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THE STRUCTURE AND FORMATION OF TOPOGRAPHY OF THE VENOUS DUCT IN HUMAN PRENATAL ONTOGENESIS

Abstract. *Using a complex of morphological methods, we have studied the venous duct development in human prenatal ontogenesis. It was established that the venous duct is formed in the embryo on the fifth week of fetal development by combining intrahepatic sinusoids. Later the venous duct anastomoses with the umbilical vein and in the fetuses it becomes its final branch together with the portal sinus.*

Key words: *venous duct, umbilical vein, portal sinus, prenatal period, human fetus.*

Introduction. The anatomical location of the venous duct (VD) is strategically important because it carries oxygenated blood coming from the placenta, bypassing the liver to the fetal heart and its brain. About 30% of the oxygenated blood from the umbilical vein runs through the venous duct [1, 2].

Doppler assessment of blood flow in the VD is becoming more common in clinical obstetrics [3]. Estimation of the fetal development includes ultrasonic Doppler examination of the umbilical artery, the medial cerebral artery and the thoracic descending aorta as well as blood flow in the VD [4, 5].

According to the current views, intrauterine fetal hypoxia is the leading cause of perinatal pathology. It results in the intrauterine growth restriction. In turn, inborn errors of trophism and old prenatal hypoxia is the main background status and a cause of a child's later neurological and somatic pathology [6, 7].

Absence of the venous duct should be excluded in the fetus with unexplained megalocardia or umbilical vein dilatation, that of systemic veins or venous sinuses [8, 9].

Objective: To establish structural features and venous duct morphogenesis at different stages of the fetal development. To follow the dynamics of morphological changes in the structure of the venous duct depending on the age of the fetus through a set of modern morphological techniques.

Materials and methods. The study was

conducted on 36 specimens of human embryos, pre-fetuses and fetuses. The material was taken from obstetrical clinics of Chernivtsi. Several series of histological sections were borrowed from the museum of M.H. Turkevych Department of Human Anatomy of HSEI of Ukraine «Bukovinian State Medical University» Fetal specimens weighing more than 500 g were studied directly in the postmortem department of Chernivtsi Regional Children's Hospital.

The fetal specimens were measured first and fixed in 10-12% solution of formaldehyde for 2-3 weeks, after which they were stored in a 3-5% solution of formaldehyde.

Using several morphological methods: histological, fine dissection and corrosion we studied the formation and structure of the venous duct in human prenatal ontogenesis.

Results and discussion. During the fifth week of fetal development the right umbilical vein and the proximal part of the left umbilical vein reduce. In the body of the fetus the right umbilical vein as the vessel that goes to the liver stops functioning and all the blood from the placenta is directed to the left umbilical vein. The width of the lumen of the umbilical vein in the embryo with 6.5 mm of crown-rump length (CRL) is 250 microns.

Entering the liver, the umbilical vein branches anastomose with the hepatic sinusoids to create a new channel. The flow through these early anastomoses plays an important role in organogenesis of the venous structures and

human liver segmentation.

With the increased volume of blood entering the liver, sinusoids, when combined, form a large vessel – the venous (Arantius') duct. The width of the lumen in the VD of the embryo with 6.0 mm of CRL is 200 microns. Through this vascular channel the flow of blood coming from the umbilical vein to the liver in its bulk is carried away by the hepatic capillaries and hepatic portal veins and this way from the umbilical vein directly to the inferior vena cava.

The sizes of the pre-fetuses aged 11-12 weeks of fetal development are sufficient (54 -79.0 mm of CRL) to study their basic anatomical structures, including the VD.

The main trunk of the umbilical vein at the end of the pre-fetal period (12 week old pre-fetuses) is $6,2 \pm 0,8$ mm long, the outer diameter at the edge of the liver is $0,90 \pm 0,15$ mm and at the site of branching it is $1,70 \pm 0,25$ mm long.

After the side branching the umbilical vein divides into two end branches at the level of the transverse fissure: the VD and the portal sinus.

