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THE MORPHOLOGICAL AND MORPHOMETRIC STATE OF THE LIVER'S VASCULAR-TISSUE STRUCTURES IN THE OFFSPRING OF INTACT EXPERIMENTAL RATS DURING POSTNATAL ONTOGENY DYNAMICS (experimental study)

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ABSTRACT

Our research has shown that the morphological examination of the liver's vascular-tissue structures in rat offspring during the early postnatal periods indicates that the processes of organ development and formation are not yet fully completed by the time of birth. During the early postnatal period, in connection with functional formation, not only does the size of the organ increase, but the processes of structural reorganization also occur. According to our data, the processes of development and formation of the liver's structural composition in rats are completed by the 30th day of postnatal development.

Key words: white rats, liver, tissue and blood vessels, postnatal ontogeny.

INTRODUCTION

Relevance of the topic. The liver is an organ where processes of detoxification and neutralization of toxic substances occur. These substances either come from the external environment or are produced within the body as a result of metabolic processes. Due to these anatomical and functional characteristics, the liver becomes the "target" of toxic-infectious and exogenous as well as endogenous toxic agents. It is well-known that the liver is considered the "biological laboratory" of the body, where metabolic processes and the synthesis of vital substances take place. Currently, there is a growing trend in the rate of chronic liver injuries and diseases, often characterized by their chronic and recurrent nature, as well as a tendency to progress into malignant forms. [1,2,3,4,5]

Objective of the study: To investigate the morphological and morphometric changes in the vascular-tissue structures of the liver in the offspring of intact experimental rats during the dynamics of postnatal ontogeny.

Materials and methods of the study: The study utilized the offspring of 22 intact white laboratory rats raised in vivarium conditions. The research objects were the livers of rat pups at 3, 7, 14, 21, and 30 days of postnatal ontogeny. The study employed general morphological, morphometric, and variation-statistical analysis methods.

Results and analysis: The liver is a vital organ that performs various important functions in regulating metabolism and systemic homeostasis in living organisms. It is considered the "biological laboratory" of the body, where almost all metabolic processes and the synthesis of essential substances take place. The liver is also the organ where bacterial and toxic substances, originating from the external environment or produced within the body during metabolic processes, are deactivated, neutralized, and detoxified.

Study of histological microslides of 3-day-old intact rat pups' livers the examination of histological microslides of 3-day-old intact rat pups' livers revealed that the processes of lobular development, microcirculatory bed formation, and hematopoiesis are still ongoing. The lobular structure of the liver is not yet well-defined. Hepatocytes are very small in size, irregularly arranged, and densely packed together. They do not form clearly oriented plates around the central vein. In the liver plates, hepatocytes form 3-4 rows. Polymorphism of hepatocyte nuclei is noted. Mitotically dividing cells are observed in significant numbers. Hepatocytes vary in shape—round or polygonal—and their cytoplasm is uniform and finely granular. Some hepatocytes contain small vacuoles. The intercellular spaces are narrow, and bile canaliculi are visible in these areas.

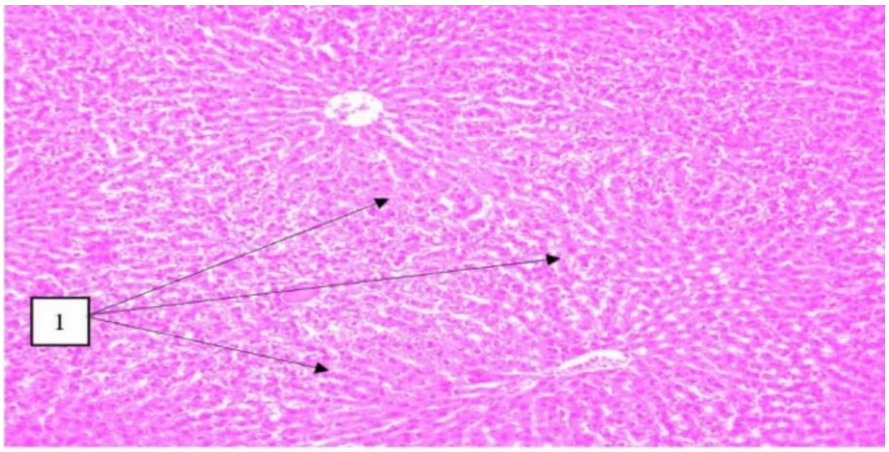

Figure 1. Morphological state of the liver in offspring of intact female rats day 3 of postnatal life hepatocytes are of various shapes, and their cytoplasm is homogeneous and finely granular. Stained with hematoxylin-eosin. Magnification: 10×10.

Thus, on the 3rd day of postnatal life, the processes of rapid formation of the liver's structural units continue. The hematopoietic system develops, and active blood formation is maintained. A significant amount of lipid inclusions is detected in the cytoplasm of hepatocytes. This phenomenon may be associated with the fact that newborn pups are fed with fat-rich colostrum.

