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Pathomorphological description of bronchial and lung arteries for patients with iii-iv stage of COPD under exacerbation

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Abstract

The paper shows the main morphological changes of the blood vessels of the lungs in COPD patients in the acute phase. It is established that the most evident changes occur in all the membranes of the arteries of the level of segmental and sub-segmental bronchi in the form of media hyperplasia, fibrinoid necrosis areas, dystrophic phenomena of vascular smooth muscle cell, structural transformation of internal and external elastic membranes, their hyperplastic, elastofibrosis, collapse and fragmentation, accretion of unsulfured glycosaminoglycans longwise fibers. Morphometrics show that media is 3-4 times thicker than intima and the lumen of the most arteries is narrowed down to 25-30% compared to the outer diameter. Moreover, at exacerbation of chronic obstructive pulmonary disease in III-IV stage there are observed lymphohistiocytic reaction longwise the arteries. Conducted comprehensive morphological studies indicate that not only the bronchial tree, but also bronchial arteries were involved in the pathological process, which leads to disorders of the different generation bronchi blood supply and disorders of normal functioning of the bronchi.

Keywords: chronic obstructive pulmonary disease, blood vessels, arteries, veins, capillaries, morphology

1. Introduction

Chronic obstructive pulmonary disease is an important problem of modern medicine, because the morbidity and mortality from this disease increases every year [2, 7]. Recently, special attention is paid to issues associated with exacerbation of the disease, frequent relapses, and chronic course. The vast majority of publications on this topic is devoted to the study of the role of immunological factors, systemic immunity, morphological changes in large and segmental bronchi in the lungs at different stages of the disease [2, 4, 5, 6, 7]. However, changes in the blood vessels of the bronchial tree and the pulmonary circulation in patients with COPD remain understudied, especially in the period of exacerbation and remission of chronic obstructive pulmonary disease [1, 3, 8]. Our research is dedicated to this particular issue.

The aim of the research is to study: The structural changes in the bronchial arteries in patients with COPD exacerbation.

2. Material and methods of research

We carried out morphological and morphometric studies of 120 lungs taken at autopsy of the deceased, whose death was caused by pulmonary heart disease associated with COPD exacerbation. 734 protocols of postmortem studies were retrospectively analyzed. Control group – lungs of the 15 deceased without pulmonary pathology. The lung fixation was performed using 10% solution of neutral formalin, in which the whole lung was immersed. After fixation, which was carried out within 5-7 days, the tissue samples were cut from all three parts of the lung – lateral fragments of lobar, segmental, sub-segmental bronchi, the level of their bifurcation, fragments of subsequent generations of bronchi along the whole branching to the level of the small bronchi and bronchioles with pulmonary parenchyma. The cut pieces were placed in paraffin. We made paraffin sections with thickness of 5-7 μm , which were stained with hematoxylin and eosin, picrotinin after Van-Gizon, after Hart, after the MSB method at Zerbino D.D. and Lukasewich L.L. modification

We carried out PAS-reactions, reactions to identify unsulfured glycosaminoglycans. Morphometric and densitometric values of bronchial mucosa of different generation were calibrated on the measuring instrument “Mira” (test control) with the image analysis on the basis of UTHSCA Image Tool for Windows software.

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We performed variation-statistical processing of the obtained morphometric data using Student t-test. Differences were considered statistically significant at the reliability level of 0.05 and above. Processing of the obtained results was conducted using the Microsoft Excel 2000 software.

3. Results and Discussion

Pulmonary perfusion is carried out by the pulmonary artery system vessels, which belong to the lesser circulation, and through the bronchial arteries, which belong to the greater circulation. By the structural organization of the walls pulmonary arteries can be divided into elastic, muscular type arteries and arterioles.

The results of our study showed that in patients with III-IV stage of COPD in the acute phase of the disease there are structural changes in all pulmonary perfusion vessels, both of lesser and greater circulation (Fig. 1, a-e). Arteries of the muscular type, which supply blood to bronchi and alveolar ducts and have a diameter from 100 to 1000 μm , were with significant changes of muscle membrane, both of its longitudinal and circular layers – in the form of hyperplasia and disorganization. In some areas internal elastic membrane is dissected, fragmented, divided into thin fibers, and ruffled. In some areas external elastic membrane is considerably thickened (Fig.1, a).

