Rhinology, 21, 135-142, 1983

Value of the Tc^{99m} particle test and the saccharin test in mucociliary examinations

L. Brondeel, R. Sönstabö, P. Clement, W. van Ryckeghem and M. van den Broek, Brussels, Belgium

SUMMARY

In a first phase, the two methods were evaluated separately, the saccharin test was done in 40 healthy test subjects, 30 atopic patients and 30 patients presenting nasal ventilation problems; subsequently the Tc^{99m} particle test was carried out in 39 test subjects under standard conditions (relative humidity and temperature). In 120 patients the tests were done in one nasal canal, whereas they were carried out in both nasal canals simultaneously in 19 patients.

In a second phase the two methods were applied simultaneously in the same nasal canal in 44 subjects, of whom 15 did not experience any nasal problems and 29 had undergone a nasal packing.

The investigators were able to establish significant differences in the results obtained by the two methods.

The present study shows that mucociliary activity is considerably influenced by ventilation and that under pathological conditions both tests should be used as complementary investigational methods.

INTRODUCTION

The mucociliary (m.c.) system consists of cilia and a cover layer of mucus. The latter consists of a sol and a gel phase, i.e. a periciliary fluid zone in which the cilia beat following a metachronal rhythm, and a more viscous layer.

Transport depends therefore on the cilia (number, structure and beating rhythm) as well as on the composition of the mucus layer, (Yates, 1924; Hilding, 1932; Orston, 1946; Tremble, 1948).

In order to test the m.c. movement, direct and indirect methodes can be applied (Ewert, 1965; Melon, 1979; Crifo, 1980).

The aim of this study was to look for a reliable method that could be used in various conditions. Two indirect methods were compared because the direct method

Paper presented at the 9th Congress of the European Rhinologic Society and 3rd ISIAN, Stockholm (Sweden), September, 1982.

makes use of a mucous membrane preparation or a limited part of the mucosa (Mercke et al., 1973; Toremalm, 1974).

MATERIAL AND METHODS

In a first phase, both tests were evaluated separately and afterwards they were carried through simultaneously in the same nasal canal. Environmental conditions were constant.

In group I 100 subjects were tested using the saccharin method (Sc). A particle of 0,5 to 1 mm on an average was placed on the inferior turbinatie, 1 cm below the top of the concha. The moment at which the saccharin is tasted, defines the transit time. The group consisted of 40 normal subjects, 30 atopic subjects and 30 patients with a history of ventilation problems. The particle was always placed on the non-congestive side.

Group II, in which the Tc^{99m} resin method (Tc) was used, consisted of 39 subjects without nasal complaints. Nineteen of them, however, presented anterior ventilation problems, but these had not been experienced as bothersome. In 19 subjects of this group the test was done bilaterally in one time. In this test, a small technetium-labelled particle of resin (DOWEX 1 × 8, 50–100 mesh) was placed with a plastic spatula 1 cm beyond the top of the inferior turbinatie, or on the septum in the ciliated zone. (Guillerm et al., 1971; Proctor et al., 1965, 1968, 1973, 1976). The test subjects were in the supine position.

The displacement of the particle can easily be assessed by means of an Anger Camera coupled to a data-processing system, (Quinlan et al., 1969). We use an Elscint Dymax Camera (Israel), equiped with a pin hole collemator and a SIMIS III computer (Informatek, France). Consecutive images were obtained with an acquisition time of 20 seconds until the particle disappeared in the nasopharynx (Kärjä et al., 1982).

The transit times were estimated by measuring the distance convered by the particles as seen on a T.V. display.

In a third group of 44 subjects the Tc test and the Sc test were carried out simultaneously. Both particles were placed next to each other on the non-congestive side in the same nasal canal and it was checked whether the end of the passage of Tc corresponded to the taste sensation.

In this third group, 15 subjects had no nasal problems and 29 had been treated with a full bilateral nasal packing after nose surgery three to eight weeks before the test.

RESULTS

Group I Saccharin method

The mean transport time in healthy subjects was 9.5 min with extremes of 4 and 16 min. In atopic patients we observed a mean transport time of 14 min ranging

between 7 and 25 min; in the group with anterior ventilation problems the transport time ranged between 8 and more than 30 min with a mean of 18 min.

Group II Technetium resin method (Table 1)
In the whole Tc group the mean transport time on the non-congestive side is 5.3 per min. However, subjects with septum problems in this group had a transport rate of 3.1 mm per min on the side of the septum deviation and the others 6.3 mm per min (Kärjä et al., 1982).
Figure 1 clearly shows the slow progression of the particle on the side of the septum deviation.
In 19 subjects a particle was placed on both sides. In 9 of them a slower transport and in 10 no Tc transport was observed on the congestive side whereas on the non-congestive side the nasopharynx was reached.
Figure 2 shows the considerably slowed down transport on the congestive side at the top and the absence of transport at the bottom.

