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Alteration of airflow and mucociliary transport in normal subjects

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Abstract
The effect that variation of nasal airflow has on the mucociliary clearance was studied in healthy volunteers. The nasal saccharin particle clearance time was found to have an inverse relationship with the nasal airflow.

Key words: Mucociliary clearance; Saccharin, particle clearance time; Nasal obstruction

Introduction

In patients with deviations of the nasal septum, saccharin particle transit times are reduced following submucous resection of the nasal septum (SMR) (Ginzel and Illum, 1980; Barr, 1988). In this paper, changes in saccharin particle transit times are evaluated in normal subjects with alteration of nasal airflow rates.

Materials and methods

Eighteen healthy university student volunteers (14 males and four females), aged 22 years 9 months to 31 years (median age 23 years), were studied. No subject had symptoms or signs of disease of the upper respiratory tract and in none were septal deviations found that could be described as obstructive.

The saccharin particle test described by Andersen *et al.* (1974) was done on three occasions over a five-day period (days one, three and five). The choice of nostril was determined by tossing a coin and the same nostril was used for the three tests. The particles of saccharin were approximately 0.5 mm in diameter and were placed 1 cm behind the anterior end of the inferior turbinate. A wool carrier was used to place the particle and the subject was asked to stop breathing during its placement. The time taken for the subject to experience a sweet taste was measured to the nearest minute with a stop watch. If the particle had not been tasted within 30 minutes, the test was terminated. During the test period the subjects remained at rest and were not allowed to smoke, eat, drink, cough or sneeze. The head was flexed to prevent the saccharin particle from falling backwards (Stanley *et al.*, 1984).

On the first occasion the saccharin particle test was done in the conventional way with the subject breathing gently through the nose. The second time the test nostril was occluded by microfoam tape. On the third test, the contralateral nostril was taped to enforce increase in nasal airflow within the test nostril. The subjects were tested at the same time of day under identical climatic conditions: temperature (18°C) and relative humidity (35 per cent). Data were analysed using the Wilcoxon signed rank test.

Results

The saccharin particle clearance times were significantly longer when the test nostril was blocked ($p<0.05$) and significantly shorter when the non-test nostril was occluded ($p<0.05$). For the 18 pairs, smaller value of $t = 40$ and 38.5 for comparison of ordinary test to ipsilateral- and contralateral-taping respectively (see Table I).

Discussion

The finding of an inverse relationship between nasal airflow and saccharin particle transit times is consistent with the findings of changes in saccharin particle transit times following SMR. The increased airflow in the nose may exert its effect on saccharin particle transport either by increasing ciliary beat frequency or by exerting some other unknown effect upon the mucous blanket. Increasing airflow through the nose would be expected to cause some degree of drying of nasal mucus by evaporation, but clearly this does not have a sufficient 'drying-out' effect upon the cilia.

Deitmer and Erwig (1986) have shown the saccharin particle transit time to be prolonged when the test nostril is occluded. This was attributed to super fluent humidity causing changes in the mucous layer. However this could equally have been a result of decreased aeration either affecting ciliary beat frequency or mucous blanket rheology.

Proctor and Andersen (1976) found the saccharin particle clearance times were reduced following laryngectomy. The absence of nasal airflow in these patients cannot necessarily be related to patients with DNS or normal subjects as laryngectomees are likely to have been heavy smokers with squamous metaplasia of the nasal mucosa. In this situation, the absence of airflow would be expected

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TABLE I

DIFFERENCES IN SACCHARIN PARTICLE CLEARANCE TIMES WITH NORMAL AND ABSENT AIRFLOW IN HEALTHY SUBJECTS (n = 18)

Subject no.	Age (years)	Sex	MCCT (mins) Nose untaped	MCCT (mins) Test nostril taped	MCT (mins) Opposite nostril taped
1	22 years 2 months	M	16	18	14
2	20 years 9 months	F	15	17	13
3	22 years 4 months	M	17	14	13
4	24 years 8 months	M	8	12	12
5	23 years 5 months	M	16	19	10
6	24 years 1 month	M	9	15	7
7	23 years 0 months	M	14	16	11
8	24 years 2 months	M	12	17	9
9	21 years 2 months	M	9	15	8
10	23 years 0 months	M	10	13	10
11	21 years 2 months	M	10	14	7
12	22 years 2 months	M	17	13	11
13	22 years 7 months	M	17	19	19
14	31 years 0 months	M	20	14	23
15	29 years 5 months	M	8	12	11
16	22 years 2 months	F	12	17	7
17	24 years 1 month	F	16	13	10
18	23 years 1 month	F	9	15	12

to revert the mucosa to its infantile state with greater efficiency of the mucociliary transport system.

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