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Protective And Adaptive Reactions Induced Lung Various Doses Of Cigarette Smoke.

K Saparov*.

Faculty of biology and biotechnology, Kazakh National university named after Al- Farabi, Almaty, Kazakhstan, street Al-Farabi, 71.

ABSTRACT

The data on the protective-adaptive reactions of pneumatic and respiratory departments of lungs at the effects of different doses of cigarette smoke. Showing adaptation and reactive changes organelles violations permeability of epithelial cells. A large dose of cigarette smoke leads to severe destructive changes ciliated and goblet cells of columnar epithelium trachea of experimental animals.

Keywords: respiratory department, goblet cells, macrophages, the air-blood Barer and cigarette smoke.

**Corresponding author*

INTRODUCTION

When exposed to toxic substances in the lung surfactant system detected changes [1,2]. It is known that the alveolar macrophages are the first line of defense against microbes, particulates and chemical contaminants in the air [3, 4, 5].

The aim of this work is a complex structural and functional study of pneumatic and respiratory portions of the lungs, especially aeroepithelial and blood barrier, as well as the reaction of alveolar macrophages on the effects of different doses of cigarette smoke.

Materials and methods of research. Experiments were performed at 3 - 3.5-month old female rats weighing 140-160 g. Animals for 3 weeks, within 2 hours a day are exposed to tobacco smoke in a plastic chamber with a volume of 20 liters. The smoke is sucked from the burning cigarette ("Prima" V class per cigarette tar content of tobacco - 29 mg, nicotine 1,3 mg) Janet syringe and quickly admitted into the chamber through the hole. The animals were kept in this atmosphere for 10 minutes and then for 3-4 minutes. Camera and aired again on 10 minutes, let in a new batch of smoke. The total duration of this "obkurivaniya" during the day is 2 hours. Fifteen animals were divided into 3 groups and were kept in separate chambers. Animals of Group 1 served as control animals the second group received a daily dose of 10 smoke cigarettes, and the third - a dose of 20 cigarettes. After 3 weeks of the experiment the animals were killed.

Slices were fixed in lungs 2.5% glutaraldehyde solution, 0.3 N phosphate buffer Milloniga for 2.5 hours with postfixation within 2 - hours in a 1% solution of osmium tetroxide (OsO₄). The pieces are then carried through a series of tissue fluids ascending concentrations of ethanol, absolute acetone and embedded in Epon. Semifine 1 micron thick sections were stained with methylene blue - azure II, and basic fuchsin. Ultrathin sections were obtained at ultramicrotome LKB - III, contrasted with uranyl acetate and lead citrate for Reynolds. Viewing slices made with an electron microscope EMW - 100 L.

The ultrastructure of the respiratory department of lungs of control albino rats was as follows. The cells of the alveolar lining arranged on a thin basement membrane. Alveolocytes type 1 classic shape with a central thickened and flattened peripheral parts. Most of the central region has the largest core of the spherical form with wavy contours of the nuclear envelope. Content euchromatin high, distribution ravnomer-noe. Perinuclear space bottleneck. The widest part of the cytoplasm arranged mitochondrial matrix of moderate electron density, short tubules granular endoplasmic reticulum, ribosomes and polysomes. Golgi complex also located near the nucleus and was presented poorly developed vesicles and cisterns. In the flattened part of the cytoplasm were seen rare organelles and microvesicles. On the apical surface microvilli were observed rare. The cells are connected by tight cell-cell contacts.

Alveolocytes II-type large, ovoid shape, with microvilli on the apical surface. Oblong form the core characterized by a high content of euchromatin and heterochromatin primarginal location. The cytoplasm raspolaga-lis large mitochondria with increased electron density matrix and numerous translucent areas. Granular endoplasmic reticulum was represented by narrow canals with a tight fixed ribosomes. In the cytoplasm could be seen elements of the Golgi complex, small vesicles smooth endoplasmic reticulum and microtubules. Multivesicular bodies were found and were rarely represented a group of small bubbles surrounded by a common membrane. A distinctive feature of alveolocytes II-type were osmiophilic plate material.

Alveolocytes III-type with typical microfibrils and microtubules are extremely rare.