The VD runs in the back part of the left sagittal sulcus in the anterior-posterior direction, it is a direct continuation of the umbilical vein and flows into the inferior vena cava. On its way, it does not branch or adds vessels. The duct is conical, its narrowed end is located near the site of division of the umbilical vein. Diameter of the duct increases towards the inferior vena cava.

The VD in 12 week old pre-fetuses(CRL 67,0-79,0 mm) is $5,7 \pm 0,4$ mm long and the outer diameter near the portal end - $1,30 \pm 0,13$ mm at the caudal one- $1,70 \pm 0,12$ mm long.

The portal sinus located in the transverse fissure of the liver goes somewhat awry from the left to the right and from the top to the bottom and connects with the left partial branch of the portal vein, which forms the right 1/3 of the portal sinus, then it becomes an anastomotic vessel between the systems of umbilical and portal veins.

In the transverse fissure of the liver the portal sinus is located deeper than the partial left branch of the portal vein and the hepatic artery proper. In its course the sinus does not branch out or accept branches, it is cylindrical in shape,

its diameter is somewhat larger than the diameter of the left partial branch of the portal vein.

At the end of the pre-fetal growth period the portal sinus is $2,6 \pm 0,2$ mm long, and its outer diameter is $0,77 \pm 0,03$ mm long.

In the early fetal period two venous systems are found in the liver. The first one is afferent and consists of the umbilical and the portal veins, through which the blood accumulates from the placenta and the intestines in the liver. The second one is the efferent venous system, consisting of the hepatic veins for blood outflow from the liver parenchyma to the heart. Through the venous duct the oxygenated blood flows to the heart from the umbilical vein system, bypassing the liver.

In four-five month old fetuses (with CRL 81,0-185 mm) the umbilical vein entered the abdominal cavity in the middle of the falciform ligament in the upward direction at an angle to the liver. Through the anterior edge of the organ the vessel passes cranially through its lower surface. Later it joins the venous sinus. The venous sinus is presented as an L-shaped broad vessel, connecting the right and the left branches of the intrahepatic part of the portal vein.

In this group of fetuses the VD originates from the venous sinus, which is located at an almost right angle to the right lobe of the liver. The vessel is hourglass-shaped, does not give the branches, runs in an upward direction towards the diaphragm. The opening of the VD corresponded to that of the umbilical vein.

The VD in 6-7 month old fetuses is mainly conical in shape and is located at the back of the left sagittal fissure of the liver between its left and caudate lobes. The length of the duct in this group of fetuses ranges from 7.0 to 12.0 mm. The diameter of the vessels varies along its length: the umbilical end is narrower (from 2.0 to 3.5 mm in diameter) in the direction of the inferior vena cava the duct gets dilated (from 3.0 to 4.0 mm in diameter).

In most observations (75%) the VD is a direct continuation of the umbilical vein in 25% of them it departed from the umbilical vein at an obtuse angle. In most cases the duct entered the

inferior vena cava by itself, slightly above the site of confluence of the hepatic veins, in some cases it formed a common trunk with the left hepatic vein, and it entered the inferior vena cava.

The portal sinus, one the end branches of the umbilical vein, is located in a transverse fissure of the liver, where it is connected to the left branch of the hepatic portal vein. From outside it is surrounded by a connective tissue sheath which is also common for the bifurcations of the left branch of its own hepatic artery and the bile ducts. The portal sinus leaves the main trunk of the umbilical vein at an obtuse angle (120-140°). Only in one observation there was no portal sinus. In this case, the main trunk of the umbilical vein connected directly to the hepatic portal vein at the level of the transverse fissure.

Conclusions. VD is formed in the embryo on the fifth week of the fetal development by combining intrahepatic sinusoids. Later the VD anastomoses with the umbilical vein and already in the fetuses it becomes its end branch combined with the portal sinus.

Prospects of further research. We are going to study the venous duct in human infants later.

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