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SUBMICROSCOPIC STATE RESPIRATORY ALVEOLI OF THE LUNGS IN DYNAMIC AFTER EXPERIMENTAL THERMAL INJURY

Summary. *In the experiment on white laboratory rats studied the state of submicroscopic components alveoli of the lungs respiratory in dynamics after thermal injury the third degree. Established that in stages toxemia and septic toxemia after severe burnsthere are significant destructive changes of ultrastructure components of aero-hematic barrier and blood capillaries.*
Key words: *alveoli of the lungs, submicroscopic state, thermal injury.*

Introduction

Heat injury is one of the important issues in modern theoretical and practical medicine. With deep, large area burns along with skin damage, there are significant morphological and functional changes in tissues and organs of the body, including the lungs. One reason for this is a significant exogenous and endogenous intoxication, which occurs in the affected body [4, 5]. Due to little knowledge of ultrastructural changes of components of the respiratory department of lungs in severe burns, the study of submicroscopic state of aero-hematic barrier in the alveoli dynamics after experimental injury is relevant [2, 7, 8, 9].

The aim was to establish submicroscopic structural changes in the components of the alveoli of the lungs respiratory in dynamics after experimental thermal injury.

Materials and methods

Experiments conducted at 20 mature white male rats. All manipulations with experimental animals were carried out in compliance with the rules "European convention for the Protection of vertebrate animals used for experimental and other scientific purposes" and under "Scientific and practical recommendations for the maintenance of laboratory animals and working with them" [3, 6]. Burn applied with copper plates heated in boiling water. Size of the area impression accounted for 18-20% of the shaved body surface of animals. The results of histological studies showed depth skin lesion damaged corresponding to the third degree burns.

The experimental animals were divided into two groups: whites intact rats and animals with burn injury. Animals kept on conventional diet vivarium. With daily inspection of their general condition controlled the degree of manifestation of local changes in the area of burn wounds, body weight and mortality.

The objects of the study were lung. To study the ultrastructural changes, the animals were decapitated using the guillotine during ketamine anesthesia on 7, 14 and 21 days, that according to modern ideas corresponds stage early and late toxemia and septic toxemia of burn disease [4].

For electron microscopic studies took pieces of the respiratory department of lungs, their fixed in 2.5% glutaraldehyde solution, post fixed with 1% osmium tetroxide solution in phosphate buffer. Further processing was carried out according to conventional methods [1]. Ultrathin sections, made on ultra-microtome UMPT-7, contrasted by uranyl acetate, lead citrate according to Reynolds method and studied in the electron microscope PEM-125K.

Results. Discussion

Electron microscope examination conducted on day 7 of the experiment after thermal injury showed that the structural components of the respiratory alveoli of lungs available adaptive-compensatory and initial signs of destructive change. There were expanding and blood filling gaps majority hemo capillaries. For endothelial typical swelling and enlightenment of cytoplasm, few organelles therein considerably changed. Mitochondria have oblong or round shape, enlightened and damaged matrix christie. Nonextensionality tubules of granular endoplasmic reticulum and Golgi complex cisterns irregularly thickened. In peripheral cytoplasmic areas was observed small number of pinocytosis vesicles and caveolae. In karyoplasm of endothelial nuclei dominated heterochromatin, nuclear membrane rough, winding through invaginations and perinuclear focal area increased.

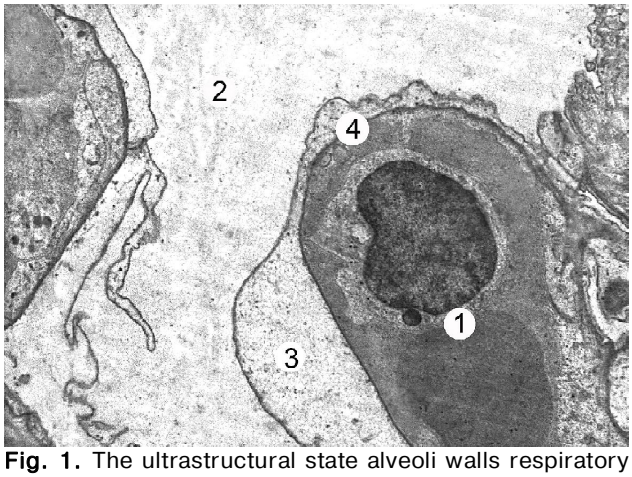


Fig. 1. The ultrastructural state alveoli walls respiratory department of lungs on day 7 after thermal injury. The lumen of the capillary (1) with blood cells, the lumen of the alveoli (2), enlightened and swollen area of cytoplasm respiratory alveolocyte (3), aero-hematic barrier (4). x9000.

