

CHANGES IN SURFACTANT ACTIVITY IN PULMONARY
EMPHYSEMA AND PNEUMOSCLEROSIS

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UDC 616.24-007.63+616.24-004]-092:612.212.014.1.014.462.8

Surfactant activity was investigated in the lungs of 103 patients with chronic suppurative diseases and tumors of the lungs. The results of the tests demonstrate a decrease in the surface activity of the lungs in emphysema, pneumosclerosis, and atelectasis of the lung tissue.

The physiological importance of the surface-active substances (surfactants) of the lungs is increasingly a subject for research. During the last 10-15 years the number of investigations in this field has increased considerably [1, 3, 9-14].

By reducing the surface tension in the alveoli the surfactant prevents their collapse during expiration and contributes to the necessary stability of the lung volumes during the act of respiration [7, 8]. Inactivation of the surfactant or its inadequate secretion by the type II alveolar cells under the influences of various factors reduces the surface tension in the alveoli of the lungs and evidently plays an important role in the pathogenesis of conditions such as the acute respiratory failure syndrome of the newborn, atelectasis and pneumonia [6, 14, 18].

EXPERIMENTAL METHOD

The surface tension in extracts from areas of the lungs was investigated in 103 patients (86 men and 17 women) aged from 20 to 63 years undergoing operations for chronic lung abscesses and tumors. An index of the stability of the air spaces of the lung tissue also was determined [14, 18]. As a rule the tests were carried out 2-3 h after the operation. Extracts from the lung tissue were prepared by Clements' method [9]. Rebinder's apparatus was used to determine the surface tension of the extracts thus obtained. Parallel with the study of the surface tension in the extracts of lung tissue and determination of the index of stability of the air spaces, a histological study was made of selected pieces of lung tissue fixed in 15% formalin and stained with hematoxylin-eosin and picrofuchsin.

Control determination of the surface tension in the lung tissue extracts and determination of the air space stability index was carried out in portions of lung tissue obtained from the cadavers of 23 persons aged 19-56 years with no history of lung diseases in life and dying suddenly from nonpulmonary diseases or as a result of accidents.

EXPERIMENTAL RESULTS

The assessment of the state of surface activity of the lung tissue in the pieces of lung taken for investigation (usually two or three pieces of lung tissue were taken for study from each resected lung and the same number of pieces were taken from the cadaveric lungs) was based primarily on the values of the surface tension in the extracts of lung tissue, compared with the results of histological examination, and the air space stability indices were regarded as supplementary to the basic (physical) method. Whatever

Respiratory Diseases Unit, No. 61 City General Hospital, Moscow. Professorial Surgical Unit, No. 2 Medical Faculty, I. M. Sechenov First Moscow Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR A. I. Strukov.) Translated from *Byulleten' Éksperimental'noi Biologii i Meditsiny*, Vol. 75, No. 2, pp. 17-20, February, 1973. Original article submitted May 22, 1972.

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TABLE 1. Surfactant Activity Accompanying Certain Structural Changes in Lung Tissue

Character of morphological changes	No. of cases	Surface tension (in dynes/cm)	Air space stability index	$P <$
Atelectasis	42	$71,66 \pm 3,60$	$0,63 \pm 0,04$	—
Pulmonary emphysema . . .	35	$66,11 \pm 1,82$	$0,98 \pm 0,14$	—
Pneumosclerosis	17	$68,69 \pm 3,31$	$0,84 \pm 0,09$	0,05
Control	23	$57,20 \pm 1,52$	$0,89 \pm 0,02$	0,001

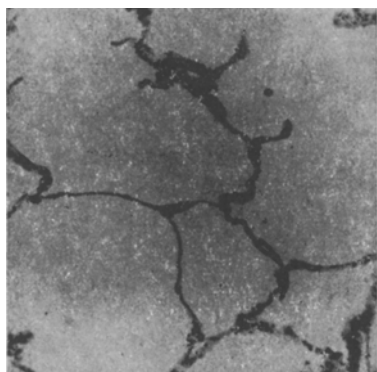


Fig. 1

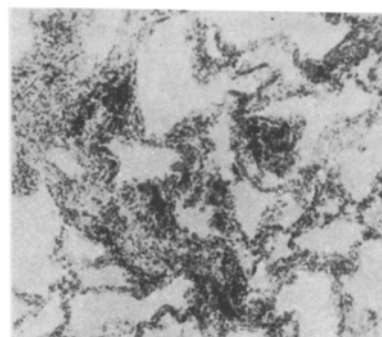


Fig. 2

Fig. 1. Marked emphysema of the lungs and sclerosis: surface tension in extracts of lung tissue 70.80 dynes/cm, stability index 0.89. Here and in Figs. 2 and 3: hematoxylin-eosin 80 \times .