Blood capillaries are located inside interalveolar septa were lined with a layer of flattened endothelial cells. Their large core oblong or oval shapes were undulating contours of the shell and primarginal distribution of condensed chromatin. In perinuclear area located mitochondria tubules reticulum, ribosome and polyribosomes micropinocytic bubbles. Extended portions stroma septum contained within the main substance of collagen, elastic fibers and reticulin and pericytes and fibroblasts. In thicker sections of interstitial macrophages met, lymphoid, plasma cells, basophils.

Alveolar macrophages were both within the alveolar walls of the alveoli, and on the surface of the alveoli. They contained the core with a high proportion of euchromatin and large nucleolus. Macrophages were characterized by well developed ultrastructure with lots of phagosomes and lysosomes primary. The ultrastructure of the respiratory department of lungs of experimental animals when exposed to low doses of cigarette smoke.

Electron microscopic study of the respiratory department of lungs when exposed to low doses of cigarette smoke revealed a sharp increase in the nucleolus and nucleus in alveolocytes type 1. The nuclear envelope acquired wavy contours, increasing the number of nuclear pores. Apical plasma membrane surface alveolocytes type 1 formed long cytoplasmic processes and intussusception, which contributed to the emergence of numerous cytoplasmic vesicles and vesicles. The apical surface of the peripheral parts alveolocytes type 1 was also characterized by an intensification of the process mikropinotsitoza. Number micropinocytic bubbles sharply increased in endothelial cells of blood capillaries.

In the cytoplasm of type II alveolocytes dramatically increases the size of osmium-core-plate cells due to the predominance of electron-transparent material. Appeared giant plate calf, squeezing, and pushed to the periphery of the cell nucleus (Figure 1). Mitochondria and tubule granular endoplasmic reticulum and remained unchanged.

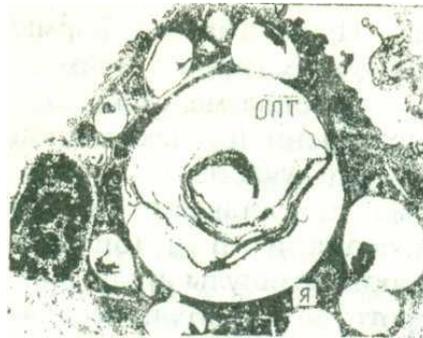


Figure 1: A small dose of cigarette smoke. The sharp increase in osmiophil plate cells (OPT). Visible narrow strip of the core (I). Electron diffraction x 12000

Alveolar macrophages, which are on the surface of the alveoli, characterized by a large number of primary lysosomes, large vacuolar structures, rod, needle and membrane impurities tobacco. This admixture of tobacco mingled with primary lysosomes to form fagolizosomalnye structure. In large phagocytic vacuoles located flocculent mass glycocalix plate and single figures phagocytosed osmiophil plate cells.

The ultrastructure of the respiratory department of lungs of experimental animals when exposed to high dose of cigarette smoke.

Electron microscopic study under the influence of pain-Scheu dose of cigarette smoke revealed a dramatic reconfiguration alveolocytes type I by reducing the basal surface. Most of the central region has the largest core of gross accumulations of heterochromatin and slightly expanded perinuclear space. The observed perinuclear cytoplasm of the Waku-lization tubules granular endoplasmic reticulum, an increase of small vesicles, Golgi complex. As a result of the partial destruction of the reticulum membranes in hyaloplasm formed small focal areas of edema. The plasma membrane of the basal surface alveolocytes II-type look loosened.

In fosfoliposomah alveolocytes I-type increased coli honors plate material. In addition, there were helically folded membrane structure of the surfactant. Granula tubules of the endoplasmic reticulum were extended, there was a partial razvoloknenie membranes and loss of fixed ribosomes. In the mitochondrial matrix there are small pockets of swelling and lysis Christie.

The cytoplasm of alveolar macrophages containing large amounts elektronoplastnyh primary lysosomes, phagocytized impurities tobacco, as well as numerous osmiophil lamellar bodies (fosfoliposomy). Number phagolysosomes were reduced as compared with the control.

The ultrastructure of the tracheal epithelium cylindrical experiments, experimental animals in the control group of the study.

Multicore ciliate columnar epithelium of the mucous membrane of the trachea in the control group of the study was presented to the following types of cells: ciliated, mikrovorsinchatymi; goblet and basal.