When staining microslides with fuchsin after Hart, we detected morphological changes of the internal elastic membrane in the form of its hyperelastosis, multiplication or evident fragmentation. The intima is thin, the cytoplasm of endothelial cells is luminal, in some areas round-formed intensely stained nuclei form a kind of stockade. Luminal surface of the

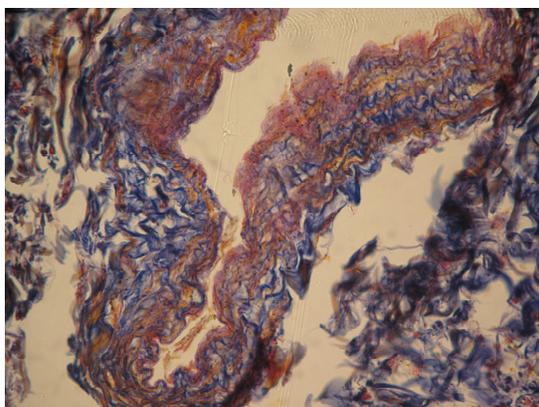
endothelial layer forms numerous protrusions and cavities, which have the same shape as the internal elastic membrane. In patients, who died from acute pulmonary heart disease, inner muscular layer of the lungs bronchial arteries is characterized by disorganization of its muscle fibers with homogeneous deposition of eosinophilic masses (Fig. 1, b).

While staining microslides for fibrin using MSB method in Zerbino-Lukasevych modification, in some areas of large arteries walls we detected focuses of fibrinoid necrosis deposition of fibrin along muscle bundles or in places of their decomposition (Fig. 1, c).

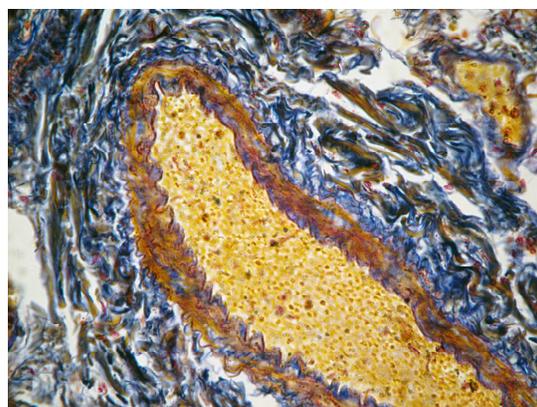
In small arteries part of smooth myocytes with hydropic degeneration phenomena, with numerous vacuoles of various sizes in the cytoplasm (Fig. 1, d).

The thickness of the muscular layer is 25-30% of the external diameter. The lumen of various arteries is distinctly narrowed due to spasm or arteriomyomatosis that is very distinctly manifested in the pulmonary arteries with the diameter from 80 to 90 μm .

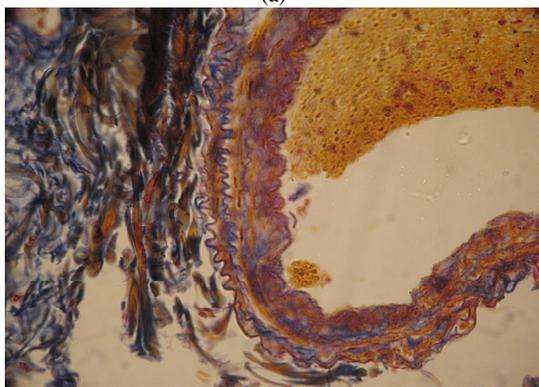
The results of our research showed that the most evident morphological changes are observed in the arterial walls of different diameter, which supply blood to the segmental and subsegmental bronchi. Some of them are characterized by significant increase in the thickness of the media and its dominance over intima for 3-4 times. Muscular layer with hyperplasia, disorganization and necrosis (Fig. 1, μ). Lumen of these arteries is narrowed down to 20-25 μm in diameter. In the walls of these arteries we often noticed hyperelastosis, swelling of endothelial cells, their desquamation, the phenomenon of disorganization. (Fig. 1, e).



