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The influence of nasal obstruction on mucociliary transport

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SUMMARY

The influence of nasal obstruction on mucociliary transport is tested by the saccharine test (Andersen). Twenty normal subjects were tested with open nose and subsequentally with the nose closed by a clamp. The transport times were significantly longer, when the nose was clamped. It is dicussed that nasal obstruction and missing ventilation leads to changes in the mucus layers by superfluent humidity. This causes a decoupling of the mucociliary transport. Thus a new aspect in pathogenesis of nasal and sinus disease is given.

INTRODUCTION

In 1974 Andersen et al. described the saccharine test as a simple method to assess mucociliary transport. Thus it was possible to examine the mucociliary system independent from technical equipment such as a gamma-camera (Quinlan et al., 1969; Kaya et al., 1984) or X-ray apparatus (Yergin et al., 1978).

As nasal obstruction by adenoids or septal deviation often leads to nasal discharge or inflammation of adjacent sinuses, we studied the nasal mucociliary transport in the obstructed nose.

MATERIALS AND METHODS

We asked subjects who had no nasal complaints and a normal X-ray of the sinuses to undergo a saccharine test. Most of the patients had been referred to our department for ear surgery without acute inflammation. The subjects did not have had a common cold during the last three weeks. None of the patients had a septal deviation of importance.

Using a moistened cotton wool applicator, saccharine powder was picked up and placed on the inferior turbinate about one centimeter posterior to its head. (Andersen, 1984).

The saccharine powder was dyed with indigotine to obtain a blue colour. The subjects were asked to remain upright, sitting or standing, but not to lie down. They were allowed to breathe through the nose at their ease without sniffing.

The transport time was taken when the subject tasted the sweetness of the tracer. After a few hours on the same day, when the sweetness had disappeared, the same test was repeated. This time after application of saccharine the nose was closed by a clamp. The transport time was taken in the same way.

RESULTS

We tested 20 persons. The results are shown in Table 1. The mean value for the transport time with open nose was 9 min 12.5 sec; with the nose closed it was 15 min 30.75 sec. (see Table 2).

The data were statistically evaluated (Institut für Medizinische Informatik und Biomathematik der Univ. Münster). Using the sign-test, the Wilcoxon-test and the t-test a significant difference between the two groups could be established. In four cases the transport in the closed nose was faster than in the open nose. In one case the transport times were the same. These five patients were not conspicuous in any respect, for instance by a dry nose, complaints, or the use of drugs.

Table 1. Transport-times (sec).

no.	nose open (sec)	nose clamped (sec)
1	720	1290
2	840	960
3	510	735
4	600	420
5	600	600
6	480	900
7	480	960
8	300	1800
9	840	1110
10	490	1000
11	285	910
12	645	780
13	530	850
14	550	490
15	705	420
16	495	275
17	450	660
18	540	1500
19	480	2100
20	510	855

Table 2. Mean-values and standard-deviations.

	mean-value (sec)	standard-deviation (sec)
nose open	552.5	145.598
nose clamped	930.75	459.854

DISCUSSION

At the first attempt we had designed this study to try the validity of the saccharine test. The hypothesis was that the transport of the saccharine powder is merely an effect of conveying by the inspired air, which might have more impact than the exspiratory flow. This question has not been raised or discussed so far (Maurizi et al., 1984).

We obtained the convincing result that mucociliary transport as measured by the saccharine test is not absent in the clamped nose. Thus it was proved that the transport is an effect of the mucociliary activity.
A second result was that the transport velocity during nasal obstruction is significantly lower. Ginzel and Illum (1980) could demonstrate an improvement of mucociliary transport after septoplasty and discussed this effect as due to removal of anatomical obstacles. They found no difference in transport time between the nasal cavity obstructed by the septal deviation and the side of the concavity.
Our results led us to the hypothesis, that the mucociliary transport in the nose is depending on a delicately balanced equilibrium of moisture (Toremalm, 1983). The inspired air is moistened by the nose; this means in return that moisture of the nose produced by the epithelial lining is removed during breathing. Thus nasal obstruction may cause superfluent production of moisture, which will lead to changes in viscosity or disturbances in the mucus layers (Petruson et al., 1984). This brings about a decoupling of the mucociliary transport.
This superfluent production of nasal secretions is well known in patients who underwent laryngectomy. We tried the saccharine test also in patients after laryngectomy and saw the blue secretions discharging through the nostrils, contrary to the direction of the mucociliary transport.

The results of Ginzel and Illum (1980) may be explained by the fact that overall nasal obstruction leads to breathing through the mouth.
It must be concluded, that missing ventilation is followed by a decoupling of the mucociliary transport; an effect of significance also in the pathogenesis of sinus diseases.

ZUSAMMENFASSUNG

Der Einfluß der Nasenatmungsbehinderung auf die mukoziliare Transportfunktion der Nase wurde mittels des Saccharintestes (Andersen) überprüft. Hierzu wurde der Test bei zwanzig Normalpersonen bei offener und danach bei durch Klammer verschlossener Nase durchgeführt. Die Transportzeiten bei geschlossener Nase waren signifikant länger. Es wird diskutiert, daß eine Ventilationsbehinderung der Nase zu einer Störung in der Schleimschichtung durch zu hohen Feuchtigkeitsanfall führt. Hierdurch wird trotz intakter Zilienfunktion der mukoziliare Transport entkoppelt. Es werden neue Aspekte in der Pathogenese von Nasen- und Nasennebenhöhlenerkrankungen diskutiert.

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