

Mucociliary Clearance in Bronchiectasis

¹Jyoti Yadav, ²Rupender K Ranga, ³Anuj K Goel, ⁴KB Gupta

ABSTRACT

Bronchiectasis is a chronic lung disease, defined pathologically as irreversible dilatation of the bronchi. There is ineffective clearance of pulmonary secretions because of damage to the cilia. The nasal mucociliary clearance was studied using the saccharine method in 75 patients of bronchiectasis and the results were compared with those of 25 healthy controls. The nasal mucociliary clearance was significantly prolonged in patients with bronchiectasis.

Keywords: Bronchiectasis, Mucus, Nasal mucociliary clearance time.

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INTRODUCTION

Bronchiectasis, a chronic and invariably progressive lung disease, is characterized by permanent dilatation of the bronchi and fibrosis of the lung parenchyma leading to lung damage over years.¹⁻³ Clinically, most patients present with a long-standing history of either persistent or intermittent sputum production, which could be viscous, mucoid, or mucopurulent.^{1,3,4} Hemoptysis does occur and may range from minor to life-threatening. Other constitutional symptoms include fever, loss of appetite, and shortness of breath.^{3,4} Approximately 50% of patients have pleuritic chest pain due to either peripheral bronchiectasis or distal pneumonitis.⁴ Although many patients may not have an associated disease that initially leads to the development of bronchiectasis, there are many conditions that have been recognized to cause bronchiectasis, however, which may be very difficult

to identify.^{1,4,5} About half the cases are idiopathic.⁶ The common feature among all the conditions that lead to bronchiectasis is that they either alter the pulmonary defense mechanisms or have associated inflammation, which results in progressive lung damage.^{1,3} The individual becomes susceptible to lung infection due to damage to the mucociliary transport consequent to ciliary damage. The mucociliary system is regarded as the means of filtration and purification not only at the nasal but also at the tracheobronchial level. Since the nose is easily accessible as compared with the tracheobronchial tree, it was planned to study the nasal mucociliary clearance time in patients of bronchiectasis of various duration using Andersen's saccharine method, which is very economical and simple.

MATERIALS AND METHODS

This collaborative prospective single-blind study was carried out in the Departments of Physiology, Otolaryngology, and Tuberculosis and Chest Diseases, Pt BD Sharma PGIMS Rohtak, Haryana, India. The investigator who carried out the mucociliary clearance time was unaware of the fact that the person in whom the test was performed was a control or a patient of bronchiectasis and of what duration. The nasal mucus clearance time was studied in 75 patients of bronchiectasis of either sex of various duration in the age group 18 to 60 years. Age- and sex-matched 25 normal persons were also studied who acted as controls. The mucociliary clearance time was studied using the Andersen's saccharine method after obtaining the consent of the patients and controls. The fully diagnosed patients of bronchiectasis were referred from the Department of Tuberculosis and Chest Diseases after chest X-rays. The test was done during the quiescent phase of the disease when the patient was not on medication.

Approximately 1 mm particle of commercially available saccharine was used for the test. The particle of saccharine was placed on the floor of the nose at the level of the anterior end of the inferior turbinate, and the time from the placement of the particle to the perception of the sweet taste was noted. The test was repeated in the other nostril and the average time was taken as the mucociliary clearance time. This was done to exclude the effect of nasal cycle, if any, on the mucociliary clearance time. The subjects were instructed to avoid sniffing, forceful inhalation or exhalation, and nasal manipulation

¹Professor, ^{2,3}Ex-resident, ⁴Senior Professor and Dean

¹Department of Physiology, Pt. BD Sharma Medical University Rohtak, Haryana, India

^{2,3}Department of Otorhinolaryngology, Pt. BD Sharma Medical University, Rohtak, Haryana, India

⁴Department of Tuberculosis and Chest Diseases, Pt. BD Sharma Medical University, Rohtak, Haryana, India

Corresponding Author: Rupender K Ranga, Ex-resident Department of Otorhinolaryngology, Pt. BD Sharma Medical University, Rohtak, Haryana, India, Phone: +9166425402 e-mail: rupenderent@yahoo.co.in

during the test. They were told to report any change of taste; however, they were not told that they were likely to perceive a sweet taste. The results were statistically analyzed using the Student's t-test. The exclusion criteria included otolaryngological diseases known to affect the nasal mucus clearance like deviated septum, sinusitis, allergic rhinitis, nasal polyps, and malignancy. Similarly, chest diseases that are likely to change the mucociliary clearance like asthma, bronchitis, pneumonitis, and tuberculosis were excluded. Care was also taken to exclude cystic fibrosis and primary ciliary dyskinesia. Patients on drugs affecting mucociliary clearance, like Bromhexine, and systemic diseases like diabetes were also excluded from the study. If the patient was a smoker, the test was carried out 3 weeks after cessation of smoking. The patients were thoroughly counseled about the ill effects of smoking. Those who did not quit smoking were excluded from the study. If the patient did not perceive any change in taste up to 30 minutes, then he or she was excluded from the study to maintain the sensitivity of statistical analysis. Five such subjects had to be excluded from the study. The study was approved by the ethical committee.

