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Anatomical Structure of Childrens' Liver in Different Age

Hulkar Kabulovna Masharipova[1], Sobir Masharipovich Masharipov[2], Sayyora Muhamadovna Akhmedova[2], Ravshan Jakhongirovich Usmanov[2], Azamat Sabirovich Masharipov[1]

[1]Urgench branch of Tashkent Medical Academy, Tashkent, Uzbekistan
[2]Tashkent Medical Academy, Tashkent, Uzbekistan

Abstract **The purpose of the work** is to study the topographic anatomy and macroscopic structure of the gallbladder and biliary tract in newborns, children and adolescents. **Material and research methods.** The object of the study was 54 corpses of newborns, children and adolescents of both sexes up to 16 years old, with body weight from 3.0 kg to 55 kg, who died for reasons not related to pathology of the liver and bile ducts. Studied in detail the formation of the common bile duct, the options for its formation. **Results.** Age-related changes in the topography of the ducts concerned the length, diameter, depth, the number of branches and the severity of anastomoses between segmental branches and between the lobar ducts. The diameter of the common hepatic duct ranged from 1.1 mm to 5.0 mm, the right hepatic duct from 0.87 mm to 3.06 mm, and the left hepatic duct from 0.89 mm to 3.03 mm in different age groups. The length of the total hepatic duct is from 4.5 mm to 35.8 mm. When considering the angles of incidence between the common hepatic and left and right ducts varies. **Conclusion.** The results showed that in children of all age groups the formation of the common bile duct is variable; 2 to 5 intrahepatic ducts take part in its formation, while the number of ducts coming from the right lobe of the liver prevails.

Keywords Bile duct, Liver, Postnatal ontogenesis

1. Introduction

The rapid development of surgical diseases of the biliary tract in recent decades has increased the demand for the further study of topographic anatomy of the biliary system [1]. The introduction of new modern, innovative methods for diagnostic and therapeutic purposes in surgical practice requires a more thorough study of the topography of the abdominal organs [1,2]. It should be noted that in recent years, diseases of the biliary tract are also increasing among the youth [3,4]. This, in turn, indicates the need for a more in-depth study of the anatomy of the liver, gallbladder, and bile ducts [5,6,7]. However, in today's foreign and domestic literature, studies devoted to the age-related changes in the anatomy of abdominal organs and their topography are insufficient.

The data in the literature do not fully meet the requirements of modern surgery. So far, there are a number of unresolved issues in the scientific literature, such as the formation and development of children's bile ducts, their age-specific characteristics. The literature provides information on the involvement of the hepatic bile ducts in the hepatic portal area. However, age-related changes in the intrahepatic bile ducts during early postnatal ontogeny are an unresolved issue. Also, the age-specific morphometry of the intrahepatic and extrahepatic bile ducts in children has not been adequately studied.

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2. Purpose of the Research

Given the above, we set ourselves the goal of studying the anatomical structure of the liver, the formation of the common bile duct, their morphometric and morphological changes in children of different ages.

3. Material and Methods

Morphological examination material included organs taken from the abdominal cavity of the 54 corpses of 16-year-old children of different ages who died of causes unrelated to gallbladder and liver defects. The corpses of children of different ages, weighing from 3.0 kg to 55 kg, were used. For the purpose of the study, we divided children into the following groups: infants (1-10 days), breastfed period (11 days-1 year), early childhood period (1-3 years), first childhood period (4-7 years), second childhood period (8-12 years), adolescence (13-16 years). The body was obtained at the Khorezm branch of the Scientific and Practical Center of Forensic Medicine of the Republic of Uzbekistan. The object of study was the preparation of the liver, intrahepatic and extrahepatic bile ducts by macroscopic and morphometric examinations. The formation of the common bile duct was studied.

4. Results and Discussion

It is known from the literature that the liver changes more than other organs after childbirth. The mean liver weight in newborns was 165.5 ± 12.2 grams, which in turn was equivalent to 5.2% of body weight. As a child grows, the rate of the liver growth slows relative to body weight. The average weight of the liver during lactation is 284 ± 7.3 grams, equivalent to 4.5% of the body.

In early childhood, the liver weighs 450 ± 2.2 grams, occupying 3.8% of body weight. The weight of the liver in early childhood is 686 ± 5.9 grams and accounts for 3.5% of body weight. In the second childhood, the weight of the liver reaches 963 ± 2.8 grams and makes up 3% of body weight. During adolescence, liver weight averaged 1409 ± 4.5 grams and accounted for 2.7% of body weight.