Basal cells are located on a slightly winding basement membrane attached thereto poludesmosomami. They had a large nucleus, occupying nearly the entire cell volume. The contours of the nuclear envelope were wavy or scalloped jagged. Primarginalno heterochromatin was located in separate clusters in karyoplasm. Perinukleonarnoe narrow space. The cytoplasm is rich in free ribosomes, polyribosome, thin tubular granular endoplasmic reticulum. A few mitochondria have an oval shape, the matrix increased electron density and densely packed Christie. The Golgi apparatus is underdeveloped. Cells have long cytoplasmic processes and connect adjacent cells via desmosomes.

Ciliated cells also attached to the basement membrane via poludesmosom. The nuclei were located in the basal part of the cells were large, oval-shaped with wavy contours of the nuclear envelope. The condensed chromatin primarginalno and individual flakes in karyoplasm. The cells contain a large number of mitochondria, especially in the apical part of the cell. Mitochondria have small dimensions, oval and oblong shape and moderate electron density matrix with a small amount of cristae. Sipes rough endoplasmic reticulum were short and generally narrow. The Golgi apparatus was located near the nucleus and has been poorly developed. On the apical surface were visible numerous cilia and basal bodies with roots. The cilia of ciliated epithelium included a central complex, which consists of two round tubules and peripherally located 9 doublets, also consisting of two tubules. Stability is provided by radial spokes axoneme and neksinovymi ligaments fixing doublets with each other and with a central complex. Ciliated cells is closely related to each other, connecting in the apical part of the obturator zones desmosomes and tight junctions.

Less common micro-vorsinchatye different cell cytoplasm high electron density and the presence of microvilli on the apical surface. We know the opinion that these cells are goblet cells in the Post-secretory state. Goblet cells contain secretory granules small-granula varying size and density. Closer to the surface of the apical secretory granules are often blended together. The cytoplasm of goblet cells are characterized by high density and contained well-developed rough endoplasmic reticulum, Golgi complex, a large number of free ribosomes and polyribosome. On the apical surface plasmolemma placed thin microvilli.

The ultrastructure of the tracheal epithelium cylindrical experiments, experimental animals after exposure to low doses of cigarette smoke.

Any changes in the basal cells has been detected. In the cytoplasm of ciliated cells was observed fullness matrix of mitochondria located in the cytoplasm of the supranuclear.

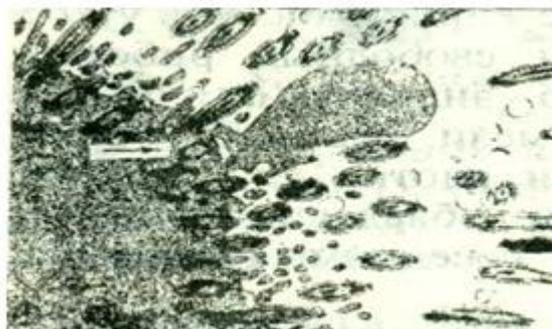


Figure 2: A small dose of cigarette smoke. Huge swelling apical surface of ciliated cells with the destruction of the plasma membrane (arrow). Electron diffraction x 22000.

Mezhkristye between the membrane and the space has been extended and electronically transparent, indicating a high degree of functionality to the activity of the mitochondria. Tubules granular reticulum endo compared with the control was measured. In some cells appear supranuclear many bubbles and vesicle associated with increased cell permeability. Occasionally on the apical surface of the plasma membrane of ciliated cells were seen enormous swelling - bubbles representing local areas edema with microdefects plasmolemma cytoplasm (Figure 2). The apical surface of goblet cells was also subjected micro-destructions and loosening.

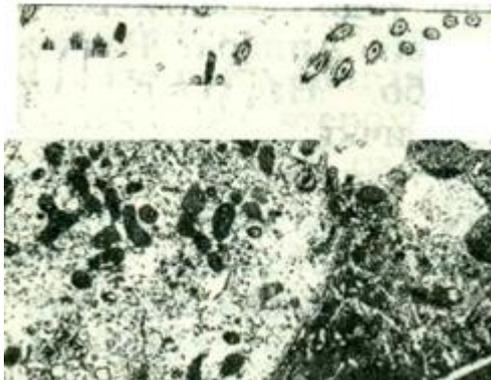


Figure 3: A large dose of cigarette smoke. Complete watering and illumination hyaloplasm ciliated cells. Electron diffraction x 21500.

