented the infraportal situation of the duct for segment III (B3) in 3.3% cases. The same infraportal location compared with the umbilical portion of the left branch of the portal hepatic vein is observed in 6% of cases by Ozden and co. in 2002 (18), by help of colangiography.

Infraportal location of the trajectory of the duct for segment III can be explained by help of arguments of embryologic development of left hepatic parenchyma (19). The left divisions of the hepatic parenchyma develop from two distinct portions of embryologic parenchyma. Thus, segment II, situated posterior and superior, develops independently from segments III and IV, which are situated anterior and inferior and is larger in dimensions. The more the segment III develops towards inferior (towards the parenchyma of segment IV), the more chance for its duct to be directed towards segment IV increases. This situation is often associated with the presence of a bridge of parenchyma situated at the level of Rex recess. The presence of a bridge of hepatic parenchyma at the level of Rex recess between the parenchyma of segments III and IV is suggestive but not patognomonic for the presence of the duct for segment III with infraportal localization (20, 18). This fact must be known by the surgeon when approaching the hepatic parenchyma at the level of the plane of the umbilical fissure and of Rex recess.

CONCLUSIONS

The situation in which the duct of segment III drains into the medial branch is a rare anatomical variation (1.67% cases in our study material represented by 120 hepatic corrosion casts). In this situation, in its trajectory towards the medial branch, the duct of segment III crosses the plane of the umbilical fissure, being placed infraportal (and at risk to be sectioned during surgical procedures where the incision plane follows the umbilical fissure and reaches the umbilical part of the left branch of the portal hepatic vein).

The drainage of the duct for segment III into the medial branch was associated in both situations with major anatomical variations of the biliary ducts of the right hepatic lobe (posterior branch, respectively anterior branch).

The presence of all these anatomical variants overloads the biliary drainage of the hepatic parenchyma into the left hepatic duct (in the prejudice of the drainage into the right hepatic duct).

The infraportal location of the trajectory of the biliary duct for segment III that forms the medial branch of the intrahepatic biliary ducts system (together with the presence of a bridge of hepatic parenchyma at the level of Rex recess) could be explained by a malfunction in the ontogenetic development of the left hepatic divisions of liver’s parenchyma.

These particular anatomical aspects of the intrahepatic biliary drainage are useful in surgical procedures where the umbilical fissure is the plane of incision.

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