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INVESTIGATING PATHOMORPHOLOGICAL CHARACTERISTICS OF THE UMBILICAL CORD IN CLINICAL MODELS OF PREECLAMPSIA

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Abstract

The world pays special attention to the diagnosis and treatment of hypertensive conditions in pregnant women, as well as related complications. Perinatal complications that occur after childbirth in women with preeclampsia and eclampsia are an urgent problem in modern medicine. To solve issues related to preserving the life and health of the mother and child, innovative approaches are needed in the study of all links of the mother-placenta-fetus system, including the use of clinical and pathomorphological methods.

Key words: *preeclampsia, umbilical cord,* eclampsia, mother-placenta-fetus system, antenatal diagnosis.

Introduction. The purpose of our study was a pathomorphological study of the umbilical cord in preeclampsia (PE) using innovative methods (atomic force and electron scanning microscopy) to improve antenatal diagnosis in the prevention of intra- and postnatal morbidity and mortality.

Materials and methods. 25 umbilical cords of women with PE (15 moderate and 10 severe) were studied. Two samples were selected from different areas. For subsequent analysis to implement a light-optical study, the samples were fixed in 10% neutral buffered formalin, and then they were embedded in paraffin and sections were made from the blocks on a microtome, which were then standardly stained with eosin and hematoxylin, described and photographed in a Topic-T Ceti microscope ".

For scanning electron microscopy (SEM), the samples were washed at a temperature of 37 °C in several portions of sodium chloride made in the form of an isotonic solution. They were then dipped into a glutaraldehyde fixation mixture (2% in phosphate buffer). After this, the objects were analyzed and photographed in microscopes: “FE1 Quanta 200 3D” and “FE1 Quanta 600 FEG”.

In addition, tissues were analyzed using probe microscopy (atomic force laboratory) after preliminary viewing of sections under a light microscope. After targeted viewing, shooting and morphometric processing were carried out. Probe scanning microscopy was performed using a Ntegra-Aura device. The work was carried out in contact modes of intermittent as well as constant profile using Si or SiN cantilevers, using a low vacuum atmosphere. Analysis and execution of atomic force images was done using standard software NOVA (“NT-MDT”) and ImageAnalysis (“NT-MDT”).

Research results. When examining the umbilical cord, we showed that in PE, as in the normal course of pregnancy, the outside is covered with single-layer squamous cubic epithelium, which is located on a massive basement membrane. It should be noted that pathology revealed a structural disorder in some of its fragments. Most of the umbilical cord is represented by

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mucous connective tissue - Wharton's jelly. Having a gel-like consistency, it provided the umbilical cord with plasticity and elasticity. In pathology, we observed some sparseness, down to focal areas of necrosis with the formation of pseudocysts. The content of myofibroblasts, and especially fibrocytes and fibroblasts (mainly with long processes), progressively increased as the severity of PE increased. This provoked the growth of collagen fibers, up to the formation of sclerosis. Stromal channels were found between the fibrous structures. Their walls were strengthened by fibroblast processes. The structure was also fragmentarily damaged by pathology.

These changes worsen the functional state of the umbilical cord, making it possible to develop macropathology with the formation of nodes, including false, local thickenings and other variants of pathology, the likelihood of which increased with PE. When studying the umbilical cord, our main attention was paid to the study of the vascular bed. It can be seen that the connective tissue substance contained one umbilical vein and two umbilical arteries. By scanning electron microscopy, their helical twisting was clearly visible. We have shown that with PE the area of the vessels was increased, especially in severe cases. The umbilical veins had a thick muscular wall with focal fragments of alteration in PE. Their wall was slightly smaller in diameter than in the arteries, and the lumen was expanded.

The inner lining of the vessels was lined with endothelium. We have identified a violation of the microrelief of these cells during PE (Fig. 1, 2). At the same time, the height of its folds was reduced, and the distance between them, on the contrary, was increased. Fragmentary areas of necrosis were revealed. In certain areas of the endothelium, adhesion of blood cells and deposition of fibrin threads were detected. Stasis, sludge, and thrombosis were detected inside the vessels. These vascular disorders progress as the severity of the pathology increases. Endothelial cells are tightly connected to each other using complex junctions. They, through thin processes penetrating the basement membrane, connected with the underlying leiomyocytes, forming a single endotheliomuscular system, the structure of which was disrupted in individual fragments during PE.

Endothelial cells of arteries and veins in pathology had a greater variation in size. When studied using atomic force microscopy, it was in the range from 0.2 to 0.8 μm. In cases of PE, especially in its severe course, a disturbance in the structure of the joints between them was observed. Necrotic fragments of endothelium were also identified.