Table 1. Group II - Technetium method.

39 subjects without nasal complaints →	$\bar{v} = 5.3$ mm/min.
11 septum deviation	$\bar{v} = 3.1$ mm/min.
28 normal ventilation	$\bar{v} = 6.3$ mm/min.

$\bar{v}$ = velocity.

Group III (Table 2)
In 25 subjects Tc and Sc transport were equal (Tc = Sc). Eleven of them were patients who had had nasal packing treatment, whereas 14 were healthy test subjects, Sixteen patients, all of them having been treated with nasal packing, showed normal Sc but no Tc transport, (Tc = 0, Sc = Nl.). In two nasal packing patients and in one normal subject the Sc transport was more rapid than the Tc transport (Tc < Sc).

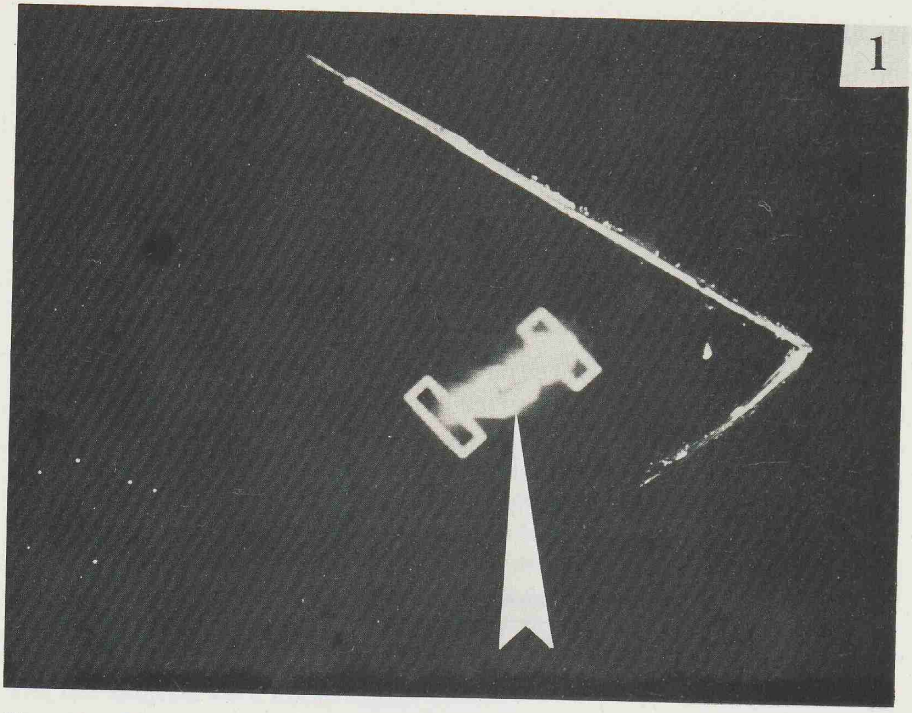

Figure 1. The configuration of the nose has been drawn on the figure. An arrow indicates the slowed progression of the particle on the side of the septum deviation.

Table 2. Group III - Tc and Sc tests combined.

A. Tc = Sc	25 subjects	14 normal
		11 post nasal packing
B. Tc = 0 Sc = N1	16 subjects	16 post nasal packing
C. Tc = Sc	3 subjects	1 normal
		2 post nasal packing

See text for explanation.