The results of observations showed that the shape of the visceral surface of the liver of children during postnatal ontogeny is different. In newborns, during lactation and early childhood, the shape of the liver was found to be elongated in 67% of cases and oval in 33% of cases. In the first and second childhood, however, the shape of the children's liver gradually approached an oval shape, and it was noted that in 70% of cases it was oval, in 9% it was oblong, and in 21% it was triangular.

By adolescence, the shape of the liver was triangular in most cases (81%) and oval in 19% of our observations. For practical surgery, the shape of the liver gate (porta hepatis) and the condition of the formations located in it are important. Typically, two sagittal and one transverse ridge appear on the visceral surface of the liver. In the transverse branch is situated the liver gate.

Depending on the degree of manifestation of this hepatic portal, the open type - all sagittal and transverse branches are clearly reflected; closed type - sagittal branches are not visible, transverse branches are short and the gate of the liver is closed by the parenchyma of the liver; and in the mixed type the sagittal and transverse limbs appear not to be clearly reflected. When we evaluated the type of liver gate, 64% of children had a closed type of liver gate, 31% had a mixed type, and 5% had a closed type.

In 42% of cases where the position of the liver gate was observed, the gate was found to be located in the middle of the liver width. In 36% of cases, the gate was located close to the posterior edge of the liver, and in 22% of cases, the gate was located close to the anterior edge of the liver. The closed type of hepatic portal is more common in newborns and infants. This in turn makes it difficult to perform surgery. The neonatal hepatic portal was found to be 5.68 ± 0.8 cm from the anterior margin and 3.7 ± 1.3 cm from the posterior margin. During lactation, the hepatic portal is 5.4 ± 0.3 cm from the anterior margin and 4.2 ± 0.3 cm from the posterior margin, and in early childhood it is 5.2 ± 1.3 cm from the anterior margin and 4.5 cm from the posterior margin. ± 0.9 cm away.

According to our observations, an increase in the size of the liver was observed in early childhood. As the size of the liver increased, the topography of the liver gate also changed as it moved to the center. In children of this age, the gate of the liver coincided with the center of the liver. At this age, the hepatic portal was found to be 6.3 ± 2.3 cm from the anterior margin and 6.1 ± 0.7 cm from the posterior margin. During the second childhood, the size of the liver does not change much compared to the previous age. The hepatic portal is located in the center, 6.7 ± 1.6 cm from the anterior margin and 6.9 ± 1.1 cm from the posterior margin. By adolescence, the hepatic portal is located 7.1 ± 2.3 cm from the anterior margin and 7.3 ± 2.2 cm from the posterior margin.

The division of the liver into segments is well covered in the literature, and this segmental division is based on the portal vein system of the liver. Although the segmental division of the liver has been extensively covered in the modern literature, data on age-related branching of the hepatic blood vessels are inaccurate. According to the 2003 International Anatomical Nomenclature, the liver consists of 2 right and left segments, 4 segments and 8 segments.

In order to define the boundaries of the segments on the diaphragmatic surface of the liver, we made the following lines: a transverse line in the portal area of the liver, left and right sagittal lines, and a middle sagittal line dividing the liver into 2 parts. On the visceral surface, however, there are several lines delimiting the segments of the liver: the first horizontal line was drawn transversely as a continuation of the liver gate, the second line passed in the left sagittal margin.

The third line is the connection between the right outer edge of the gallbladder cavity and the outer edge of the inferior vena cava. With the 3 lines listed above, the liver can be divided into 6 segments. The visceral surface of the liver is divided into 7 segments from the point of intersection of the transverse sac with the right sagittal sac to the right anterior lateral angle.

The fragmentation of the liver is determined by two systems: the portal venous system and the inferior system. It divides the liver into segments according to the branching of blood vessels within the liver. In surgical practice, resection of parts of the liver is performed according to the branching of the portal vein.

Couinaud S. According to (1957), the liver consists of 8 segments, each segment receiving a network of hepatic arteries and portal veins, and a network of bile ducts exiting. The first four segments form the left part of the liver, the remaining four segments form the right part of the liver. The border of the liver segments separates the border from the fossa vesicae of the gallbladder to the branch of the vena cava.

