The effect of air currents on the naso-respiratory mucosa

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SUMMARY

The direction of air currents through the nose have been studied by many investigators.
However, in injury of the nose followed by deformities, a marked change in the nasal configuration occurs. Many patients will present localized areas of crusting and attention is not drawn to this condition until the patient is seen with an epistaxis.
In this study, we are interested in the character of the mucosa and their changes as affected by long-term injury from the trauma of the inspiratory and expiratory air currents, which, on sniffling or snorting, may reach hurricane speeds.
In the study of the naso-respiratory mucosa from these areas by electron-microspy, it was found metaplastic respiratory epithelium where the cells have undergone mucinous transformation and areas exposed to air jets how metaplastic changes followed by erosion.
We wish to thank Nikolajs Cauna, M. D. for his assistance and making available the micrographs used in this paper.

INTEREST in the subject of "The Effect of Air Currents of the Naso-Respiratory Mucosa" started as a cooperative effort between the Department of Anatomy and Cell Biology under Dr. N. Cauna and the Department of Otorhinolaryngology at the University of Pittsburgh Medical School. As a result, there has emerged the feeling that the nasal lining has a unique submicroscopical and histochemical organization which may have some clinical interest.
On examination of many electron-micrographs, it was felt that this effort may have no clinical value. But, when associated with clinical findings, two points were evident which will be presented in this paper.
First, the role of the nasal glands in the humidification of the inhaled air is still under discussion. It now appears that the moisture is provided by a vast network of fenestrated capillaries found immediately beneath the respiratory epithelium. The mucous blanket secreted by the glands may have the property of a holding fluid that is released by the capillaries and may play an important intermediary

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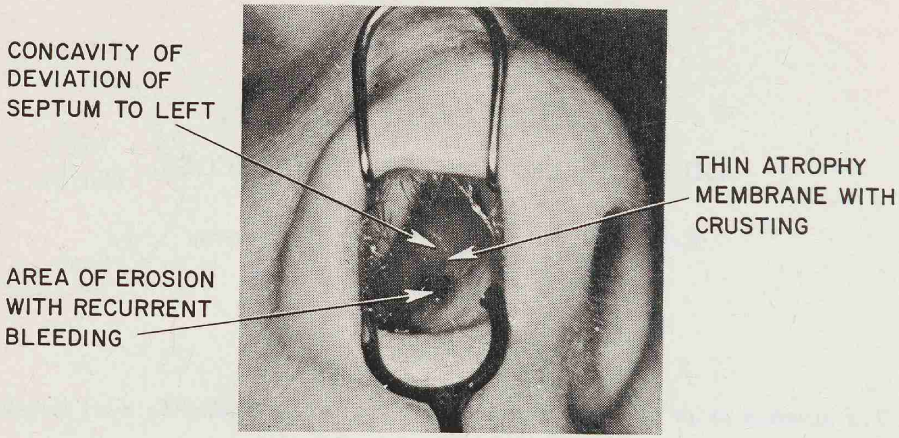
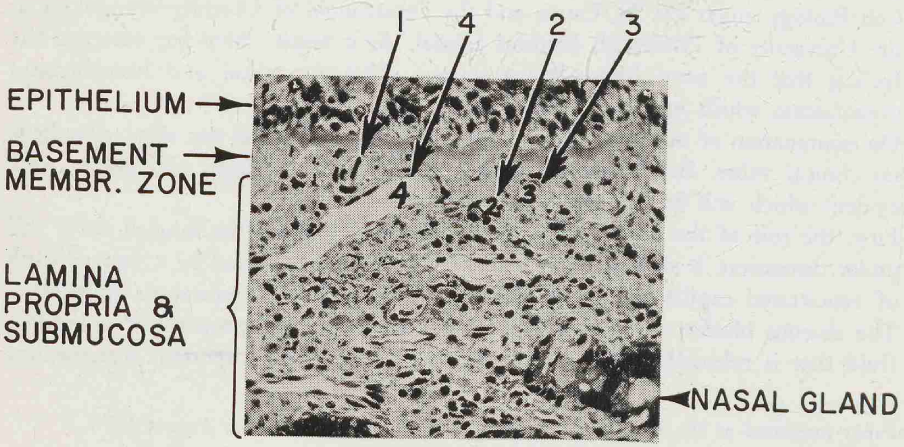


Figure 1
Clinical protographs of a typical septal deformity with area of erosion with recurrent nose bleeds. Concavity of septum traumatized by inspiratory air currents with thinning and crusting of nasal mucosa.

role in the humidification process. The nasal glands eleborate a mucous blanket over the respiratory epithelium of the nose which is continously moving backward and downward towards the pharynx as a result of the ciliary action. It serves as an expendable protective covering, and it is also involved in the humidification process.