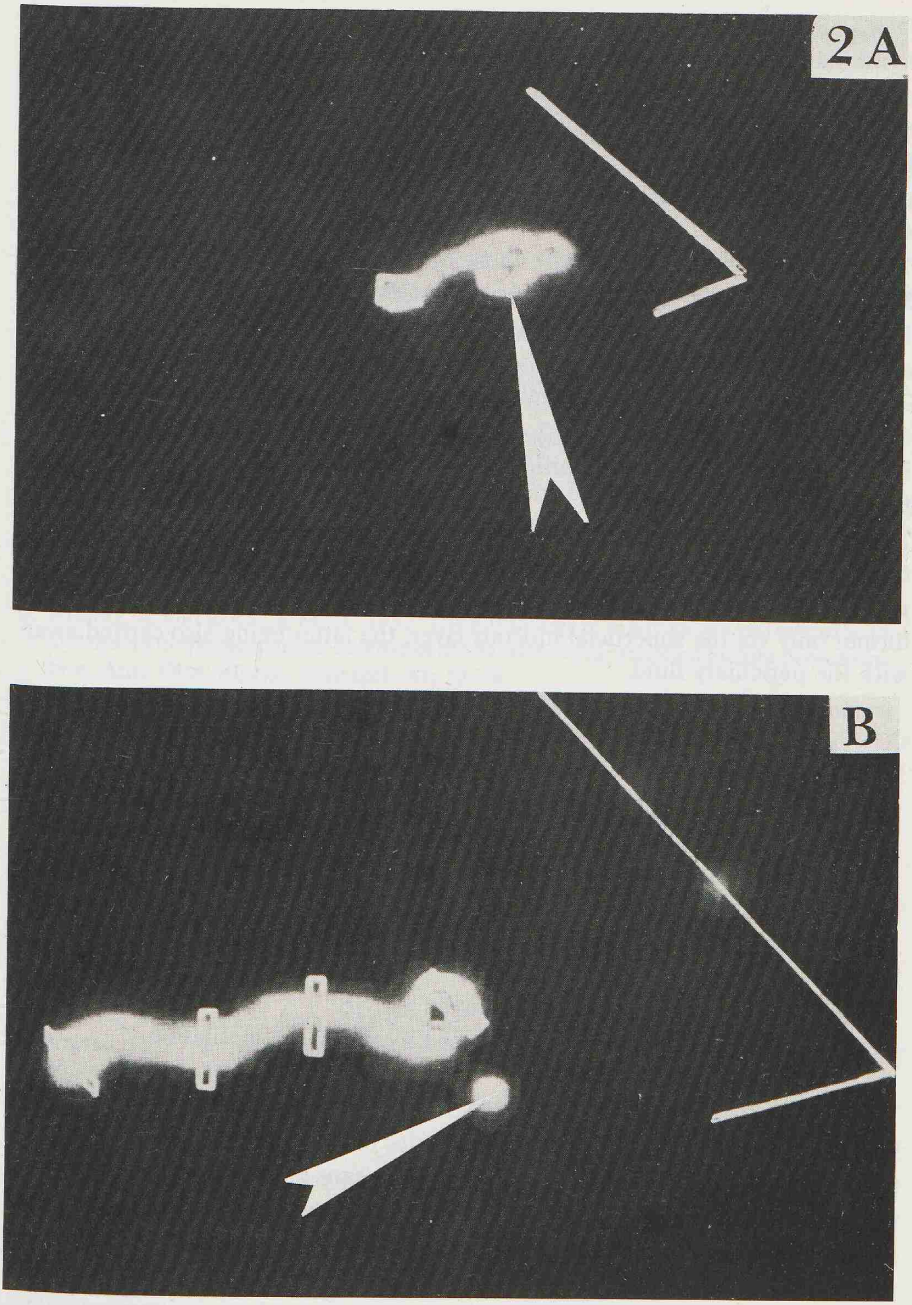

Figure 2.
a. Slowed down progression and
b. Absence of transport at the congestive side.

DISCUSSION

In normal subjects, the two methods applied on the non-congestive side showed a mean transport time of ± 10 min, corresponding to ± 5 mm/min. The two methods applied simultaneously in normal subjects, took a very similar course.
In atopic patients the m.c. activity was slowed down and in those with septum problems transport was slow bilaterally as demonstrated in the tests in group I and II.
The results are in agreement with those obtained by others (Bang et al., 1967; Puchelle et al., 1980; Van Ree et al., 1962; Ginzel et al., 1980).
In other circumstances, however, e.g. after nasal packing, the comparison showed a significant difference with normal subjects as regards Tc and Sc transport.
The non-parametric test showed no difference in the saccharine transport values of groups, A, B and C of Table 2 or in the distribution of group A.
Furthermore, there was no significant difference in time after nasal packing between groups A, B and C.
Under those circumstances, therefore, there appears to be a discrepancy between the Tc resin particle transport and the Sc particle transport. This could be explained by the different mechanism by which both particles are transported: the former only via the superficial mucous layer, the latter being also carried away with the periciliary fluid.

CONCLUSIONS

1. The Tc and Sc tests measure partly different mechanisms of m.c. activity. However there is a good correlation between the two methods under normal circumstances, nevertheless in deviating conditions they are complementary in the evaluation of the m.c. clearance.
2. Our results obtained in patients after nose surgery by using both methods showed that the Tc test is a more sensitive method.
3. These results also suggest that the tests should be done on the non-congestive side if not, bilaterally to asses the m.c. activity.
4. The m.c. clearance is highly influenced by the nasal ventilation.