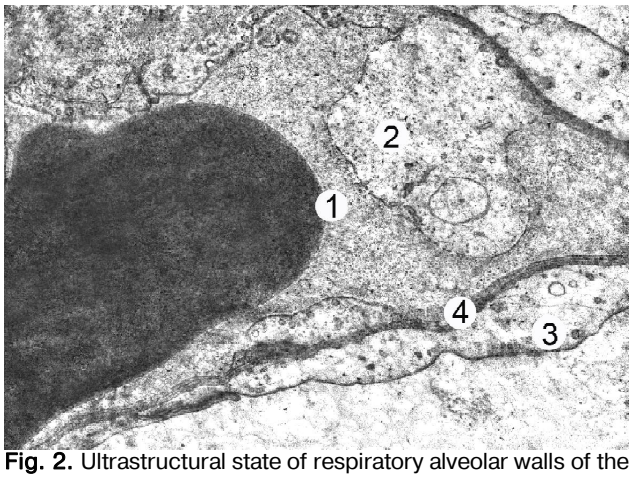


Fig. 2. Ultrastructural state of respiratory alveolar walls of the lungs on 21 days after heat injury. The lumen capillary with erythrocytes (1), voluminous endothelial cytoplasm protrusion (2), swollen cytoplasmic area of alveolocyte type I (3), basement membrane (4). x15000.

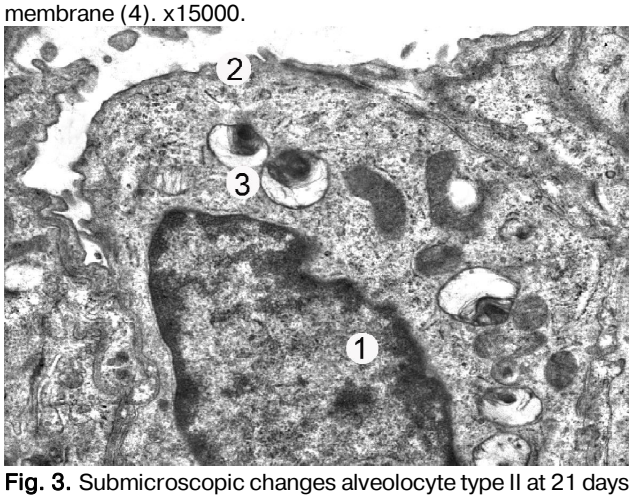


Fig. 3. Submicroscopic changes alveolocyte type II at 21 days after experimental thermal injury. The core (1), small microvilli (2) on the apical surface, modified lamellar bodies (3) with low osmiophil content. x15000.

Submicroscopic reactive changes were recorded in respiratory alveolocyte. There was swelling and enlightenment of cytoplasm, hypertrophy and signs of destruction organelles. Oblong or oval nuclei had intussusception of nuclear membrane, perinuclear space poorly expressed. Peripheral cytoplasmic areas of cells were observed irregularly thickened and local destruction of luminal surface (Fig. 1).

The ultrastructure of secretory alveolocyte in this term of experience also changed, existing swelling and vacuolization of the cytoplasm and nucleus with shallow nuclear membrane intussusception. In karyoplasm small nucleoli are identified, prevailed uniformly euchromatin. Perinuclear space in some areas significantly expanded, formed overemphasizing the cytoplasm. Mitochondria have a spherical shape, electronic light matrix and partially destroyed christie. Endoplasmic reticulum tubules were thickened, fragmented on the surface of their membranes few ribosomes. Golgi complex represented by advanced tanks and large bubbles. Lamellar bodies in the cytoplasm are few and mostly housed at plasmolemma. Apical portion of these alveolocyte contained a small amount of microvilli.

