

Microscopic and ultramicroscopic alterations of the respiratory mucous membrane in experimentally provoked bronchitis

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SUMMARY

The noses of four experimental dogs were surgically obstructed, and thus their entire respiration was disturbed, and this affected the mucous membranes of the lower respiratory passages. Normal histological examinations and electronic microscopy found chronic irritation of the bronchial mucous membranes. It was possible histologically to follow the most subtle alterations on the membranes from the very beginning of the chronic bronchitis. The importance of nasal obstruction as a contributing factor of chronic bronchitis is stressed.

INTRODUCTION

Chronic bronchitis is becoming a disease that by its incidence in the general morbidity is approaching the top. This refers particularly to industrially developed countries. Protracted exogenous irritants are decisive in originating this disease. Most significant are sulphuric dioxide, ozone, ammonia, nitric dioxide and others, as well as cigarette smoke, which favour the production and retention of secretion in the bronchi and bronchioles. Viral infections are also significant in originating chronic bronchitis. Both mentioned factors, exogenous irritants and viral infections, damage the cylindrical epithelium of the respiratory mucous membrane of the bronchi and bronchioles followed by the proliferation of the mucoserous glands and goblet cells in the mucous membrane and lead to hyperchiria and mucostasis; all together offering a favourable basis for bacterial infection (Harambašić, 1965, Fortic et al., 1967). The presence of the haemophilus influenzae and of the pneumonial diplococcus has been proved in the majority of patients with chronic bronchitis. Attention is also to be paid to possible immunological disturbance, especially to diminished amounts of the immunoglobulins G and A, then to the patient's age, sex, constitution, to the climat, the social condition, alcoholism as well as to other factors

favouring the development of chronic bronchitis (Kozamernik, 1966; Kortekangas, 1959; Sala et al., 1968; Nicoucar, 1968). Infectious alterations of the lower respiratory passages, however, must neither be considered nor treated isolatedly, but as part of the respiratory system as a whole, including the nose and paranasal sinuses. Chronic suppuratory inflammation of the nose and the paranasal sinuses are well known to be able to cause chronic inflammation of the lower respiratory passages by a descending pathological mechanism, and this condition is known as sinobronchial syndrome (Lüthgerath, 1970). Obstruction of the nose by a broken nasal septum, nasal polyposis, tamponades, or artificially caused obstruction induce a series of disturbances in the lower respiratory passages and lungs, such as sustaining the infectious irritation of the bronchial mucous membrane, increasing the resistance in the lower respiratory passages and in the lungs, reducing the pulmonary compliance, increasing the functional residual capacity (FRC). Such conditions also lead to disturbing the gas exchange between the blood and the atmosphere. Nasal obstruction also excludes the nose as origin of the nasopulmonary and nasothoracic reflexes, which are important for calm, sufficient and deep breathing (Šercer, 1940; Ogura et al., 1964; Cassisi et al., 1971; Onishi et al., 1971; Cook et al., 1973; Cvetnić et al., 1974, 1976, 1976).



Figure 1. One nostril surgically obstructed. For two months the dog breathed through one nostril only.



Figure 2. Both nostrils were surgically obstructed. For two months the dog breathed only through its mouth.

MATERIAL AND METHOD

Starting from the mentioned fact that nasal obstruction sustains the irritation of the respiratory mucous membrane of the lower respiratory passages, it was decided to prove this experimentally on animals.

For the experiment dogs were chosen because of the histological structure of their bronchial mucous membrane is, barring that of monkeys, nearest the human one. Both nostrils of two dogs were surgically closed, two other dogs had only one nostril each thus closed, and the fifth dog served as control. Before the experiment clinical and laboratory examinations had proved the dogs healthy (Figures 1 and 2).

Two months after the surgery the dogs were sacrificed and the respiratory mucous membrane of their bronchi and bronchioles were examined by the usual histological methods and by electronic microscopy.

RESULTS

The histological findings of the mucous membrane of the lower respiratory passages showed infectious alterations in the four experimental animals. These alterations were obviously pronounced beginning with the bronchi of the



Figure 3. Histological finding of bronchitis. The epithelium is tasselled, the bronchial lumen contains mucus and considerable quantities of leukocytes. Enlarged 100 times.

second order. The intensity of the alterations, however, was not the same in the four animals. In the lumina of the bronchi of the four animals, mucopurulent exudation was found while the alterations on the mucous membranes of the four animals were described thus: strong chronic, hyperplastic and desquamative catarrhally purulent bronchitis and bronchiolitis.

The electronmicroscopic examination found infectious alterations of the mucous membrane of the smaller bronchi manifest in serious damage to epithelial cells with such vacuolarization of the cytoplasm that some cells resembled sponges. Observed was also ample secretion from goblet cells. The stroma showed and partial lysis of the basic substance. In the stroma were found infectious infiltration predominantly of lymphocytes and plasma cells while granulocytes were fewer. New collagenous fibrils were created secondarily and caused thickening of the propria. Histological alterations of the respiratory mucous membrane were not obviously pronounced in the animals with surgically closure of both nostrils, probably because of the short duration of the experiment. The alterations were otherwise most often found on the epithelium (Figures 3, 4, 5, 6 and 7).



Figure 4. Electronmicroscopic finding of damaged epithelial cells. Visible deterioration of cilia. Enlargement 20.000 times.



Figure 5. Electronmicroscopic finding of damage to cells of the respiratory bronchial mucous membrane. Appearance of vacuoles, in goblet cells increased production of mucus. In the lumen mucus and detritus. Enlargement 5000 times.



Figure 6. Electronmicroscopic finding of chronic bronchitis. Detail of inflamed infiltration. Plasmacytes and histiocytes. In the plasmacytes characteristic lamellae of ergastoplasm. Enlargement 8000 times.



Figure 7. Electronmicroscopic finding of the creation of connective fibers in the development of chronic bronchitis. Between fibroblasts polymerization of bundles of collagenous fibers. Enlargement 6000 times.

DISCUSSION

In the development of the chronic inflammation of the bronchial mucous membrane a definite dynamic sequence can be observed. At the beginning hypertrophy and hyperplasia of the mucinous glands appear, the epithelium metaplastes cylindrically without cilia, then cubically and platelike while the submucous membrane becomes infiltrated by an abundance of inflamed cells. The bronchial wall thickness, and microabscesses in the mucous membrane gradually cause granulation and cicatrization, which make the wall lose its elasticity while the retained contents deform it. In our experiment with animals it was not possible to observe all the mentioned development stages of chronic bronchitis because the duration of the experiment was too short. However, we observed the initial thickening of the bronchial wall owing to the formation of collagenous fiber bundels, which irreversibly leads to changes in the bronchial wall, and which we consider of special importance.

CONCLUSION

The surgical nasal obstruction of the experimental animals led to the irritation

of the mucous membrane of the lower respiratory passages, which was confirmed by normal histological examination and electronic microscopy. Nasal obstruction by itself does not cause bronchitis but the thus impeded respiratory mechanism creates favourable conditions for its inception. The described experiment, too, confirms the principle of the indivisibility and integrity of the entire respiratory system.

ZUSAMMENFASSUNG

Die Nasen von vier Hunden wurden chirurgisch geschlossen, und dadurch ihre gesammte Atmung gestört, was auch die Schleimhäute der unteren Atmungswege beeinflusste. Gewöhnliche histologische Methoden und elektronische Mikroskopie fanden die bronchialen Schleimhäute irritiert. Von allem Anfang an war es möglich die Wichtigkeit einer verstopften Nase, als mittelbaren Faktor im Entstehen der chronischen Bronchitis ist hervorgehoben.

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