

## The prognostic value of mucociliary clearance in predicting success in tympanoplasty

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### Abstract

Mucociliary and equipressive eustachian tube functions have been studied, using saccharin solution (five per cent sodium saccharinate) and tubal manometry respectively, in 58 ears with chronic disease undergoing tympanoplasty. The position of the perforation site determines the results as the poorest results are obtained from the posterior ones, positive cases (47 per cent) and mean transport time (37.7 minutes), compared to the greater percentage of positive cases (86 per cent) and mean transport time (22.2 minutes) for anterior perforations.

When both parameters are analysed together there is a direct relationship between normal equipressive function and normal mucociliary transport time and between negative transport time and tubal blocking. Significant differences in transport times have been found for the anterior and posterior perforations being shorter for the anterior ones.

When surgical outcome is correlated with mucociliary transport, the normal transport time percentage is seen to be considerably higher in the success group (50 per cent) than in the failure group (22 per cent).

**Key words:** Otitis media; Eustachian tube; Mucociliary clearance

### Introduction

The role of the eustachian tube in chronic otitis media (COM) genesis is still open to controversy, and its value in the prognosis of reconstructive middle ear surgery remains uncertain.

The eustachian tube possesses two primary functions *i.e.* equipressive and mucociliary drainage. Studies of the mucociliary drainage function are more recent than studies of the equilibration of middle ear pressures. Thus, Lafaye *et al.* (1974) and Gaillard de Collogny *et al.* (1974) were the first to employ radioisotopic techniques, which were improved due to the contributions of Vallés *et al.* (1981 a, b) and Nuutinen *et al.* (1983). Radioisotopes were found to be very useful in the detailed study of tubal mucociliary transport. However, the complicated apparatus necessary led to the evaluation of alternative, simpler techniques with which to study mucociliary drainage.

Elbrond and Larsen (1976) and Hadas and Sadé (1979) deposited saccharin crystals in the tympanic cavity of individuals with eardrum perforation secondary to COM, to measure the time required for the patient to indicate a sweet taste in the pharynx, which coincided with the time the saccharin reached the pharyngeal ostium of the eustachian tube. We have used saccharin solutions to determine the normal reference parameters of the method (Giménez *et al.*, 1990).

In the present paper we have studied tubal mucociliary transport using a saccharin solution in a group of patients with COM and central perforation. This relationship is

studied by (i) perforation topography; (ii) state of equipressive function and (iii) result of reconstructive middle ear surgery (when performed).

### Materials and methods

Eighty-two ears with COM and central perforation were studied, comprising 33 males and 49 females (aged between 12 and 63 years: mean 34.2 years). All ears had been free of supuration for at least two months. A complete otolaryngological evaluation was performed to rule out associated pathologies and the absence of acute head colds and/or severe allergies was verified. The perforations were classified as shown in Table I.

We used 10 µl of five per cent sodium saccharinate solution. A micropipette fitted with a needle aspirator was used under microscopic control to deposit the solution into the tympanic cavity through the perforation. The patient was seated and instructed to indicate when a sweet sensation at the back of the pharynx was noticed. In former studies we have noticed that in both healthy ears

TABLE I  
PERFORATION SITE DISTRIBUTION WITHIN THE TYMPANIC MEMBRANE

Perforations	
Anterior	30 cases (36%)
Subtotal	26 cases (31%)
Posterior	17 cases (20%)
Inferior	9 cases (11%)

TABLE II  
RESULTS OBTAINED FOR ALL CASES IN RELATION TO MUCOCILIARY  
TRANSPORT TIME

Transport time		
Group 1	Under 20 minutes	Normal
Group 2	Between 20 and 90 minutes	Prolonged time
Group 3	Negative after 90 minutes	Non existent transport

and those with traumatic perforations, transport times are less than 20 minutes (Giménez *et al.*, 1990). In patients with COM we have not found the transport time to be more than 80 minutes coinciding with the Elbrond and Larsen (1976) results. They fixed a maximum transport time of 90 minutes in their test. After this time has elapsed without detection of saccharin, the clearance is considered nonexistent. We classified patients into three groups as shown in Table II.

