HISTOLOGICAL AND ELECTRON-MICROSCOPIC INVESTIGATION OF THE IMMATURE LUNGS

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One of the most common reasons for death in perinatal period is the pulmonary insufficiency (1, 3, 4). The beginning and development of the respiratory disorders is usually connected with the insufficient secretion of the superficial active substance due to immaturity of the new-born lungs (12). Therefore, the morphological biochemical and functional characteristics of the immature lung (IL) attracts the attention of great number of investigators from various branches of the medical science and practice. The histological structure of IL is still not enough studied and it is not well known by the pathomorphologists. The investigation of the precise criterion of the IL will allow a proper interpretation of the various pathological processes in new-born lungs.

The object of the present study was to examine histologically and electron-microscopically the lungs of foetuses and new-born mice and lungs of still-born and new-born children in order to find out some certain morphological criteria for pulmonary immaturity (PI) and its frequency among autopsy material of children.

Materials and methods

We studied the lungs of mice: foetuses and new-born, divided into the following groups: 2—3 days-before-birth foetuses, new-born (killed immediately after birth), mice killed on the 7-th and 14-th day after birth; 5 animals from each group were studied. Together with this we investigated histologically the lungs of 308 new-born and still-born children in order to analyse the frequency of PI among them.

The materials for histological study were worked after the parafine method; the preparations (5 microns thick) were stained with HE; silver impregnation after Gomori (reticular fibres); with AZAN; with resorcin-fuxin after Weigert; PAS — reaction and staining with primulin and actiflavin for luminescent examination of colagen and elastic fibres. Part of the pulmonal parenchyme (1 mm³) was fixed in 5% glutaraldehyde and 1% osmium oxide, then incorporated in durcopan and investigated under electron microscope JEM-7A; the cuts were contrasted with uranil-acetate and plumbum-nitrate after Reynolds.

Results and discussion

The lungs of mice-foetuses (2—3 days before birth) were tough-looking, highly hyperaemic. The alveoli were small-size, oval, difficult to identify from the alveolar ducts. The alveolar epithelium, tapering the airy spaces, was high-cylindrical with excess bright and slightly granulated cytoplasma, where certain amount of glycogen was detected. The nucleus was centrally located,
oval, with lightly stained chromatin. The capillary set was well developed; the capillary loops in the alveolar septi were distributed between the epithelial cells but some of them were not covered by the epithelium and thus they reached the surface. The alveolar septi were thickened and consisted of spotted, immature, embryonal mesenchyme tissue. The mesenchyme cells were larger, with excess cytoplasm, containing glycogen. The intercellular spaces were broad, loose and lightly stained by eosin. The reticular fibres were tender, fine, hardly outlining the alveolar septi; collagen was not detected after AZAN-staining.

The intersegmentary and interlobullary connective tissue was formed in wide stripes. The latter were loose, lightly-stained by eosin, with scarce quantity of fibroblasts and tender reticular and collagen fibres. Intercellular space (substance) was lightly stained. Pleura was thickened, oedemic, with tender reticular and collagen fibres.

The vessel walls were thick with excess immature connective tissue in their perivascular spaces.

The histological features of lungs of new-born mice did not show any differences from the aforementioned ones, excluding that here the alveoles were larger and their ducts were swelled.

The electron-microscopic study of these groups of mice shew a rich capillary set in alveolar septi; the alveolar pneumocytes, II-nd type, were with well formed osmium-phile lamellar corpuscles in cell cytoplasm (fig. 1), but there were no vacuoles around them and the cytoplasmatic membrane was
not damaged. A scarce amount of osmium-phile material with layer-like structure was detected on the surface of the alveolar epithelium and lumen.

The lungs of mice killed on the 7-th and 14-th day after birth had also excess interstitial tissue but their alveolar epithelium was short-cubic and flattened. Alveolar septi were more tender, airy spaces — wider and their participation was more expressed than that of the first two groups, concerning the comparison with the mesenchymal elements. The electron microscope shew greater quantity osmium-phile corpuscles with vacuolisated cytoplasma (fig. 2). The osmium-phile material on the surface of epithelial cells and alveolar lumen was in excess and had same layer-like structure.

From all 308 investigated autopsies of children 157 shew morphological signs of PI (50.9%). Most often (89.09%) PI was established in new-born with III-rd degree of immaturity, followed by that in still-born (88.8%). The frequency of PI in new-borns correlated to the degree of immaturity, determined by the weight of birth. Thus, it was 23.1% for maturely-born, 43.1% — for immaturity-born I degree, 78.2% — immaturely-born II degree and 89.09% — immaturely-born III degree. However, low weight of birth was not always considered as a feature of immaturity of the organism.

Based on the data of the present study it could be presumed that the most characteristic and constant signs of morphological PI were: excess of mesenchymal elements (thick alveolar septi, excess intersegmental and interacyclosic connective tissue, excess immature connective tissue in perivascular spaces); small airy spaces and high alveolar epithelium. Under the electron micro-
scope could be established: rich capillary set, scarce amount of osmium-phile corpuscles in pneumocyte cytoplasma (II type cells) and scarce osmium-phile material in alveolar lumen. Our data coordinated with those of other authors (Weibel, Polgar, Burry). The histological investigation of the lungs of still-born and new-born children did not allow us to accept undoubtfully the opinion of Burry, who presumed that at the moment of birth all human lungs show certain signs of PI. Our results proved that part of the studied children had no features of PI, neither of they were still-born, nor new-born. Therefore, the PI could not be contributed to any physiological manifestation, but it is certainly a pathological process which can be the reason for various pneumo-pathies. Besides, the PI shows a definite functional insufficiency of the lungs, which can be explained by the greater resistance of the respiratory ducts compared to those of the mature babies and adults (Burry P.). The immature lung due to its functional insufficiency can be certainly a possible reason for the development of respiratory insufficiency and as a result can cause the death of the new-born.

Conclusions

1. The immature lung is characterized with small airy spaces, high alveolar epithelium, excess mesenchymal tissue in the alveolar septi, intersegmental, interacynosic and perivascular areas, scarce amount osmium-phile corpuscles and scarce osmium-phile material in alveolar lumen.

2. The knowledge of the morphological features of PI and the pathological processes based on PI itself allow us to interpretate more precisely and properly the pulmonary pathology of new-born.

REFERENCES


ГИСТОЛОГИЧЕСКОЕ И ЭЛЕКТРОННО-МИКРОСКОПИЧЕСКОЕ ИССЛЕДОВАНИЯ ЛЕГОЧНОЙ НЕЗРЕЛОСТИ

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ПЕЗЮМЕ

Одной из основных причин развития респираторной недостаточности у новорожденных является легочная незрелость. Знание гистологических и электронно-микроскопических признаков легочной незрелости дает возможность правильно интерпретировать легочную патологию. С этой целью проведено гистологическое исследование легких 308
новорожденных и мертворожденных детей. Проведены также оптическое и электронное микроскопические исследования легких фетусов и новорожденных мышей. Устанавливается, что наиболее яркими признаками легочной незрелости являются малые размеры альвеол, высокие альвеолярные эпителиальные клетки, избыточное количество соединительной ткани в альвеолярных стенках и в интерсегментарных пространствах. Электронно-микроскопически обнаруживаются густая сеть капилляров, а так же меньшее число лямеллярных телец в альвеолярных пневмоцитах типа II при большей их плотности.

Знание указанных морфологических признаков позволяет более правильно интерпретировать различные патологические процессы в легких новорожденных.