Day 7 of postnatal life in rat offspring on the 7th day of postnatal life, the processes of liver lobule development, formation of the microcirculatory bed, and hematopoiesis continue. Liver plates begin to form, but their radial orientation is not yet clearly expressed. Central veins, which were round in earlier stages, now take on a star-like shape. A significant portion of sinusoidal capillaries are narrow, with slit-like spaces, although localized areas of wider spaces are observed, particularly in the periportal region.

Hematopoietic foci in the liver appear as small islands, containing single megakaryocytes and other immature blood cells. Numerous hematopoietic foci are located in the portal tracts and pericapillary zones. Accumulations of hematopoietic cells are observed around the triads and between hepatocytes. Infiltration with cellular elements around the portal veins is less pronounced compared to earlier stages. No hematopoietic foci are detected around the central veins. The triads (portal tracts) are more clearly defined.

In the parenchyma, central veins are more densely distributed per unit area compared to adult rats. Sinusoidal capillaries are small, with narrow spaces. Hepatocytes are irregular in shape, and nuclear polymorphism is noted. Hematopoietic foci are visible.

Summary of findings on day 7 of postnatal life in rat offspring the studies on the 7th day of postnatal life in rat offspring indicate that the processes of structural

reorganization in the liver continue. Hematopoietic foci are still present, but their intensity significantly decreases. The proliferative activity of hepatocytes decreases, and the number of binucleated cells increases.

Thus, the examination of the morphology of the liver's vascular-tissue structures in rat pups during the early postnatal periods shows that the processes of organ development and formation are not yet fully completed by the time of birth. During the early postnatal period, in connection with functional formation, not only does the size of the organ increase, but the processes of structural reorganization also occur.

Electron microscopic examination electron microscopic studies revealed that during this period, further accumulation of organelles is observed in hepatocytes. Liver cells are densely packed together. Their cytoplasm contains densely packed oval and elongated mitochondria. The nuclei are round or oval in shape, and granular endoplasmic reticulum with its tubules is identified around the nuclei and mitochondria.

Electron microscopic examination (continued) free ribosomes and lysosomes are observed. The cytoplasm of many hepatocytes contains lipid droplets of various sizes. In some hepatocytes, glycogen granules begin to accumulate, forming dense clusters. Mitochondria are numerous, small, and round in shape. The granular endoplasmic reticulum is well-developed and located around the nuclei and between mitochondria. Some poorly differentiated hepatocytes are also observed, containing fewer organelles. Bile canaliculi have narrow spaces, and their microvilli are weakly developed.

Summary of findings on day 7 of postnatal life in rat offspring the studies on the 7th day of postnatal life in rat offspring indicate that the processes of structural reorganization in the liver continue. Hematopoietic foci are still present, but their intensity significantly decreases. The proliferative activity of hepatocytes decreases, and the number of binucleated cells increases. Unlike the 3-day-old stage, the amount of glycogen in the liver noticeably increases during this period. Glycogen appears in all hepatocytes in the form of granules and clusters.

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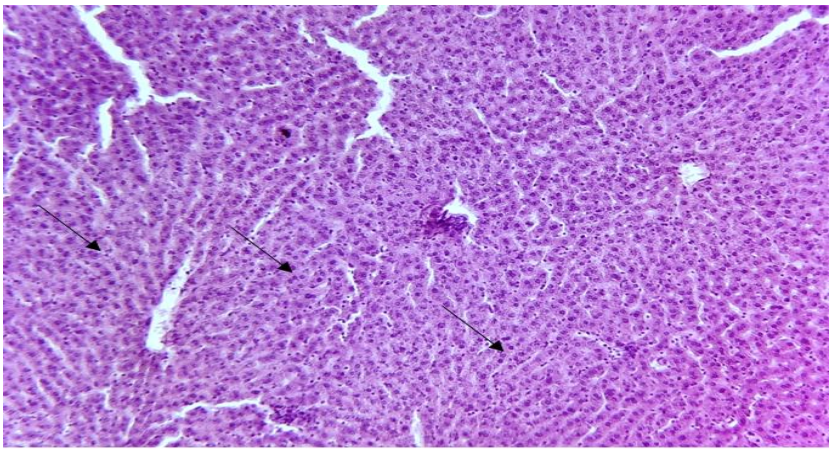

Figure 2. Liver of intact rat pups on the 21st day of postnatal life.
Radially oriented slit-like sinusoidal capillaries and liver plates are clearly visible around the central vein. Stained with hematoxylin-eosin. Magnification: 3.5×10.

Histochemical examination histochemical studies revealed a significant amount of glycogen in hepatocytes, which is irregularly distributed within the lobules. The mitotic activity of hepatocytes continues to decrease compared to the indicators observed in 14-day-old animals.

Electron microscopic examination electron microscopic studies showed a noticeable increase in the cytoplasmic area of hepatocytes. The density of mitochondria is reduced, and they are identified as round or oval in shape. The granular endoplasmic reticulum is well-developed and located near mitochondria, with some areas showing accumulation in various parts of the cytoplasm. The cytoplasm contains a large number of free ribosomes and polysomes.