In all cases, tubal manometry was performed according to the technique described by Elner *et al.* (1971). The results were classified as follows:

- Normofunction: full equilibration capacity for positive and negative pressures.
- Blocking: inability to compensate both positive and negative pressures (even partially).
- Dysfunction: all intermediate situations.

Full equilibration capacity was taken to represent residual pressures of under +100 or -100 mmHg.

Fifty-two ears were subjected to reconstructive middle ear surgery. The tubal evaluation was carried out prior to surgery or on ears that had been re-perforated after surgery. Surgery was considered to be a success in those cases resulting in an intact membrane without evident retractions. The remaining cases were considered failures. The patients were followed-up after surgery as shown in Table III.

## Results

Of the 82 ears studied, 60 (73 per cent) sensed the saccharine taste within 90 minutes. The other 22 patients (27 per cent) were considered negative. Figure 1 shows the distribution of mucociliary transport time for all cases. No positive case was recorded for the 80–90 minute interval. Mucociliary transport time was within normal limits in 26 per cent of cases prolonged in 46 per cent, and nonexistent in 27 per cent of patients.

Results obtained on grouping the patients according to perforation topography are shown in Table IV. It appears that the greater percentage of positive cases and the best clearance times correspond to the anterior perforations. The subtotal and inferior perforations in turn gave intermediate results. If we study the

TABLE III  
FOLLOW-UP TIMES AFTER SURGERY

Length of time	
9–12 months	24 cases
12–15 months	16 cases
15–18 months	8 cases
18–21 months	6 cases
21–24 months	5 cases

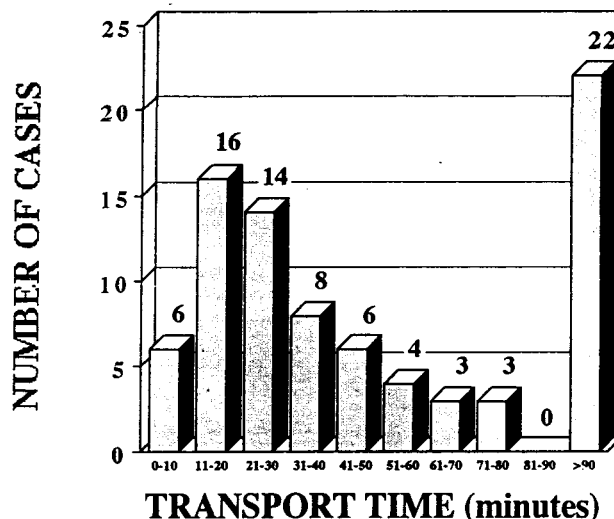


FIG. 1

Mucociliary transport time in COM using saccharin solution.

relationship between time of transport and type of perforation using the Chi-squared test, we find a statistical significance ( $\chi^2 = 9.068$  and  $p < 0.05$ ). We studied the relationship between type of perforation and average transport time, in the cases in which this exists, by the Kruskal-Wallis test, and found a statistical significance ( $p < 0.05$ ). Comparing the groups in pairs, we found significant differences between anterior and subtotal perforations. In the rest of the pairs we cannot confirm the difference because of the fewer cases studied.

Comparisons of the results of mucociliary clearance with equipressive functions are given in Table V. Using the Chi-squared test we obtained significant differences ( $\chi^2 = 20.735$  and  $p = 0.0004$  ( $< 0.001$ )). To look for the cause of the difference, we compared groups with normal equipressive function with dysfunction and repeated the test:  $\chi^2 = 16.906$  (81.5 per cent of the former  $\chi^2$ ) and  $p = 0.0002$  ( $< 0.001$ ) were obtained. This means that the cause of the relationship between both variables is the difference in behaviour of group 'blocked' in comparison with the other two groups (normal and dysfunction).