This boundary can sometimes correspond to the fossa vesicae of the gallbladder on the anterior side and to the middle of the caudal segment on the posterior side. Couinaud

S. (1957) classified the posterior segment (CI) corresponding to the caudal segment in the left lobe of the liver, the posterior left lateral segment (CII), the anterior left lateral segment (CIII), and the left medial segment (CIV) in the square segment; in the right lobe, the anterior right medial segment (CV), anterior right lateral segment (CVI), posterior right lateral segment (CVII), and posterior right medial segment (CVIII).

Experiments have shown that the posterior (CI) segment of the liver is located in the caudal segment. It is bordered on the anterior side by the transverse branch of the liver and on the left by the venous longitudinal. The boundary of this segment can be determined only on the visceral surface of the liver. This segment is the smallest in terms of size, and its size depends on the size of the tail piece.

(CII) segment (left lateral segment) occupies the posterior left lobe of the liver. On the visceral surface of the liver, its boundaries are as follows: the right side is formed by the venous longitudinal, the posterior and left by the left part of the liver. The anterior border of this segment is the transverse arch passing through the portal portion of the liver. The size of the segment depends on the shape of the liver, its size, the age of the child, and the development of the blood vessels and branches of the (CIII) segment.

When the anterior lateral left segment (CIII) is clearly developed, the veins and streams of this segment touch the posterior margin of the left segment, covering not only the anterior lateral segment but also the posterior segment. The (CII) segment is often not large, approaching the medial and closer to the sulcus of the venous longitudinal. At this time, the boundary between the segments was changed, first transversely, and then a curved change in the direction of the posterior lateral margin of the left lobe of the liver.

It was found that segment (CIII) was located anterior than segment (CII). Its topography (CII) depends on the development of the blood vessels and network of the segment. The size, on the other hand, varied with age, depending on the shape of the organ and the level of development of the internal blood vessels and streams. In the triangular shape of the liver, the blood vessels were not well developed and the size of the (CIII) segment was found to be smaller.

The fourth segment of the liver (CIV) contains a square segment. The boundaries of THIS segment form the free edge of the hepatic roundwall, the sulcus of the gallbladder, and the posterior hepatic portal area. In the broad-shaped type of liver (CIV), the segment is often broad. In the round near the anterior margin of the hepatic portal, this segment was found to be short and wide.

The CV and CVI segments have been shown to be bounded by a mutually curved line occupying the anterior lateral portion of the right lobe of the liver. This curved line starts at the right border of the liver gate and is directed 45 degrees to the anterior lateral edge of the member. These two segments (CVII) are bounded by a transverse line that is a continuation of the liver gate from the segment. It was found that the size of these segments also depends on the branching of the vessel.

The CVII segment is the largest of the segments in the right segment, and its size and thickness are determined at the back of the right segment. This segment is located between segments CVI and CVIII.

CVIII segment is located in the posterior medial part of the right lobe of the liver and is visible only on the diaphragmatic surface. Segment CVIII is bounded on the left by CIV, on the right by CVII, and in front by the CV segment.

We began our study of the condition of the bile ducts with the formation of a common bile duct. The common bile duct was found to be located within the duodenum and in 80% of cases to the right and in front of the portal vein. Segmental pathways were seen when we administered a contrast agent in newborns. It was found that the anastamoses between adjacent segments and segments of the segmental bile ducts were not clearly reflected. Intra-organ bile ducts in the right lobe of the liver join together to form the right hepatic duct.

In addition, in the formation of the right hepatic duct, there may be tracts exiting the tail section, and in rare cases, the square exit from the hepatic segment of the liver. The formation of the left hepatic tract involves the bile ducts coming out of the left side of the liver, the bile ducts coming out of the quadriceps and the caudal part.

Thus, 4-5 rows of intrahepatic bile ducts, starting from the periphery of the liver, merge with each other at different angles from the acute angle to the impenetrable angle, leading to the hepatic portal. By the time, the number of bile ducts decreases and the diameter increases before arrives to the liver. 1 row of bile ducts intersect to form the right and left hepatic pathways, which in turn intersect to form the common hepatic tract located in the area of the hepatic portal.

Different types of formation of the common hepatic tract can be seen. According to our data, it is formed from 2-5 bile ducts. It can be seen that the total length of the bile duct varies from 4.2 mm to 39.5 mm and the diameter from 0.95 mm to 4.93 mm at different ages. The total bile duct length ranged from 3.5 mm to 5.2 mm in newborns and averaged 4.5 ± 1.2 mm.