Fig. 2. Chronic inflammation, pneumosclerosis, and emphysema of the lungs: surface tension in lung tissue extract 75.65 dynes/cm, stability index 0.80.

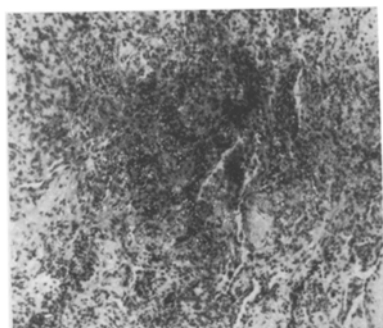


Fig. 3. Area of atelectasis: surface tension in lung tissue extracts 72.90 dynes/cm, stability index 0.50.

the concrete form of pulmonary disease, the morphological changes in the pieces of lung tissue studied were a combination of chronic bronchitis and bronchiectasis, atelectasis of varied duration, pulmonary emphysema, pneumonia, and pneumosclerosis. In each concrete case certain types of these changes predominated and it was rarer for them to be of about equal severity. Since the changes in surface activity of the lung tissue in disease are determined by the degree and character of the morphological changes in the lung tissues, it was decided that the best way to analyze the activity of the surfactant was to compare its indices with the character of the structural changes in the lungs in each particular case. Accordingly, atelectasis was predominant in 42 cases, emphysema in 35, and pneumosclerosis in 17.

In emphysema of the lungs the decrease in surfactant activity was rather less marked than in atelectasis. The surface tension in the lung tissue extracts in this case varied from 60.60 to 70.80 dynes/cm (mean 66.11 ± 1.82 dynes/cm) while the air space stability indices varied from 1.13 to 0.73 (mean 0.98 ± 0.14). The degree of lowering of the surface activity of the lung tissue corresponded to the severity of the emphysema and the accompanying pneumosclerosis. In a severe form of emphysema of the lungs accompanied by rupture of the alveolar septa, for instance, the surface tension in the lung tissue extracts reached 70.80 dynes/cm but the airspace stability index in this and similar cases remained close to normal (0.89; Fig. 1). The cause of the lowered surfactant activity in these cases was evidently a decrease in the secretion of surfactant as the result of a decrease in the area of the alveolar epithelium and the sclerotic changes in the alveolar septa in pulmonary emphysema. In areas with predominantly sclerotic changes the surface tension in the lung tissue extracts was higher still, reaching 75.65

dynes/cm, while the air space stability index fell, in some cases almost to zero. In one case in which microscopic examination revealed thickening and sclerosis of many of the alveolar septa, with the formation of foci of emphysema in some places with rupture and thinning of the alveolar septa (Fig. 2), the surface tension in the lung tissue extracts was 75.65 dynes/cm although the air space stability index in this case was 0.80. The mean surface tension in the area of pneumosclerosis was 68.69 ± 3.31 dynes/cm and the stability index 0.84 ± 0.09 .

In atelectasis the surfactant activity was usually lowered, as shown by the increased surface tension in extracts from those areas of the lung tissue and the reduced air space stability index. In the cases studied, the surface tension in extracts from the atelectatic lungs varied from 66.87 to 80.87 dynes/cm, with a mean value of 71.66 ± 3.60 dynes/cm, i.e., it was close to the surface tension of water (72 dynes/cm). The air space stability index under these circumstances ranged from 0.80 to 0.30 with a mean value of 0.63 ± 0.04 (Fig. 3). The degree of lowering of surfactant activity depended on the severity not only of the atelectasis, but also of the sclerosis which accompanied it in some cases.

In the control investigation the surface tension in the lung tissue extracts had a mean value of 57.20 ± 1.52 dynes/cm, with variation between 47 and 58 dynes/cm. The air space stability index had a mean value of 0.89 ± 0.02 (variation from 1.31 to 0.78).

The changes in surfactant activity accompanying the various changes in the lung tissue are summarized in Table 1.

According to data in the literature the development of atelectasis is linked with a decrease in surfactant activity [12, 16, 17]. The results of the present investigation agree with this hypothesis. They also show that a decrease in surfactant activity can also be observed when sclerotic changes are found in the lung parenchyma, and in these cases, moreover, they may be just as severe as in atelectasis. Results obtained by Barinova [1] are additional evidence in support of this view. Finally, the present experiments show that surfactant activity is reduced in chronic pulmonary emphysema, possibly on account of the decrease in the alveolar surface area and the atrophy and sclerosis of the alveolar septa.

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