The 52 cases operated on and studied corresponded to 30 surgical successes and 22 failures. The correlation between mucociliary clearance and surgical outcome is shown in Table VI. The percentage of normal transport times is seen to be considerably higher in the group of successes than in the group of failures; this situation is reversed in the case of negative transport. The patients with delayed transport show intermediate results. If we use the Chi-squared test, we find significant differences ( $\chi^2 = 7.08$  and  $p < 0.05$ ). Although the total failure figures may seem high, this is due to the fact that patient selection in the study was not fully randomized and some of them

TABLE IV  
MUCOCILIARY TRANSPORT TYPE AND TIME IN RELATION TO  
PERFORATION SITE

Site of perforation	Negative transport	Positive transport	Positive mean time
Anterior	4 (13%)	26 (86%)	22.2 minutes
Subtotal	6 (23%)	20 (77%)	37.0 minutes
Inferior	3 (33%)	6 (67%)	31.8 minutes
Posterior	9 (53%)	8 (47%)	37.7 minutes

TABLE V

RELATIONSHIP BETWEEN MUCOCILIARY TRANSPORT TIME AND TUBAL EQUIPRESSIVE FUNCTION

	Mucociliary clearance			
	Normal	Delayed	Nonexistent	
Equipressive function				
Normal	19 (63%)	8 (27%)	3 (10%)	30 cases
Dysfunction	10 (38%)	8 (31%)	8 (31%)	26 cases
Blocked	7 (27%)	2 (8%)	17 (65%)	26 cases

corresponded to eardrums already reperfomed following surgery.

### Discussion

In the present study mucociliary function was found to be best in the ears with anterior perforations, both in the cases with positive transport and in their corresponding mean transport time. Mucociliary function was worst amongst posterior perforations. Subtotal and inferior perforations showed intermediate results.

Vallés *et al.* (1981a) studied these phenomena. Their results are different from ours: they observed no important differences between the sites of perforation, and the incidence of positive transport was found to vary between 54 and 35 per cent. Moreover, their best results corresponded to posterior and paracentral perforations, where as the worst cases were subtotal perforations. They also evaluated subtotal perforations by depositing contrast in the antero-inferior and postero-inferior quadrants and observed a three to four minute difference between the two transport times, corresponding to the supplementary displacement through the cavity. Our results point to the existence of a longer transport time in posterior perforations than in anterior ones. However, these results cannot be exclusively attributed to the depositing of saccharin in one zone or another of the cavity. The differences suggest the existence of a relationship between mucociliary transport and the site of perforation; the varying topography of the perforation would thus influence the integrity of the mucociliary transport system, or else the better or worse condition of the latter would influence the appearance of one type of perforation or another.

Elbrond and Larsen (1976) compared the results obtained by the impedance aspiration test and the determination of clearance time, no significant correlation being found between the two parameters. Vallés *et al.* (1981b) performed tubal manometry and clearance time study in 78 patients. They found that in cases of normal equipressive function, clearance time was considerably better than in those tubes with manometric dysfunction or blocking, with no significant differences between these latter two cases. Our own results are partially similar to the above ones.

Attempts have been made to correlate the state of the mucociliary transport system with the results of reconstructive surgery of the middle ear. Thus, Elbrond and Larsen (1976), in 41 successfully operated ears, found transport to be positive in 78 per cent of patients (including our normal and delayed cases). In the case of the three failures studied by these authors, transport was positive in all three. With the exception of the latter data (hardly analysable due to the limited size of the series involved) the

TABLE VI

CORRELATION BETWEEN MUCOCILIARY TRANSPORT TIME AND POST-OPERATIVE RESULT

Transport time	Mucociliary clearance			Total
	0-20 minutes	20-90 minutes	>90 minutes	
Successes	15 (50%)	9 (30%)	6 (20%)	30 (100%)
Failures	5 (22%)	5 (22%)	12 (54%)	22 (100%)

remaining results of the above study were very similar to our own. Poch-Broto and Vallés (1983) used sequential scintigraphy to likewise obtain results parallel to our own. In 57 tympanoplasties, they found transport to be positive in 96 per cent of the successfully operated ears, *versus* only 28 per cent among the surgical failures.

### Conclusions

In this paper we have shown that there is a direct relationship between tubal mucociliary transport and tubal equipressive competence. This fact may be used to predict the result of tympanoplasty either alone or in combination, taking into consideration the anatomical site of the perforation in the eardrum.

The existence of good tubotympanic mucociliary drainage constitutes a favourable prognostic factor in the outcome of reconstructive surgery of the middle ear.

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