The average length of the common bile duct in children of breastfed age is -9.9 ± 1.1 mm, in early childhood -19.1 ± 1.7 mm, in the first childhood 24.3 ± 1.4 mm, in the second childhood 29.1 ± 2.2 mm, and by puberty the total bile duct length was 35.8 ± 2.7 mm. When total bile duct length was analyzed in infants of different ages, the total bile duct length of breastfed infants was 2.2 times greater than the total bile duct of newborns, 1.9 times greater in early infancy than in breastfed infants, and 1.2 times greater in first and second infancy. and 1.1 times greater in adolescent children.

The total bile duct diameter ranged from 1 to 1.3 mm in newborns, averaging 1.1 ± 0.02 mm. In breast-fed children, the average diameter of the common hepatic duct was 1.4 ± 0.09 mm, in early childhood the average was 1.5 ± 0.09 mm, in the first infancy the diameter of the common hepatic duct was 1.85 ± 0.5 mm, in the second infancy -2.91 ± 0.2 mm, and in adolescence -5 ± 1.7 mm.

According to our analysis, the growth rate of total hepatic duct diameter was 27% in breastfed children, 7% in early childhood, 23% in the first infancy, 57% in the second infancy, and 71% in adolescence. It should be noted that, according to our observations, 3 out of 37 cases result in 2 pathways from the right side of the liver. The anterior bile duct exiting the right lobe of the liver is drained into the left hepatic duct, and the posterior bile duct is drained into the common hepatic duct.

2 to 4 bile ducts are involved in the formation of the common hepatic tract. In most cases, the common hepatic duct is formed in the presence of the right and left hepatic ducts. In 80% of cases, the right hepatic tract is shorter than the left hepatic tract. In 5% of cases, the right hepatic duct is drained into the left hepatic duct. In 15% of cases, 3 hepatic pathways are involved in the formation of the common hepatic tract.

In only 5% of cases, the common hepatic duct is formed by the following 4 pathways, the anterior and posterior branches of the right hepatic duct, the network of the square segment, and the junction of the left hepatic duct. In 3% of cases, the common hepatic duct was found to be formed by the fusion of the left hepatic duct, the anterior and posterior branches of the right hepatic duct, and the ducts of the quadriceps and caudal segment.

The angle of intersection of the left and right hepatic ducts of the common hepatic tract may vary. In newborns, the right hepatic duct is infused at an angle of 90 degrees to the common hepatic duct and the left hepatic duct is inflated at an angle of 70-80 degrees. According to our observations, the right hepatic duct is inserted into the common hepatic duct at a sharper angle than the left hepatic duct.

