Mucociliary Clearance Time in Patients with and without Rhinitis.

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ABSTRACT

Background: Rhinitis may be allergic or non allergic. Allergic rhinitis, intermittent or persistent is the most common type of rhinitis, affecting approximately 20% of the population while nonallergic rhinitis affects 5-10%. While rhinitis is not a life-threatening condition, complications may occur and the condition can significantly impair quality of life. In order to measure the mucociliary clearance time in patients with and without rhinitis a study was conducted in the ENT, H&N, and orthopedic departments at KNH.

Methods: 130 cases between the age of 18 and 40 years and matched controls were inducted. The Anderson saccharine test was conducted.

Results: The average mucociliary clearance time was significantly different, 12.64 and 7.80minutes in cases and controls respectively (p = <0.01). Nasal crusting as well as the rheology of mucus were significant factors in determining mucociliary clearance time (p>0.01).

Conclusion: The normative values of MCT remain debatable with overlap between the cases and controls.

Key words: rhinitis, mucociliary clearance time, saccharine test

Introduction

Rhinitis is defined as inflammation of the mucous membranes lining the nasal passages. It is characterized by a symptom complex that consists of any combination of the following: sneezing, nasal obstruction, nasal itching, postnasal dripping, rhinorrhea and occasionally nasal pains[1,2,3]. Rhinitis could be allergic or non allergic. Non-allergic rhinitis is subclassified into Infectious rhinitis, Recumbency rhinitis, Occupational rhinitis, Hormonal rhinitis, Drug-induced rhinitis, gustatory rhinitis, nonallergic rhinitis with eosinophilia syndrome (NARES), non airflow rhinitis and Idiopathic rhinitis. The exact prevalence of nonallergic rhinitis is not known but estimates indicate that up to 50 percent of patients with rhinitis actually have non-allergic causes[2]. Measurement of cilia beat frequency started in 1844 with Martius who used a stroboscope to estimate frequency beat. This is unreliable at frequencies about 6-20Hz [4]. Later, in 1974 the saccharine test was described [5].

The defensive function of the nose rests upon the efficiency of the mucociliary mechanism to move mucus from the nose to the pharynx to be swallowed. The vibrissae arrest large particles[5,6,7,8]. The mucociliary system of the airway forms a highly efficient defense mechanism that protects the lungs against inhaled particles including living organisms like bacteria, viruses, fungi and mycoplasma as well as chemical irritants. The vital part of this system is an adequate quantity of mucus with appropriate rheological quality and adequately functioning cilia, which allow the continuous exchange of the covering fluid layer and removal of engulfed particles. Any disturbance in this system leads to stagnation of secretions and secondary infection[5, 9, 10].

Ciliary activity is affected by drying, temperature, saline solutions, changes in Ph, drugs, viruses and bacteria, allergic rhinitis, chronic rhinosinusitis, nasal polyposis and aging [5,6,7,8,11,12,13,14,15,16,17,18,19]. The nasal cycle is a well-recognized physiological phenomenon exists in order to replenish the water content of nasal mucus, allowing continued humidification of inspired air [20]. Some workers have noted asymmetry in mucociliary

clearance at the morning peak of the nasal cycle [21] although others have found no significant difference at different times of the day or in different phases of the cycle [22].

Methods used to test nasomucociliary flow

Several techniques have been utilized to measure mucociliary clearance; Andersen's saccharin test, visible dyes or particles, small metal discs (imaged by fluoroscopy) and radiolabled particles (detected by gamma scintigraphy)[5,18]. Of these, the Andersen's test has become the most useful screening test in clinical practice and compares well with the imaging studies. The advantages being that it is easy to learn, it is cheap, readily available, lacks toxicity, and has no radioactivity, has a high level of tolerance, results are reproducible and can be performed in a clinical setting[23, 24]. However, the test can be difficult to perform in children and cannot be repeated in a short time since the sweetness takes some time to disappear[25]. A study curried out on college students in the catchment area of KNH showed that 13% suffered from allergic rhinitis[5]. But what are the values for mucociliary clearance in patients with rhinitis in our population and what is the effect of rhinitis on mucociliary clearance?

