NASAL MUCOCILIARY CLEARANCE IN HEALTH AND DISEASE

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Abstract: "Standard saccharine test is used to detect nasal mucociliary clearance time in healthy individuals both adults and children. The length of the nose was measured radiologically and with the help of a soft malleable rubber catheter. For healthy individuals, mean nasal mucociliary clearance time is 8.2 minutes in children and 9.5 minutes in adults. The mean nasal mucociliary clearance rates were 11.1 mm/min for children and 12.7 mm/min for adults.

Deviated nasal septum, chronic sinusitis, allergic rhinitis, atrophic rhinitis, chronic smokers and patients with recent nasal packings were taken as diseased conditions in adults, whereas children with adenoid hyperplasia were taken for the study. In all of these, nasal mucociliary clearance was significantly prolonged."

Keywords: Mucociliary clearance, adenoid hyperplasia, saccharine test

INTRODUCTION :

Since Messerklinger introduced the concept of functional sinus surgery based on physiological mucociliary clearance of nose and paranasal sinuses, people started studying the mucociliary function itself from various angles.

The mucociliary system can be divided into two fundamental units - The mucus and the cilia. Both are studied extensively for chemical composition and ultrastructure respectively. The clinicians are interested more in combined effect of both -the mucociliary clearance.

AIMS :

1. To find out values of nasal mucociliary clearance rates in our population for healthy adults and children
2. To study the effect of different nasal mucosal pathologies e.g. chronic rhinosinusitis, allergic rhinitis and atrophic rhinitis on nasal mucociliary clearance.
3. To determine the effect of mechanical obstructions on the mucociliary clearance of the nose in children (adenoid hyperplasia) and in adults (deviated nasal septum)
4. To see early effect of nasal packing on the mucociliary clearance
5. To study nasal mucociliary clearance in chronic smokers

MATERIALS AND METHOD :

The study was done initially in normal subjects - volunteers from medical students and patients with other problems having absolutely normal nose and paranasal sinuses as control group. Later, patients with various sino-nasal pathologies described above were studied for mucociliary clearance excluding those, with multiple problems known to affect the mucociliary clearance.

In this study classical saccharine test was performed in sitting position. Approximately 0.5mm particles of saccharin were placed

1cm behind the anterior end of the inferior turbinate and the time recorded. Subjects were instructed to breathe through the nose normally and were told not to sniff, sneeze, eat or drink. They were instructed to notify the first definite taste sensation. When a sweet sensation was perceived the nasal mucociliary transport time was recorded in minutes (Table I)

After measuring mucociliary clearance time, measurement of the length of the nose from anterior nares to posterior pharyngeal wall just lateral to uvula was done with help of a thin soft rubber catheter. X-ray soft tissue nose-nasopharynx lateral view was done in all subjects to correlate between direct and radiological measurement of the length of nose. With the help of nasal mucociliary transport time and the approximate length of the nose the mucociliary clearance rates in mm / minute were calculated. (Table I)

DATA ANALYSIS AND DISCUSSION

First we have to decide what is normal, if we review literature (Table II), different values of the nasal mucociliary transport time are considered normal for different population and different ages. When it comes to the normal nasal mucociliary clearance rate, it is more or less equal in all studies indicating nasal mucociliary clearance rate is superior to the nasal mucociliary transport time for record and reference purposes. The reason being, differences due to different lengths of the noses of different population are automatically eliminated. The normal nasal mucociliary transport time is 5.6 to 10.8 minutes for children of 5-12 years. The mucociliary clearance rate for them is 7.1 to 14.1mm / minute. The nasal mucociliary transport time for adults of 18 to 60 years is 5.6 to 13.4 minutes and the rate is 7.5 to 17.9 mm / minute. Sakakura, Maurizi, Birch and Elbrand all found longer saccharin transport time in children than adults and concluded that immaturity of mucociliary function in young subjects. Passali and Juhani Karja et al found no significant difference in the nasal mucociliary function of adults from children. In present study unpaired 't' test suggest no real difference in mucociliary function of young subjects when compared with adults. The reason for significantly

reduced mucociliary clearance transport time observed in many studies may be asymptomatic adenoid hyperplasia in their normal children group. In present study X-ray soft tissue nose nasopharynx was done routinely to measure the length of the nose. Many normal children were found to have large obstructing adenoids in their nasopharynx, they were excluded from the study.

Regarding diseased conditions of nose and paranasal sinuses, in the present study we used unpaired 't' test here, nasal mucociliary clearance rates of an individual condition are compared with the same for the control group of identical age. The 'p' value less than or equal to 0.001 suggests truly significant difference. We found significantly decreased nasal mucociliary clearance in all pathological conditions.

For chronic sinusitis our results are synchronous with results of Sakakura and Toremalm. Sakakura suggested bacterial reinfection and self mediated inflammation causing functional and structural impairment responsible for mucociliary dysfunction.