The left hepatic duct was most often located in the left part of the longitudinal sulcus or at the very exit from the parenchyma of the left lobe of the liver, much less often in the middle part of the transverse sulcus, approximately in the middle of the distance between the beginning of the common hepatic duct and the left longitudinal sulcus. Its length ranged from 6,4 mm in newborns to 60,1 mm in adolescents; the extreme parameters of the diameter of the left hepatic duct ranged from 0.7 mm in newborns to 4.7 mm in adolescents. The diameter of the left hepatic duct increased evenly with age. It was practically the same in infants - 1.43±0.4 mm and in early childhood - 1.37±0.15 mm, then the diameter increased, in children of the second childhood it was 2.67 ± 0.2 mm and in adolescents - 2.8 ± 0.11 mm, which practically corresponded to the diameter of the left hepatic duct of an adult. The length of the left hepatic duct up to 7 years of age, as well as the diameter, increased evenly, by about 1,9 mm in each age group. In children of the second childhood, a sharp increase in the length of the duct to 36.3 ± 2.9 mm and adolescents to 40.3 ± 5.3 mm was observed, which is associated with the period of puberty of the child and a sharp increase in body growth. In all age groups observed that, there were significant fluctuations in all parameters and, in particular, length - from ± 3.8 mm to ± 9.2 mm and diameter - from ± 1.1 mm to ± 0.67 mm. In addition, a significant range of parameters is associated with different physical development of children and individual age characteristics. In accordance with MAT (2003), we adhered to the description of the topography of the intrahepatic ducts according to their formation by segments. The left hepatic duct can be formed from 2, 3, or 4 ducts. In 8% of cases, the left hepatic duct was a direct continuation of its lateral branch. Such formation of the left hepatic duct may be favorable for the imposition of “end-to-side” anastomoses between the duct and the stomach after resection of the left lobe of the liver. From the left lobe of the liver, bile mainly flowed through two ducts - 75%, which drain bile from the CII and CHI segments. According to our data, the number of their second-order branches ranged from 1 to 4. In 15.19% of observations in the area of the left lobe of the liver, the ducts of the square and caudate lobes of the liver were located, which took part in the diversion of bile from this lobe. When the left hepatic duct is formed from two, the first of them was formed from 3-7 large branches of the second order. The duct was located on the border of the upper and middle third of the left lobe, closer to the visceral surface and collected bile from the entire CHI segment and part of the CII segment of the liver. The second duct, which diverts bile from the CII segment, is most often of a smaller diameter and its course is more straight. This duct collected bile from the posterior part of the left lobe of the liver and was formed from 3-10 branches of the second order. In 18%, after its formation from 2, the duct of the right medial section flowed into the left hepatic duct, which diverted bile from the CV and CVIII segments. In 84.53% of cases, from 1 to 3 ducts of the square lobe of the liver flowed into the left hepatic duct. In 82% of observations, from 1 to 3 branches flowed into the left hepatic duct, diverting bile from the posterior segment of the CI. In 15% of cases, in addition to the main ducts of the CII and CHI segments, 2 ducts of the CI segment and 1 duct of the CIV segment (ducts of the square and caudate lobes of the liver) fell into the left hepatic duct, in addition to the main ducts of the CII and CHI segments . In fact, in this case, the formation of the left hepatic duct from five sources was observed. According to our data, the duct of the CHI segment from the anterior left lateral segment was formed from branches of the second order, the number of which varied from 3 to 9. The duct of the CII segment from the posterior left lateral segment in most cases was small in diameter, formed from 3-10 branches of the second order. Most often, their diameter is much smaller than the branches involved in the formation of the duct from the left medial LLSV. Analysis of the number of branches, their diameter showed that the branches forming the duct of the anterior left lateral segment (LLS) in most cases - 87%, are longer and have a larger diameter than the branches of the duct of the posterior left lateral segment (LLS). In the liver, which has a triangular shape, with a powerful development of its posterior part, the branches forming the duct of the posterior left lateral segment (LLS) in 14% had a greater length and diameter than the sizes of the branches forming the duct of the anterior left lateral segment (ALLSIII). In all other cases, the branches of the second order of the ducts SII and SIII were of the same length and diameter. Comparing the options for the number of 2nd order branches involved in the formation of ducts that drain bile from the anterior and posterior left lateral segments, CII and CHI segments of the left lobe of the liver, it should be noted that, in percentage terms, there was a significantly smaller number of 2nd order branches involved in the formation of duct of the CIII segment of the liver compared with the number of tributaries of the duct of the CII segment of the liver. The greater number of 2nd order branches forming the CII duct of the liver segment is explained by the presence of a larger number of 3rd order ducts (8-10 branches). The percentage of the presence of such a number of branches is high: accordingly, during the formation of the duct of the posterior left lateral segment from 8 branches - 13% of cases, from 9 - 10 branches - 14% of cases. The data obtained in the study of radiographs made it possible to analyze the angles of confluence of the 2, 3, 4 orders of ducts forming the anterior and posterior left lateral segments of the liver (CII and CIII). Analysis of the material showed the predominant confluence of the ducts at an acute angle - 94%. The number of ducts falling in at right and obtuse angles is insignificant: 3.5% of ducts flowed in at right angles, and even less - 2% under obtuse angles. This fact deserves attention, since the acute angle of confluence prevents the stagnation of bile and creates the most optimal conditions for the outflow of bile through the ducts.

When studying the intrahepatic bile ducts that drain bile from the square lobe of the liver or from its CIV segment, we found the presence of 1, 2 or 3 segmental ducts. Most often (71.13%) there was a large single duct formed from 2-4 branches. In 27.83%, two ducts were found parallel to each other. Three ducts were observed in 1.03% of the square lobe of the liver.

Several options for the confluence of the intrahepatic bile ducts, which drain bile from the square lobe of the liver, have been identified:

1) the most common variant of the confluence of one or more ducts of the square lobe of the liver into the left hepatic duct along its entire length, from the place of formation to the confluence with the common hepatic duct - 71% of cases;
2) the second in frequency of confluence - 15% of observations, were preparations where one or more ducts of the square lobe of the liver fell into the duct of the anterior left lateral segment CIII;
3) in 12% of cases with the formation of 2-3 ducts, bile from the square lobe of the liver, the ducts flowed into both the left hepatic duct and the duct of the anterior left lateral segment - CIII, which was observed only in the presence of several ducts diverting bile from the square lobe of the liver;
4) during the formation of the common hepatic duct from 3 ducts, the duct that diverted bile from the square lobe of the liver flowed directly into the common hepatic duct - 8% of observations;
5) the duct of the square lobe of the liver participated in the formation of the common hepatic duct of 4 branches (6% of cases), while in one branch of the first order, branches of the second order, almost the same in diameter, were poured into one branch;
6) in 3% of observations, 1 duct of the square lobe of the liver was formed, flowing directly into the common hepatic duct when it was formed from 5 ducts. Thus, the duct of the square lobe of the liver in 17% of observations fell into the common hepatic duct, participating in its formation.