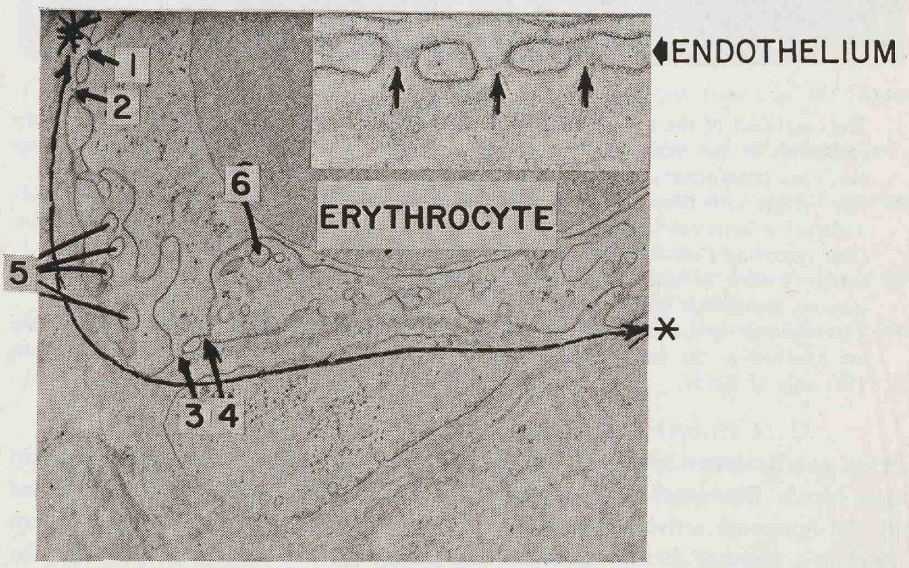
Figure 2
Optical microscopic picture for orientation. Epithelium above. The basement membrane zone next lamina propira plus submucosa. Same elements of the nasal glands below. Sub-epithelial zone contains large capillaries of the fenestrated variety cut tranversely (1, 2, 3), cut longitudinally (4).



Second, the feeling of dryness in the nose and the development of crusts in certain pathological conditions seem to be the result of reduction in function of the mucosa due to damage of the fenestrated capillaries rather than dysfunction of the glands. Blood vessels of the nasal glands are richly innervated by adrenergic and cholingeric axons. Therefore, the nasal glands are affected by the adrenergic element of the autonomic nervous system through innervation of their blood vessels (Cauna, 1970). Further studies are needed to confirm the above findings. Williams (1958) presented his view on the subject of progressive dryness and increased air space "senile atrophy" so common in the older patient as part of the aging process (not to be confused with ozena). The nasal interior enlarges from the thinning of the tissues, decreasing activity of the nasal cycle, diminished flow of blood by the fine capillaries with decreasing resistance with the loss of pressure although the nose is wide open as found by examination. This syndrome presents the feeling of stuffiness. Due to this, many patients develop the "nose drop habit" when all that is needed is moisture and not vaso-constriction.
Examination of many noses in the active practive of Rhinology has revealed that many patients have this problem of dry areas with crusting and bleeding. Attention

Figure 3

Part of a fenestrated capillary under electron microscope. Lumen contains erythrocyte. In this capillary, some fenestra have been cut transversely (1, 2, 3, 4). No other areas showing fenestra in the surface view (5, 6). Insert shows fenestra under higher magnification, black arrows figures 2 to 5.
Areas from the nasal lining exposed to air jets caused by obstructive deformities of the nose. The respiratory epithelium shows metaplastic changes followed by erosion.



PART OF A FENESTRATED CAPILLARY UNDER ELECTRON MICROSCOPE.