For allergic rhinitis, Chevance observed local destruction of the nasal cilia when challenged by intranasal deposition of the specific allergen. Our study clinically supports his experimental study. For atrophic rhinitis we found significantly prolonged mucociliary clearance the most probable reason for this is the replacement of ciliated epithelium by squamous epithelium and thick dry secretions.

It is important to note that frequently patients with mechanical obstructions in the nose have mucociliary clearance in normal ranges. It means mucus readily passes over minor deflections but when the obstruction is severe enough to impinge one mucosal surface on the other, the mucociliary clearance is hampered.

We had seen many patients, miserable because of their noses even after removal of nasal packings. We measure, mucociliary clearance in such patients within 24 to 72 hours of pack removal and found prolonged mucociliary clearance in majority of them. The reason for this will be traumatized nasal mucosa and stagnated sinus secretions. It taught us to think twice before packing the nose for any condition and to do frequent suction cleaning of the nose after removal of the packings.

As we know, cigarette smoking is hazardous to health, in many ways, one more being impairment in the mucociliary function of the respiratory tract as found in the nose in this study. Many authors have demonstrated the same thing responsible for repeated upper and lower respiratory tract infection generalized morbidity and carcinogenesis. The mechanism of action of tobacco smoke is mainly due to vasoconstriction and enzyme effect.

CONCLUSION :

Mean normal nasal mucociliary transport time in our population is 8.2 minutes for children and 9.5 minutes for adults, the mucociliary clearance rate is 11.1mm/minute for normal children and 12.7 mm/minute for normal adults.

We found that the mucociliary clearance is hampered in almost all pathological conditions affecting the nose so the detection of decreased nasal mucociliary function is not diagnostic for any particular pathological conditions, but it suggests the severity of the pathological condition. This might be beneficial in forecasting treatment response. The standard saccharin test is simple, inexpensive and highly consistent for measuring the nasal mucociliary clearance.

Table I: Nasal Mucociliary Transport Time (Min) and Nasal Mucociliary Clearance Rate (mm/Min) for various conditions

Conditions of the nose & age group. n= 20 in each group	Mean time required for mucociliary transport (MCT) in minutes	Standard deviation	Statistical range of MCT mean +/- SD	Mean Mucociliary clearance rate in mm/Min	Standard deviation	Statistical range mucociliary clearance rate mean +/- SD
Normal Children 5-12 yrs.	8.2	2.6	5.6 to 10.8	11.1	3.5	7.6 to 14.6
Adenoid Hyperplasia 5-12 yrs.	13.9	6.1	7.8 to 20.0	7.1	4.3	2.8 to 11.4
Normal adults 18-60 yrs.	9.5	3.9	5.6 to 13.4	12.7	5.2	7.5 to 17.9
Deviated Nasal Septum 18-60 yrs.	30.2	14.1	1.6 to 44.3	4.3	2.3	2.3 to 6.6
Chronic sinusitis 18-60 yrs.	27.2	11.7	15.5 to 38.9	4.9	3.3	1.6 to 8.2
Allergic rhinitis 18-60 yrs.	32.8	15.2	17.6 to 48.0	3.8	1.4	2.4 to 5.2
Atrophic rhinitis 18-60 yrs.	32.5	14.5	18.0 to 47.0	4.5	4.7	-0.2 to 9.2
Chronic smokers 18-60 yrs.	30.4	11.1	19.3 to 41.5	4.1	1.4	2.7 to 5.5
Nasal packing 18-60 yrs. 24 to 72 hrs after pack removal	31	11.8	19.2 to 41.8	4.2	2	2.2 to 6.2

Table II: Nasal Mucociliary Transport Time (Min) and Nasal Mucociliary Clearance Rate (mm/Min) for various conditions

Name of the study	Normal nasal mucociliary transport time in minutes (age group specified)		Normal nasal mucociliary clearance rate in mm/ min age group specified
Andersen et al	12 to 15	adults	
Birch & Elbrnd	15	4 to 18 yrs.	
	10	> 18 yrs.	
Mackay et al	12.2 to 14.8	adults	
Passali et al	7.7 to 12.3	3 to 12 yrs	
	9.6 to 15.4	19 to 74 yrs	
Shashi Chetan	8 to 19	adults	
Yasuo Sakakura et al	-1.6 to 28.8	5 to 7 yrs	
	1.1 to 29.3	10 to 11 yrs	
	4.8 to 22.6	15 to 59 yrs	
Juhani Karja et al			6.0 to 9.6 (children)
			5.8 to 13.5 (adults)
Proctor and Wagner			6.0 (adults)
Quinlan			5.0 to 7.5 (adults)
Present Study	5.6 to 10.8	5 to 12 yrs	7.1 to 14.1 (5 to 12 yrs)
	5.6 to 13.4	18 to 60 yrs	7.5 to 17.9 (18 to 60 yrs)

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