Below it was an endothelial layer, the thickness of which was slightly increased during PE. The muscle layer in the umbilical cord arteries is divided into two: internal and external. The inner layer consisted of loosely arranged, poorly differentiated smooth muscle cells without a clear orientation, separated by an amorphous substance. The outer muscle layer was observed in the form of closely spaced smooth muscle cells with a circulatory pattern. With PE in these structures, we described local alterative changes in the form of stromal-vascular protein degeneration, up to necrosis, which may be a consequence of hypoxia developing during the pathology. Electron microscopy shows that muscle cells become homogeneous, with a disruption in the structure and connections between them.

When studying red blood cells, it was revealed that in the lumen of blood vessels during pregnancy pathology, the number of discocytes was reduced to 46% (85% in the control group). They had a fairly large range in size with a diameter of 5.92±0.83 μm and a thickness of 1.98±0.51 μm. As the severity of the disease increased, both the content of reversibly changed forms, as well as pre-hemolytic and degenerative ones, increased. At the same time, the number

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of erythrocytes in the form of a flattened and swollen disk, as well as cells in the form of a complete and incomplete sphere and spiny erythrocytes, increased significantly.

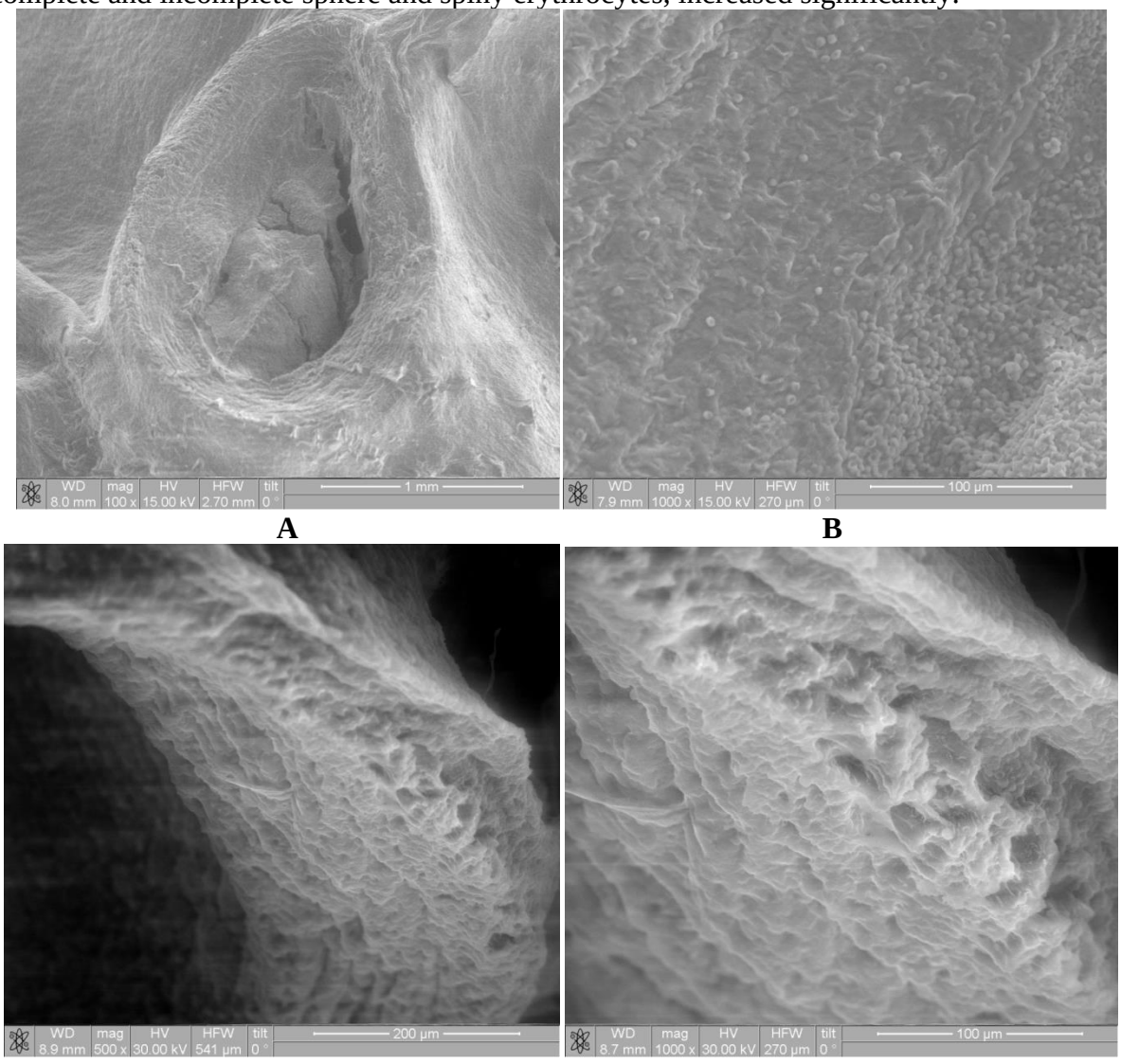

Figure 1. Umbilical cord fragments from women with moderate preeclampsia.
Pic 1. A, B. In the lumen of the vessel - the formation of a blood clot. The structure of endothelial folds is disrupted. Stasis of erythrocytes near endothelial cells and their diapedesis.
Pic 2. C, D. The lumen of the vessel is free. The structure of endothelial folds is disrupted. Cells of various sizes and shapes.
SAM. Pic. B (x1000) fragment of Pic. A(x100). Pic. D (x1000) fragment of Pic. A (x500).