Thus, low doses of cigarette smoke altering cell permeability columnar epithelium of trachea: on the apical surface of the plasma membrane were seen microdefects edema and local zones. The process intensified hyaloplasm mikropinotsitoza also associated with a disruption of the cell permeability of the epithelial cells.

Ultrastructure columnar epithelium of the trachea after exposure to high doses of cigarette smoke.

When exposed to high doses of cigarette smoke cell permeability of epithelial cells increased. There was a sharp increase of micro-pinocytosis, vacuolization and destruction of granular endoplasmic reticulum tubules. Depending on the degree of cell permeability partial or complete hydration and illumination hyaloplasm (Figure 3).

Compensatory-adaptive response from the mitochondria energezirovannyh alternated signs homogenization and destruction with the formation of secondary lysosomes.

Complete rupture of plasma membrane leads to a sharp intercellular CURRENT and partial necrosis of epithelial cells (Figure 4).

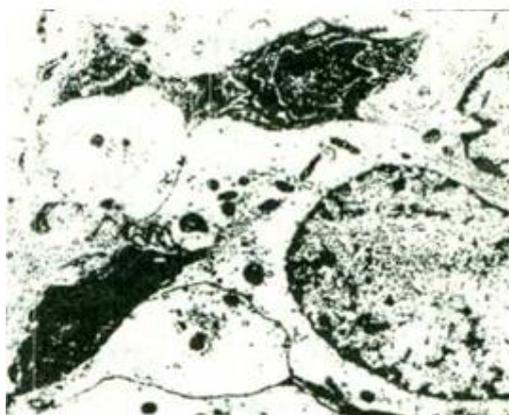


Figure 4: A large dose sigaret-mnogo smoke. Partial necrosis of the epithelial cells of the trachea. Electron diffraction x 14000.

On the basal membrane preserved only isolated basal cells with normal ultrastructure. Goblet cells are less vulnerable to destruction by srav-neniyu with ciliated cells. It should be emphasized hyperplasia and activation of the Golgi complex that enhance the secretory function of goblet cells. Discussion of the data. At the electron microscopic level, the impact of small to cigarette smoke on the respiratory department of lungs of experimental animals resulted in an increase in the process mikropinotsitoza alveolocytes type 1. This fact reflects the involvement of these cells in the alveoli of the purification of macromolecules of cigarette smoke. The increase in the number of micro-bubbles and pinocytosis in endothelial cells of blood capillaries, probably related to the movement of absorbed particles from the connective tissue of the perivascular areas into the bloodstream. In alveolocytes P-type a sharp increase in secretory activity. It should be emphasized active secretion elektronnoprozrchnogo material osmiophil lamellar bodies, while it will continue, as in the control, screen plate material. The absence of swollen mitochondria, and vacuolated tubules granular endoplasmic reticulum UD-telstvovalo cell permeability alveolocytes II-type within the normal range. Compensatory-adaptive reactions osmio-core-plate cells was directed, likely to maintain the surfactant layer of the alveolar lining. The phagocytosed material alveolar macrophages were noted inclusion of impurities and tobacco flake material destroyed glycocalyx. Phagocytic activity of alveolar macrophages was high. Exposure to cigarette smoke in a small dose does not overwhelm the process of merger of phagosomes and lysosomes. Exposure to high doses of cigarette smoke leads to severe vacuolization of organelles and starts swelling vnutrikletoch-nomu alveolocytes I-type. Loosening of the basement membrane and the basal part of the plasma membrane of the cells and starting svide-telstvuet interstitial edema alveolar walls. Violation cell permeability observed in the cytoplasm alveolocytes type II. At the same time, along with the swelling of the matrix lysis cristae mitochondrial membrane destruction of granular endoplasmic reticulum, preserved compensatory-adaptive reactions in the form of hypersecretion osmiophil plate counts, high secretory activity combined with the appearance in the cytoplasm alveolocytes II-type surfactant and membrane structures. The emergence of numerous osmiophil lamellar bodies in the cytoplasm of alveolar macrophages also confirmed an increased secretory activity alveolocytes II-type. A large dose of cigarette smoke fagatsitarnuyu depressed activity of alveolar macrophages, as can be judged by the slowdown merger elektronnoplotnyh primary lysosomes and fagotsitiruemogo material. Thus, large doses of cigarette smoke leads to severe destructive changes ciliated cells and compensatory-adaptive changes in the columnar epithelium goblet cells of the trachea of experimental animals.

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