A similar picture was observed in cases when the left hepatic duct was formed from the anterior and posterior lateral ducts of the left lobe of the liver not within the left lobe and left longitudinal sulcus, but in the middle part of the transverse sulcus. The confluence of the duct of the square lobe of the liver into the duct of the anterior left lateral segment must be taken into account when resecting the left lobe of the liver. To prevent complications, you should not ligate the left hepatic duct, but each of the ducts separately.

The biliary tract of the caudate lobe of the liver varies even more in children than in adults. In 59%, one branch of the 1st order passes through the caudate lobe, taking in a small number of branches of the 2nd and 3rd orders. In 45%, 2 branches of the first order pass through the caudate lobe, flowing separately into the right or left hepatic ducts.

In 71%, the ducts of the first order of the caudate lobe of the liver are formed due to 6-8 branches of the second order of small diameter.

In 12% of cases, the duct of the caudate lobe or the duct of the posterior segment participated in the formation of the common hepatic duct, flowing directly into it. In 4.12%, the duct of the tail lobe of the S1 segment formed a common hepatic duct together with the right and left hepatic ducts, that is, the common hepatic duct in this case was formed by the fusion of three ducts. The duct of the caudate lobe of the liver participated in the formation of the common bile duct from four sources in 3,4%. In addition to it, the left hepatic duct flowed into the common bile duct, as well as the anterior and posterior branches of the right hepatic duct, which flow into separate bodies without the formation of the right hepatic duct. When the common hepatic duct was formed from 5 bodies, the duct of the caudate lobe of the liver in 3,7% flowed into it together with the left hepatic, anterior and posterior branches of the right hepatic duct, as well as the duct of the square lobe of the liver. In the presence of one branch of the first order, which we observed on 49 preparations (55,1%), in the majority - 89% of observations, it fell into the left hepatic duct, and in 19% of cases flowed into the common hepatic duct. If the outflow from the caudate lobe of the liver was carried out by 2 branches of the 1st order, which was observed on 34 preparations, then the percentage of branches falling into the right and left hepatic ducts was approximately the same - 89%. In 12%, both ducts flowed into the left hepatic duct. In cases of formation of bile outflow from the caudate lobe of the liver along 3 branches of the first order, which was 14%, their confluence varied as follows. In 56%, two branches flowed into the left hepatic duct, and one of the branches into the right, and in 46% there was a reverse topography of the first order bile ducts.

At the place of confluence, they are extremely diverse, but most often they flow into the left hepatic duct. Large differences in the places of confluence are explained mainly by the fact that not only the left hepatic duct, the right hepatic duct pass near the caudate lobe, but also ducts are formed that drain bile from the anterior left lateral segment of CHI, the posterior left lateral segment of CIV, as well as ducts draining the square lobe of the liver.

Intraorgan topography of intrahepatic biliary ducts of the right lobe of the liver. In most cases, the right hepatic duct was formed at the right border of the porta hepatis from the anterior and posterior branches extending from the right medial section and the right lateral section of the liver in the form of one duct. This duct arose from several fan-shaped primary branches that collected bile from the right lobe of the liver. The anterior branch of the right hepatic duct bent around the branch of the portal vein from below, and then merged with the posterior branch, which diverts bile from the right lateral sector. The end part of this duct, as a rule, was filled with ducts collecting bile from the right half of the gallbladder bed. The posterior branch of the right hepatic duct, diverting bile from the right lateral section, was formed from the anterior duct and from the posterior divisions of the segment duct. Further, merging from the segmental ducts of the 3 segments, the posterior branch of the right hepatic duct circled behind the base of the paramedian vein and connected to the anterior branch of the right hepatic duct. The duct lay at a depth of 15-20 mm from the visceral surface of the liver, the convexity of the arch of this duct is directed to the lower edge of the liver. The location of the posterior branch of the right hepatic duct was variable. In some cases, it was located closer to the caudate lobe, in others closer to the right edge of the square lobe of the liver. However, it was always located within the middle third of the right lobe of the liver.