RESULTS

The mean value of nasal mucociliary clearance time observed in 25 controls (13 males and 12 females) was 7.84±0.92 minutes (6.71–12.13). The study group comprised 45 males and 30 females in the age group 18 to 60 years. The mean nasal mucociliary clearance observed was 25.72±3.31 in bronchiectasis. The mean nasal mucociliary clearance time observed in patients having bronchiectasis up to 5, 6 to 10 years, and more than 10 years of duration was 23.12±2.74, 24.88±3.43, and 26.34±1.89 minutes respectively. When compared with controls, the difference was statistically significant (p<0.001, for each, Table 1). There was increase in the

mucociliary clearance time with increase in the duration of bronchiectasis; however, when the three groups of bronchiectasis were compared with each other, there was no significant difference (p>0.5) (Table 1).

Since pulmonary function tests did not form a part of the study and were not carried out in all the cases, a correlation of pulmonary function test with nasal mucociliary clearance could not be done. However, it may have shown an interesting correlation. It should form a part of further studies.

DISCUSSION

Patients with bronchiectasis have impaired mucociliary clearance and excess sputum production.¹⁻³ Defective mucociliary clearance can be due to abnormalities in the ciliary or mucus components or a combination of both.⁷ Mucus of high elasticity and low viscosity is ideal for mucociliary clearance. Various investigators have reported abnormalities of nasal cilia in patients with bronchiectasis under electron microscope.⁸⁻¹⁰ Neutrophil elastase is a serine proteinase that has been implicated in the pathogenesis of bronchiectasis, emphysema, and adult respiratory distress syndrome. It leads to mucous gland hyperplasia, increased airway secretion, damage of the ciliated epithelium, and acceleration of airway inflammation.¹¹⁻¹⁴ Thus, the impaired mucociliary clearance can be explained on the basis of altered rheologic properties of secretions and defective cilia in patients with bronchiectasis. Methods to evaluate the nasal mucociliary clearance include direct observation of dyes or particles deposited on nasal mucosa,¹⁵ use of radioactive microdroplets,¹⁶ single radioactively tagged resin particles,¹⁷ and radiopaque Teflon discs monitored by external device.¹¹ Andersen et al described a very simple method consisting of depositing a particle of saccharine on the nasal mucosa and observing the time when the subjects reported the first taste of sweetness.¹⁷ This method is very simple, reproducible, quick, noninvasive, and costs next to nothing; hence it was used in the study. Klingbeil et al¹⁸ studied the results of saccharine test in the pediatric bronchopulmonary outpatient department and found that in 381 children aged 3 to 17 years, the average nasal mucociliary clearance time was 6.6±4.8) minutes in healthy controls. The nasal mucociliary clearance in controls of this study was 7.84±0.92) minutes, which was significantly longer in patients with bronchiectasis. Similar result was reported by Currie et al,¹⁹ who measured tracheobronchial clearance by a radiosol technique in 12 patients with bronchiectasis and found that clearance in the first 6 hours after inhalation of radioaerosol was significantly slower in patients with bronchiectasis.

Table 1: Mucociliary clearance time in controls and patients with bronchiectasis

Sl. no.	Groups	n	M/F	NMC in minutes (mean±SEM)	Range
1	Control	25	13/12	7.84±0.92	6.71–12.13
2	Bronchiectasis	75	45/30	25.72±3.31	18.22–28.36
3	Bronchiectasis up to 5 years' duration	25	15/10	23.12±2.74	18.22–25.40
4	Bronchiectasis up to 6–10 years' duration	25	16/9	24.88±3.43	19.98–26.40
5	Bronchiectasis for more than 10 years' duration	25	14/11	26.34±1.89	26.34–28.36

n: Number of subjects; NMC: Nasal mucociliary clearance; M/F: Male/female; SEM: Standard error of the mean



Svartengren et al²⁰ studied mucociliary clearance in bronchiectasis patients and the clearance time varied from normal to extremely slow. Nasal cavity is part of the respiratory tract and its respiratory epithelium is continuous and similar to a tracheobronchial tree, so its nasal mucociliary clearance time indirectly gives the respiratory clearance time especially of the trachea, in which it can be studied only by using radioactive aerosol and followed up with gamma camera, which becomes very time consuming and not cost effective at all. Since Andersen's method is simple and economical, so it was used in the study. In this study, although nasal mucociliary clearance was found to be increased with the duration of the disease, among the three groups of bronchiectasis, this difference was insignificant, suggesting that the ciliary damage that occurred at the initial stage is responsible for the increased mucociliary clearance time and the damage does not increase significantly with the passage of time as is evident from any significant increase in mucociliary clearance with an increase in the duration of the disease. In the present study, all patients were secondary to infection and inflammation.

The mucociliary system forms a highly efficient defense system that protects the lungs against environmental pollutants and various living organisms like bacteria, fungi, virus, and mycoplasma present in the inhaled air. The anatomical structure and physiological properties of the nose are remarkable in maintaining a fairly constant environment for the mucociliary system to function at its best; although nasal mucociliary clearance is fairly constant, it may vary with place, habit, habitat, climate, race, and temperature. So it is advisable that individual laboratories establish their own normal value of nasal mucociliary clearance in normal patients, which was found to be 7.84 ± 0.92 minutes. In our earlier study, it was 7.90 ± 0.32 minutes.²¹

Two relatively common otolaryngological diseases are chronic nonspecific laryngitis and sinusitis. The former may be a consequence of bronchiectasis and the latter may be associated with bronchiectasis, where the mucociliary mechanism is involved, e.g., Kartagener syndrome and immotile cilia syndrome, so an appreciation of this pathophysiological linkage will help the otolaryngologist to better understand respiratory tract comorbidity, which may help in improving the diagnosis and management of the lower respiratory tract disease. This linkage has already been accepted in the case of allergic rhinitis and bronchial asthma.

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