In the stage toxemia after thermal injury in the lumen of the alveoli was observed increase in the number of macrophages. Their surface has a significant amount of cytoplasmic invaginations and outgrowths. In cytoplasm existing small oval mitochondria, hypertrophied Golgi complex cisterns and tubules of endoplasmic reticulum, many primary lysosomes and large osmiophil phagosomes.

Electron microscope study conducted structural components of the respiratory department of lungs in later periods after heat injury revealed the growth of destructive changes and especially at 21 day experiment. Alveoli were observed that had detergents gaps, and much, emphysematous expanded. Enlightenment of alveolar blood capillaries expanded, full-blooded, with symptoms of sludge effect and thrombosis. In their gaps observed mainly red blood cells available also segmented neutrophils, platelets, lymphocytes. Endothelial cytoplasmic areas have been thickened, swollen, formed overemphasizing the lumen of the blood capillaries containing a small amount of organelles and pinocytosis vesicles and caveolae. The nuclei of the cells pyknotic, with fuzzy contours nuclear membrane in their karyoplasm dominated heterochromatin (Fig. 2).

Basement membrane was uneven thickness homogeneous. In the interstices between the alveolar walls revealed a significant amount of collagen fibers formed as a result of increased activity of fibroblasts. For respiratory epithelial ultrastructure characteristic was enlightenment cytoplasmic areas, swelling and bulk formation of protrusion into the lumen of the alveoli. The nuclei of these cells have deep intussusception of nuclear membrane, fuzzy contours of membranes. In karyoplasm were recorded osmiophil clumps of heterochromatin. In type 1 alveolocyte cytoplasm few organelles and they destructive changed, few little pyknotic bubbles.

Submicroscopic alveolocyte in type II also observed significant violations ultrastructure nucleus and organelles. The nuclei were irregular in shape, available nuclear membrane deep intussusception, locally advanced perinuclear spaces. In karyoplasm are identified marginally located heterochromatin clumps. In cytoplasm existing swollen mitochondria, spherical, and their homogeneous matrix have few cristae due to their destruction. Endoplasmic reticulum tubules significantly expanded, partially fragmented and similar to vacuoles. Golgi complex represented by advanced tanks and bubbles.

In most secretory cells alveolocyte number plate cytoplasm is small, in them few osmiophil plates. On the apical surface of secretory alveolocyte there is small number of microvilli (Fig. 3).

In the late stages of toxemia and septic toxemia in the lumen of the alveoli also were many alveolar macrophages and they are characterized by histological polymorphism status. Available actively phagocytic cells and macrophages destructive change. In the first plasmolemma formed numerous cytoplasmic overemphasizing, a sign of active phagocytosis. Characteristic for their cytoplasm were a significant number of primary lysosomes and phagosomes. Phagocytized material contained fragments of destroyed cells. In the cytoplasm existing small mitochondria with electron dense matrix and partially reduced cristae. Golgi complex represented by advanced tanks vacuoles and bubbles.

Observed macrophages with destructive-degenerative changes. Their plasmolemma has little and small microsized and overemphasizing invaginations. The nuclei of macrophages pyknotic changed, osmiophil, deformed with intussusception of nuclear membrane. Karyoplasm contains large lumps of marginally located heterochromatin. The cytoplasm locally enlightened includes many vacuoles similar structures. Tubules of granular endoplasmic reticulum and Golgi complex cisterns expanded and fragmented, also there are few ribosomes and polysomes. Mitochondria have enlightened matrix and reduced christie. In the cytoplasm there are few large phagosome and lysosome in which available inhomogeneous electron density osmiophil material and fragments of destroyed cells.

Conclusions and prospects for further development

1. In the stage toxemia (7 days) in experimental burns set adaptive-compensatory processes and characteristics of destructive changes of alveolar epithelial secretory alveolocyte and walls of hemo capillary.

2. In the late stage of toxemia and septic toxemia (14, 21 days) after heat injury is undergoing profound changes submicroscopic structural components of the respiratory alveoli of the lungs. Developed significant degenerative-dystrophic changes aero-hematic barrier hemo capillaries and of alveolar macrophages. This significantly impairs gas exchange in the respiratory department of lungs.