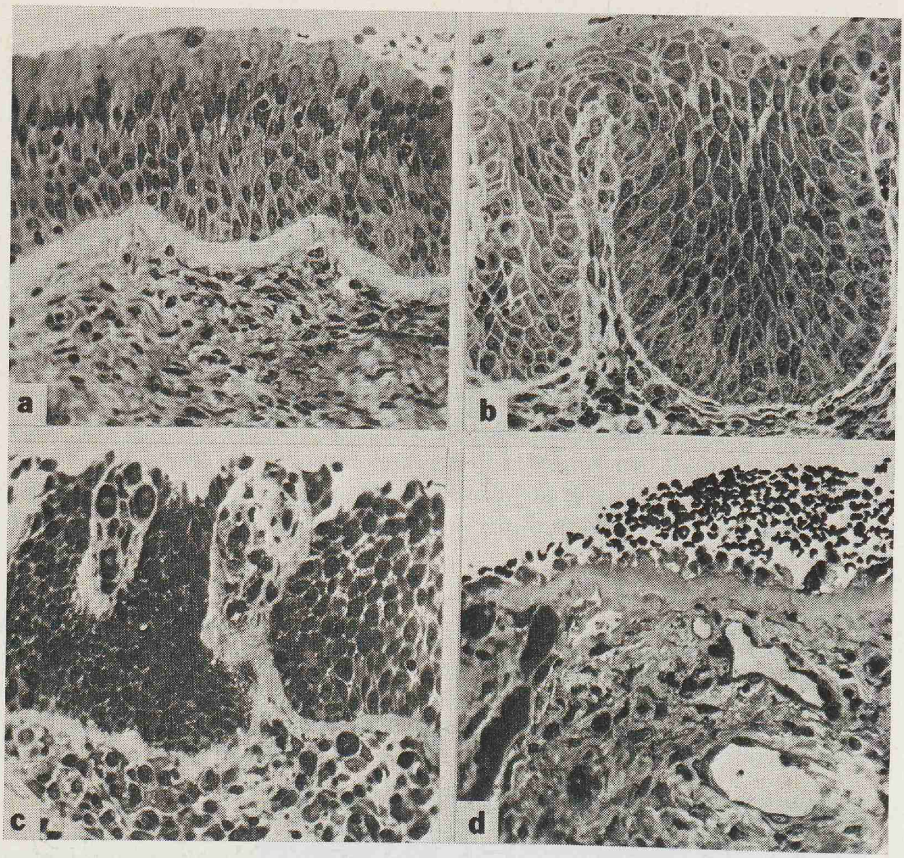


Figure 4

a. The basal half of the epithelium consists of polygonal cells similar to those found in the epidermus of the vestibule. The surface cells are high columnar and are undergoing mucinous transformation.
b. The surface cells have lost their mucous producing capacity. They are flattened and are undergoing keratinization. High vascular papillae have grown into the thickened epithelium extending close to the external surface.
c. Surface erosion of metaplastic. The vascular papillae are exposed to the air stream and contains thrombotic capillaries.
d. Ulceration of epithelium, only some basal epithelial cells (arrows) have survived. They are attached to the basement membrane. Some sub-epithelial capillaries are thrombotic (left side of field).

is not usually drawn to these localized areas until the patient is seen with recurrent nose bleeds. The nasal cycle is most active during adolescence which is explained by the hormonal activity at this age (Keuning, 1968). But in the older patient there is a decrease in the activity of the noasal cycle. This decrease is noted by decreased resistence to air flow which makes the patients aware of sensitivity to changes in temperature, crusting, and facial pain. Through these findings, clinical

investigators have repeatedly shown that there is a definite connection between naso-respiratory and cardio-vascular disease (Ogura et al., 1964). This interrelationship has been studied from the standpoint of aerodynamics, gas exchange, and reflex regulation of the breathing cycle (Sercer, 1930). The nose is a very complex organ. It contains many types of tissues which are sensitive (Sercer 1930) to their environment. They react to sudden changes in temperatures, barometric pressures, and presence of inhaled irritants. The membranes are affected by dehydration from inadequate fluid intake, low humidity, and constant trauma of inspired air currents which give symptoms never associated with pathology of the nose.

In this study we are interested in the character of the mucosa and their changes as affected from the long term injury to localized areas caused by the inspiratory and expiratory air currents during the actual act of breathing under all conditions. To date, there has been no electron-microscopical studies of the normal nasal mucosa. These studies which are still in progress have revealed interesting and significant characteristics which in time and with further study help to better understand the function of these tissues, which indicates that the naso-respiratory mucosa is a complex structure and serves many functions.

This paper will illustrate some of the changes that occur in the mucous membrane that have been exposed to localized effects of air turbulence. The speciments used in this series were from the nasal lining from the inferior turbinate and the nasal septum posterior to the muco-cutaneous junction.

Changes were observed in all tissue layers. These included the epithelium, the basement membrane zone, the blood vessels connective tissue elements, and nerve fibers.

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