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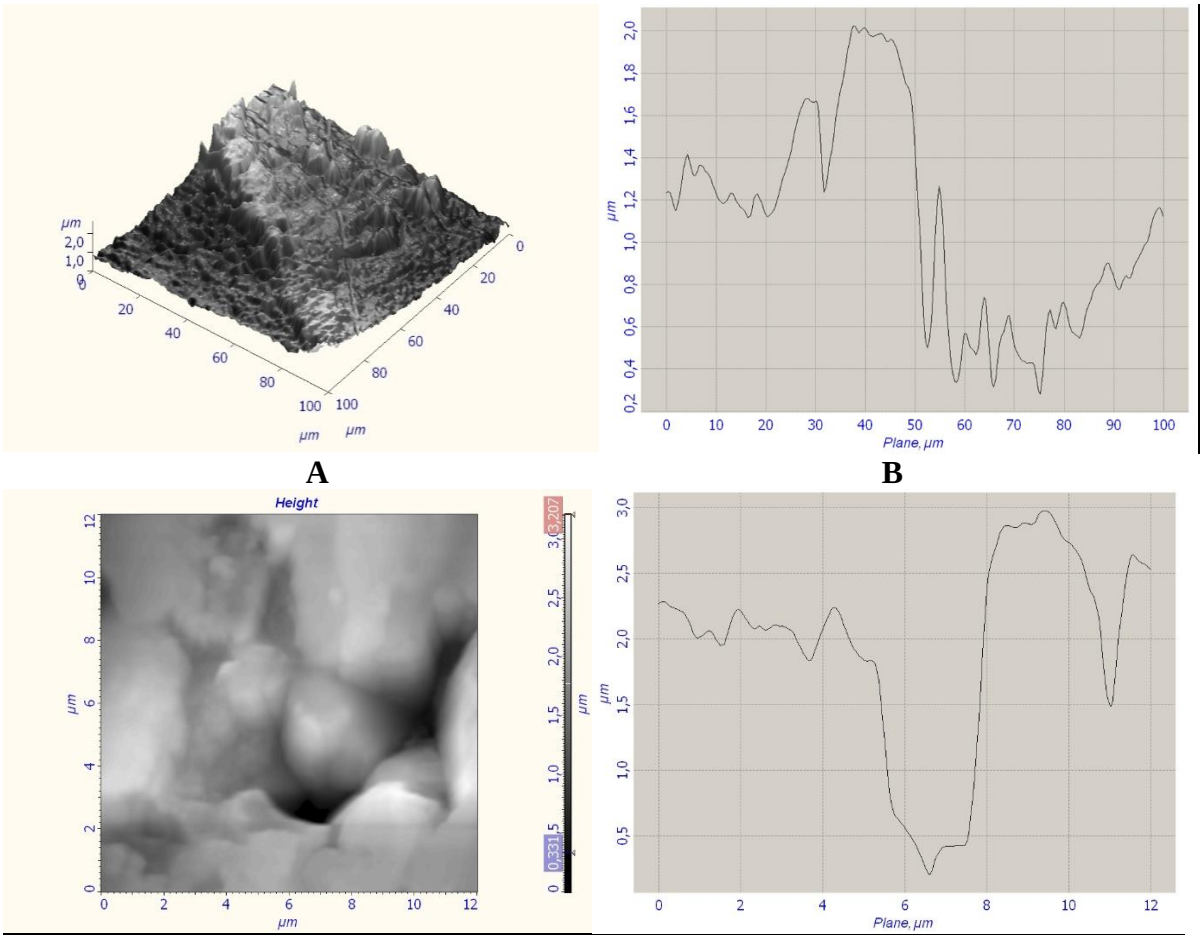

Figure 2. Fragments of the umbilical cord of a woman with severe preeclampsia.
Pic. A, B. Endothelial cells of various sizes and shapes. Some of them are with necrosis. The structure of endothelial folds is changed. The connections between cells are partially broken. There are single red blood cells in the lumen of the vessel.
Pic. C, D. The lumen of the capillary is narrowed. The structure of endothelial folds is disrupted. In the lumen there are red blood cells with a changed shape.
Atomic power laboratory (A, C - three-dimensional histogram).
Rice. B, D – graphical representation of Fig. A, C.

Thus, innovative approaches to the study of the pathomorphology of the umbilical cord in preeclampsia make it possible to expand information about the morphogenesis of this pathology in order to improve antenatal diagnosis in the prevention of intra- and postnatal morbidity and mortality.

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