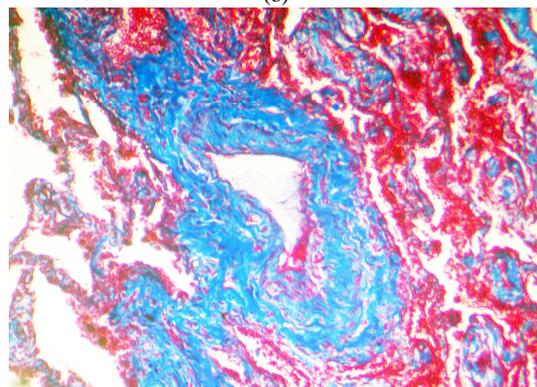
(a)



(b)



(c)



(d)

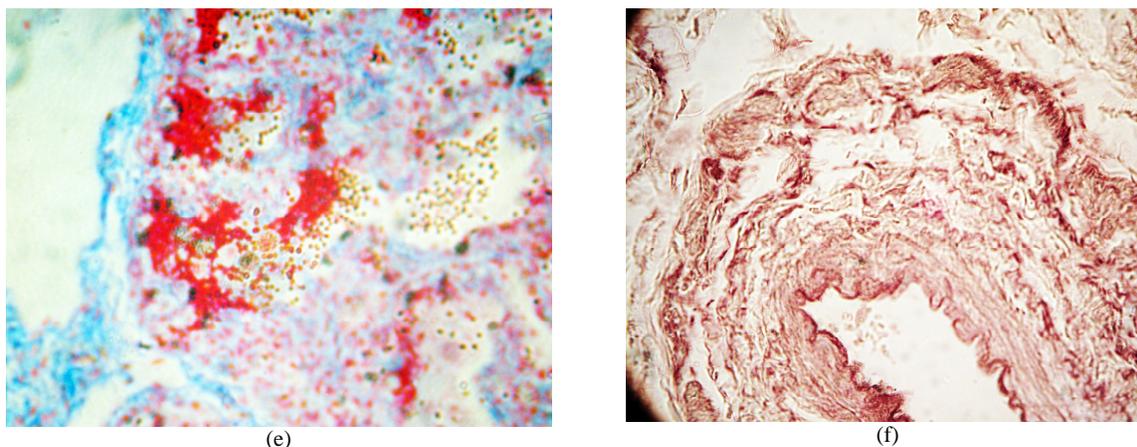


Fig 1: The morphology of the bronchial arteries of the lungs in the acute phase of III-IV stage of COPD: a – bronchial artery wall with symptoms of disorganization; б - bronchial artery wall hyperelastosis; в – changes in luminal surface of epithelial layer and distinct bellows of external elastic membrane; г – hyperplasia of media; д – fibrinoid necrosis of the bronchial artery walls; e – lamination, fragmentation and disorganization of the bronchial artery elastic membranes. Staining: a-в – after Mason; г-д – by MSB method in Zerbino-Lukasevych modification; e – with fuchsin after Hart. Zooming: a-в – ocular 10, lens 10; r-e – ocular 10, lens 20.

In the areas of peribronchial inflammation along the arteries we detected small-cell infiltration, swelling of the outer shell. Polymorphonuclear leukocytes are dominated among infiltrate cells. In some cases, plasma cells, macrophages and lymphocytes are detected (Fig. 1, f).

Histochemical studies showed that in the arteries wall in some patients with the III stage of COPD in the period of exacerbation, especially with heavy smokers, there detected unsulfured glycosaminoglycans, which are mostly localized along the internal elastic membrane.

4. Conclusions

Thus, the research showed that a number of structural changes in the bronchial and pulmonary arteries, which lead to a narrowing of their lumen, and as a result to ischemic areas of perfusion, proliferation of connective tissue elements and subsequent sclerosis of the walls of the large bronchi, are definitive for exacerbation of chronic obstructive pulmonary disease in the III-IV stage.

These morphological changes were more evident with some patients without permanent cure for COPD that proves the need for basic treatment of the principal disease in these patients.

5. Prospects for further research

The further research will be devoted to the study of histochemical and ultrastructural changes in bronchial vessels under COPD exacerbation at different stages of disease development

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