In further research is planned to establish the degree of morphological changes in the respiratory department of lungs dynamics after experimental thermal injury under conditions of corrective agents.

References

1. Гоpальський Л.П. Основи гістологічної техніки і морфофункціональні методи досліджень у нормі та при патології /Л.П.Гоpальський, В.Т.Хомич, О.І.Кононський.- Житомир: Полісся, 2011.- 288с.
2. Даценко Г.В. Динаміка ультраструктурних змін альвеоло-капілярного бар'єра легеневої тканини щурів після кріодеструкції шкіри /Г.В.Даценко //Вісник морфології.- 2001.- Т.7, №1.- С.117-120.
3. Науково-практичні рекомендації з утримання лабораторних тварин та роботи з ними /[Кожем'якін Ю.М., Хромов О.С., Філоненко М.А., Сайфетдінова Г.А.].- Київ: Авіцена, 2002.- 156с.
4. Нетюхайло Л.Г. Патогенез опікової хвороби (в 2 частинах) /Л.Г.Нетюхайло, С.В.Харченко, А.Г.Костенко //Світ мед. та біол.- 2011.- №1.- С.127-131, 131-135.
5. Опікова травма та її наслідки /Г.П.Козинець, С.В.Слесаренко, О.Ю.Сорокіна [та ін.].- Дніпропетровськ: Преса України, 2008.- 216с.
6. European convention for the protection of vertebrate animals used for experimental and other scientific purposes.- Council of Europe, Strasbourg, 1986.- 56p.
7. Lepekha L.N. In vitro effects of pulmonary surfactant on macrophage morphology and function /L.N.Lepekha, E.A.Alexandrova, M.V.Erokhina //Bulletin of Experim. Biology and Medicine.- 2012.- Vol.152.- P.489-493.
8. The comparative characteristics of pulmonary and renal ultrastructural changes in burn sepsis /B.V.Vtiurin, I.A. Chekmareva, E.N.Gordienko [et al.] //Arhiv Patol.- 2008.- Vol.70, №1.- P.29-35.
9. Pathogenesis of indirect (secondary) acute lung injury /M.Perl, J.Lomas-Neira, F.Venet [et al.] // Expert Review of Respiratory Medicine.- 2011.- Vol.5, №1.- P.115-126.

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СУБМІКРОСКОПІЧНИЙ СТАН АЛЬВЕОЛ РЕСПІРАТОРНОГО ВІДДІЛУ ЛЕГЕНЬ В ДИНАМІЦІ ПІСЛЯ ЕКСПЕРИМЕНТАЛЬНОЇ ТЕРМІЧНОЇ ТРАВМИ

Резюме. *В експерименті на білих лабораторних щурах проведено вивчення субмікроскопічного стану компонентів альвеол респіраторного відділу легень в динаміці після термічної травми III ступеня. Встановлено, що в стадіях токсемії та септикотоксемії після важких опіків відбуваються значні деструктивні зміни ультраструктури компонентів аерогематичного бар'єру та кровоносних капілярів.*

Ключові слова: *альвеоли легень, субмікроскопічний стан, термічна травма.*

Небесна З.М., Маевский А.Е.

СУБМИКРОСКОПИЧЕСКОЕ СОСТОЯНИЕ АЛЬВЕОЛ РЕСПИРАТОРНОГО ОТДЕЛА ЛЁГКИХ В ДИНАМИКЕ ПОСЛЕ ЭКСПЕРИМЕНТАЛЬНОЙ ТЕРМИЧЕСКОЙ ТРАВМЫ

Резюме. *В эксперименте на белых лабораторных крысах проведено изучение субмикроскопического состояния компонентов альвеол респираторного отдела легких в динамике после термической травмы III степени. Установлено, что в*

стадиях токсемии и септикотоксемии после тяжёлых ожогов происходят значительные деструктивные изменения ультраструктуры компонентов аэрогематического барьера и кровеносных капилляров.
Ключевые слова: *альвеолы легких, субмикроскопическое состояние, термическая травма.*

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