Before the fusion with the anterior branch of the right hepatic duct, its diameter ranged from 1 to 3 mm. Branches flowing into the duct of the right lateral section collected bile from the lateral side of the right lobe of the liver, except for the right half of the fossa of the gallbladder and a small anterior portion of this lobe. The posterior branch of the right hepatic duct bent posteriorly, forming from several radially running segmental bile ducts. One segment was drained by 2-3 segmental ducts. This was especially pronounced in the 7th segment. With this form of fusion, the total number of bile ducts in the right lobe of the liver was greater.

In newborns and infants, the diameters of the segmental ducts did not exceed 1 mm and the number of bile ducts forming the segmental duct was less than in adults. The length of the right hepatic duct varied from 2 mm in newborns to 57 mm in adolescents. The extreme numbers of the diameter of this duct ranged from 0.6 mm in newborns to 5 mm in adolescents.

The diameter of the right hepatic duct increased evenly with age. It practically did not change in infants - 1.33 ± 0.16 mm and in children in early age (from 1 to 3 years) - 1.37 ± 0.17 mm. Indeed, in these age groups there is no significant difference in height among children, which in our opinion is the most significant factor in the size of the liver and biliary tract. Then the diameter increased evenly, by about 0.5 mm in each subsequent age group. In children of the second childhood (8-12 years old), its diameter was 2.45 ± 0.47 mm and in adolescents it was equal to 3.06 ± 0.56 mm.

The length of the right hepatic duct increased evenly with age, on average by about 4 mm in each subsequent age group. Noteworthy is the rather large increase in the length of this duct in children of the first two age groups, amounting to 15.15 ± 5.59 mm, and, accordingly, 19.33 ± 7.27 mm. This may be due to the rapid growth of the right lobe of the liver in children of this age.

In all age groups, significant fluctuations in the length of the right hepatic duct were observed, starting from the neonatal period, where the length fluctuations were within ± 5.59 mm, and ending with the older age group of adolescents, where the variation was ± 6.93 mm. Such fluctuations are characteristic of each age period and are associated with the individual characteristics of the liver and biliary system.

Typical formation of the right hepatic duct from the duct of the right medial region and the duct of the right lateral section was observed in most cases - in 76.28%, and in the rest, various variants of the topography of the ducts of the right lobe of the liver were observed.

In 23.7% of cases, there was no right hepatic duct, and the ducts that form it typically flowed into the common hepatic duct or into the common and left hepatic ducts.

In 11.34% of cases, the duct of the right lateral section formed the right hepatic duct, and the duct of the right medial part of the fell into the left hepatic duct, that is, in this In this case, there is a transposition of the confluence from right to left, which must be taken into account when performing operations on the liver and bile ducts.

In 12.36% of cases, the ducts of the right lobe of the liver fell into the common hepatic duct independently, as separate ducts. On 5.15% of preparations, the ducts of the right lateral section and the right medial section of the liver formed a common hepatic duct from three sources with the left hepatic duct.

In 5% of cases, the ducts of the right lateral section and the right medial portion of the liver participated in the formation of the common bile duct from four sources together with the left hepatic duct, as well as the duct that diverts bile from the caudate lobe of the liver (2.06%) or the duct that diverts bile from the square lobe of the liver (2.06%). When the common bile duct was formed from five sources, the right hepatic duct was absent. In this case, the ducts of the right-lateral section and the right medial part of the liver fell into the common hepatic duct in separate trunks together with ducts from the caudate and square lobes of the liver, which was found in 3.2% of preparations.

The right hepatic duct was observed on 77 preparations, in 49% of cases there were 2 duct tributaries of the same diameter and number - the duct of the right lateral section of the liver, or the posterior branch of the right hepatic duct, and the duct of the right medial part of the liver or the anterior branch of the right hepatic duct, which diverts bile from the segments. The number of first-order branches forming them ranged from 2 to 4. Such a formation can be attributed to the main type, with this type a greater number of branches of the 2nd order was more often observed in the anterior branch of the right hepatic duct.