Summary of findings on day 21 of postnatal life in rat offspring studies of the liver in 21-day-old rat pups indicate that the lobular structure of the liver is well-developed by this stage. Hepatocytes vary in size and structure, ranging from small and poorly differentiated to large cells. The process of hematopoiesis is completed. The development of the portal vascular system continues.

Findings on day 30 of postnatal life in rat offspring: examination of the liver in 30-day-old rat pups shows that the lobular structure of the liver is almost indistinguishable from that of adult animals. Radially oriented liver plates are clearly visible around the central veins. Sinusoidal capillaries are slit-like, with narrow spaces, and contain numerous Kupffer cells. A small amount of connective tissue is observed around the triads. Hepatocytes have a uniform structure, although their sizes vary. The nuclei of hepatocytes are round, and larger hepatocytes may contain 2-3 nucleoli. The cytoplasm of hepatocytes is coarse and granular, with periportal hepatocytes being significantly smaller in size. The mitotic activity of hepatocytes is low. The number of binucleated cells has nearly doubled compared to earlier stages of examination.

Summary thus, studies of the morphology of the liver's vascular-tissue structures in rat pups during the early postnatal periods indicate that the processes of organ development and formation are not yet fully completed by the time of birth. During the early postnatal period, in connection with functional formation, not only does the size of the organ increase, but the processes of structural reorganization also occur. According to our data, the processes of development and formation of the liver's structural composition in rats are completed by the 30th day of postnatal development.

Table 1.

Morphometric Indicators of Hepatocytes in the Liver of Intact Rat Pups During Postnatal Ontogeny Dynamics

Indicators	"3-day-old"	"7-day-old"	"14-day-old"	"21-day-old"	"30-day-old"
Number of binucleated cells (%)	0,57±0,04	0,74±0,05	0,95±0,07***	2,46±0,19***	4,35±0,34***
Mitotic activity (%)	1,0±0,08	0,93±0,007	0,78±0,06*	0,69±0,005***	0,59±0,05***
Hepatocyte area (μm²)	85,60±6,21	104,5±7,7	123,2±9,3***	136,5±10,7***	160,7±12,9***
Bile canaliculus (μm)	0,235±0,002	0,217±0,02	0,195±0,001	0,186±0,001	0,174±0,001

Note: The differences are significant compared to the indicators of 3-day-old rat pups (* – P < 0.05, ** – P < 0.01, *** – P < 0.001).

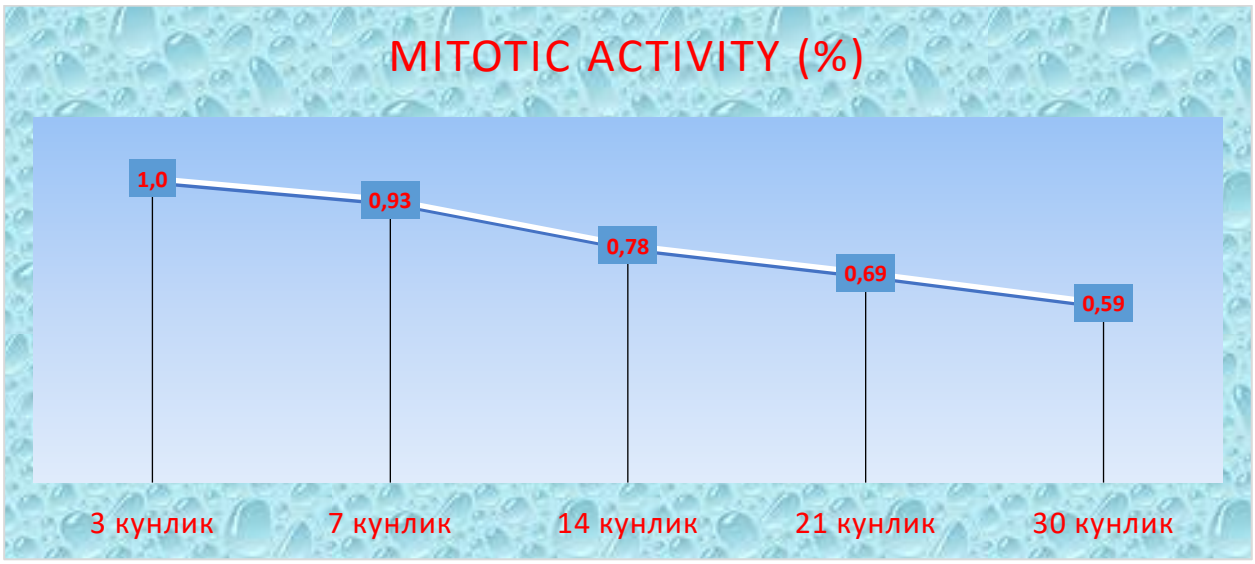

Figure 3. Dynamics of Morphometric Indicators of Hepatocytes in the Liver of Intact Rat Offspring.

Conclusions. Thus, studies of the morphology of the liver's vascular-tissue structures in rat pups during the early postnatal periods indicate that the processes of organ development and formation are not yet fully completed by the time of birth. During the early postnatal period, in connection with functional formation, not only does the size of the organ increase, but the processes of structural reorganization also occur.

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