RÉSUMÉ

Dans une première phase, les deux méthodes ont été evaluées séparément. Le test au saccharine a été effectué chez 40 patients sans problèmes nasales, chez 30 patients souffrant d'atopie et chez 30 patients présentant des problèmes de ventilation nasale. Ensuite, le test avec la particule Tc^{99m}, a été exécuté chez 39 patients dans des conditions standardisées (humidité relative et température).
Dans une seconde phase, les deux méthodes ont été appliqueés simultanément dans la même cavité nasale chez 44 patients, dont 15 n'avaient pas de problèmes nasales et dont 29 avaient subi une tamponnade nasale.

Les chercheurs ont constaté des différences significantes dans les résultats, obtenus en appliquant les deux méthodes.

L'étude effectuée montre que l'activité mucociliaire est considérablement influencée par la ventilation et que les deux tests, en cas de pathologie, sont utiles en tant que méthodes d'investigations complémentaires.

REFERENCES

1. Bang, R. G., Mukherjee, A. L. and Bang, F. B., 1967: Human nasal mucus flow rates. John Hopkins Med., J., 121, 10–17.
2. Crifo, S., 1980: Über das Sinusbronchiale Syndrom und das Immotile Cilia Syndrom. Folia Broncho-oesophagologica, 295–301.
3. Ewert, G., 1965: On the mucus flow rate in the human nose. Acta otolaryngol., Suppl. 200.
4. Ginzel, A. and Illum, P., 1980: Nasal mucociliary clearance in patients with septal deviation. Rhinol., 18, 177–181.
5. Guillerm, R., Morcellet, J. L., Riu, R. and Renon, P., 1971: Etude du drainage mucociliaire nasal chez l'homme par scintigraphies séquentielles d'une particule marquée au technetium 99m. Ann. Otolaryngol. Chir. Cervicofac. 88, 303–310.
6. Hilding, A. and Rochers, M. D., 1932: The physiology of drainage of nasal mucus: cilia and mucin in the mechanical defense of the nasal mucosa: a motion picture demonstration. Ann. Otol. Rhinol. Laryngol., 41, 52–58.
7. Kärjä, J., Nuutinen, J. and Karjalein, P., 1982: Radioisotopic method for measurement of nasal mucociliary activity. Arch. Otolaryngol., 108, 99–101.
8. Melon, J. and Daele, J., 1979: La mesure de l'activité ciliaire. Acta otorhinolaryngol. Belg., 33, 772–782.
9. Mercke, V., Häkanson, C. H. and Toremalm, N. G., 1974: A method for standardized studies of mucociliary activity. Acta otolaryngol. (Stockh.), 78, 118–123.
10. Ornston, D. G., 1946: Office study of cilia. Arch. Otolaryngol., 44, 19–23.
11. Proctor, D. F. and Wagner, H. N., 1965: Clearance of particles from the human nose. Arch. Environ. Health, 11, 336–371.
12. Proctor, D. F., 1969: Measurement of mucociliary activity in man. Ann. Otol. Rhinol. Laryngol., 78, 518–532.
13. Proctor, D. F., Andersen, I. and Lundqvist, G., 1973: Clearance of inhaled particles from the human nose. Arch. Intern. Med., 131, 132–139.
14. Proctor, D. F. and Andersen, I., 1976: Nasal mucociliary function in normal man. Rhinol., 14, 11–17.
15. Puchelle, E., Ang, F., Pham, Q. T. and Betrand, A., 1981: Comparison of three methods for measuring nasal mucociliary clearance in man. Acta otolaryngol. (Stockh.), 91, 297–303.
16. Quinlan, M. F., Salman, S. D., Swift, D. L., Wagner, H. N., Donald, W. J. R. and Proctor, D. F., 1969: Measurement of mucociliary function in man. Ann. Rev. Respir. Dis., 99, 13–23.
17. Ree, J. H. L. van and Dishoeck, H. A. E. van, 1962: Some investigations on nasal ciliary activity. Pract. otorhinolaryngol., 24, 383–390.
18. Toremalm, N. G., Häkanson, C. H., Mercke, V., Dahlerm, B. and Huberman, D., 1975: Mucociliary wave pattern. Acta otolaryngol. (Stockh.), 79, 436–441.
19. Tremble, G. E., 1968: Clinical observation on the movement of nasal cilia. An experimental study. Laryngoscope, 58, 206–224.

20. Tremble, G. E., 1962: Milestones in research of upper respiratory cilia. Arch. Otolaryngol., 76, 346–351.
21. Yates, A. L., 1924: Methods of estimating the activity of the ciliary epithelium within the sinuses. J. Laryngol. Otol., 39, 554–560.

L. Brondeel, M.D.
ENT-Department
Academic Hospital
Free University of Brussels
Laarbeeklaan 101
1090 Brussels, Belgium