In 24% of cases, the formation of the right hepatic duct was carried out from 3 branches. With this mixed type, the ducts of the 1st order are short; the segmental ducts of the anterior right medial segment and the posterior right medial segment formed the anterior branch of the right hepatic duct, and the lateral ducts from the anterior right lateral segment and the posterior right lateral segment did not join into the posterior branch of the right hepatic duct, but fell directly into the right hepatic duct. There are 5-6 rather large second-order ducts that form these ducts. The last, rarely encountered types, when the right hepatic duct was formed from a larger number of ducts, can be attributed to the loose type of branching. The formation of the right hepatic duct from a greater number of ducts of the right lobe of the liver is associated with their segmental inflow into the right hepatic duct. In 5.15% of observations there were 4 first-order ducts, in 3% 5 branches of the first order were found and in 1.03% there were 6 branches of the first order. Moreover, it increases to 7-12 and the number of branches forming them of the 2nd order, evenly distributed over the entire right half of the liver. Thus, from the right lobe of the liver, bile can flow into the right hepatic duct along 2-6 ducts of equal diameter.

In 30% of cases, after its formation, 1 duct flowed into the right hepatic duct from the anterior and posterior branches, diverting bile from the caudate lobe of the liver, segment C1. In 6.8% of cases, 2 ducts flowed into the right hepatic duct, diverting bile from the caudate lobe of the liver, the right and left ducts of the caudate lobe of the liver. Evaluating the number of branches that make up the ducts of the right lateral section and the right medial part of the liver, it is possible to conclude that there is a certain predominance of branches that form the anterior branch of the right hepatic duct.

When comparing the length and diameter of the branches, it is possible to note the predominance of the length and thickness of the second order branches forming the posterior branch of the right hepatic duct, which apparently compensates for the smaller number of branches.

The data obtained in the analysis of radiographs of the intrahepatic ducts of the right lobe of the liver made it possible to reveal the predominance of acute angles of confluence of the ducts of 2, 3, 4 orders. 94% of the ducts were connected at an acute angle, inflows at right and obtuse angles were observed in isolated cases – 4.2% and 3.3%.

Analysis of the data obtained in the study of the intrahepatic bile ducts that form the right and left hepatic ducts, made it possible to note that the total number of ducts is 1 of the order of the left lobe of the liver, their length and diameter are greater than the corresponding measurements of similar ducts of the right lobe of the liver.

At the same time, it should be emphasized that although the number of branches of 1 order of the left lobe of the liver in the back (segment CII) is slightly more than the number of similar branches in the front (segment CIII), their length and diameter are much larger than similar branches of the anterior part of the left lobe of the liver.

Thus, wounds and blunt trauma to the left lobe of the liver and especially the posterior part of it are most dangerous because of the possibility of greater bile leakage.

The left hepatic duct was in most cases longer than the right, with practically the same diameter, which, apparently, depends on the level of confluence of the branches of the first order into these hepatic ducts.

During the formation of ducts of all orders, acute angles of confluence prevailed in the right and left lobes of the liver. The percentage of observations when the ducts flowed at a right or obtuse angle was negligible. This fact is of great clinical importance, since the acute angle of confluence prevents the stagnation of bile and creates the most optimal conditions for the outflow of bile through the ducts.

5. Conclusions

The topography of the liver gate varies depending on the shape of the liver, its size, and the age of the person. The topography of the hepatic portal indicates the branching of hepatic blood vessels, the state of formation of bile ducts within the liver. In children, the hepatic portal may be located in the middle of the visceral surface of the liver, or closer to the anterior or posterior margin. Thus, in children, in most cases, the location of the hepatic portal is of the closed type.

The location of the liver gate close to the posterior margin poses a challenge for the surgical procedure. The boundaries between the segments are conditional, and they correspond to the branches of the vascular branches and branches. The variability in the location of the segments makes it difficult to determine their boundaries. During surgery, it is advisable to tie a vascular leg that supplies blood to a specific segment to determine the boundary of the segment.

The segments join together to form a larger part of the member. For example, segments CII and CIV mutually form the left paramedian sector, segment CII the lateral sector, segments CV and CVII together form the right paramedian sector, and segments CVI and CVII the right lateral sector. The CI segment is the dorsal sector.

Thus, 2 to 4 pathways are involved in the formation of the common hepatic tract. In all cases of our observations, the right hepatic tract is shorter than the left hepatic tract. Cases of infiltration of the right hepatic duct into the left hepatic duct were observed. However, we did not observe the infiltration of the left hepatic duct into the right hepatic duct. The practical significance of these conclusions is that the left hepatic duct expels bile fluid not only from the left lobe, but also from the right lobe of the liver.

Such anatomical structure of the liver should be taken into account when resecting the left side of the liver. The above data prevent the occurrence of serious complications in liver surgery.

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