Subjects and Methods

After approval by the ethical committee, data was collected over a period of 4 months. A total of 260 subjects aged 18-40 years were seen during the study period, giving an informed consent and meeting the inclusion criteria were recruited consecutively. History was taken then anterior rhinoscopy performed on the subjects to rule out any abnormalities; morphological or pathological. Normal subjects were patients seen in the orthopedic clinics and wards who were under follow up for traumatic conditions. Patients with conditions treated with steroids or oncological conditions were excluded. Eligible patients were entered in the control group while patients under follow up for rhinitis were entered in the cases. These were matched for sex and age.

To perform the Anderson saccharine test, a saccharin particle (1.5-mm diameter) was carefully placed on the floor of nasal cavity about 1 cm behind the anterior end of the inferior turbinate. The subject was asked not to sniff, sneeze, smoke, eat or drink during the test and to avoid deep breathing [5]. The subject was also asked to swallow every 30 seconds and to report the first change in their sensation of taste. The time taken by the subjects to perceive sweet taste in the pharynx was taken as MCT in that nose. The test was repeated on each side and the average of two was taken as the NMCT. This was done to exclude the effect of nasal cycle on mucociliary clearance [8, 23].

Reference values were 7-15 minutes in normal subjects [5, 16, 27, 28, 29]. Data collected was analyzed by SPSS statistical package. Descriptive statistics such as means, median, frequency and standard deviation were calculated, including comparisons for sex and age. Tests of statistical significance were carried out using the Chi square test and Mann- Whitney test where applicable. The patient evaluation sheet was pre-tested before commencement of the study and necessary modifications made before final data entry was initiated in order to minimize errors. No incidents of patients sneezing or sniffing in the course of the test were encountered as this was overcome during the pre-testing.

Results

Nearly a third (31.5%) of the subjects was in the 26 – 30 years age group. This had the highest frequency. The median age was 27 years. This applies to the controls since they were

matched for sex and age. Females accounted for 65% of the case and matched controls. Both factors did not affect MCT (P<0.01) Majority of the cases presented with sneezing, 96.2%. Other symptoms included runny nose, nasal blockage, post nasal drip, headache and facial pains. On examination 67.7% had hypertrophy of the left inferior turbinate, 60% had hypertrophy of the right inferior turbinate, while 51.6% had rhinorrhoea. Of those with rhinorrhoea, 11.5% reported having thick mucus, 39.2% had watery mucus while 47.7% had no mucus at the time of presentation. It is worth noting that this observation is subjective and patient dependent. The average MCT in cases was 9.67 minutes with a range of 1.34 to 54.07minutes, while the average MCT in the controls was 7.51 minutes with a range of 2.11 to 15.64 minutes. Differences in the MCT in both nostrils could be due to the nasal cycle. Of the 130 cases 55 (42.3%) had normal MCT, 39 (30%) had prolonged MCT while 36(27.7%) had decreased MCT.

Table 1. Average MCT in Minutes in Cases and Controls

MCTin minutes	**Cases (n=130)**		**Controls (n=130)**	
	Frequency	**%**	**Frequency**	**%**
Decreased (< 7)	36	27.7	56	43.1
Normal (7-15)	55	42.3	73	56.2
Prolonged (>15)	19	30.0	1	0.8
Total	130	100	130	100

Conversely, 73 (56.2%) of the controls had normal MCT; it was accelerated in 56 (43.1%) and prolonged in 1 (0.8%) as summarized in the table above. There was no significant difference in the symptom presentation in relation to the MCT in the cases (p =<0.01). The consistency of mucus was a significant factor that affected the MCT. None of the cases with thick mucus had a decreased MCT. (p<0.01) Presence of nasal crusts affected MCT as resulting in delayed MCT. 6 of the 9 cases that had nasal crusting had delayed MCT. (p>0.01)

Discussion

There is no consensus on the limits for normal MCT. Some studies quote <20 minutes as being the normal cut off [28] while others propose 7-15 minutes[5, 16, 27, 28, 29]. In our study, the later was considered the normal range. In their study, Prior et al obtained a mean of 12 minutes in their cases while the controls had a mean of 8 minutes[28]. The current study agrees with previous workers, obtaining a mean of 12.6 and 7.8 minutes for the cases and controls respectively.

Ultrastructure of cilia has been shown to change beyond the age of 40 years but remains normal below this age. The changes observed were not related to sex[19]. In our study, only cases under 40 years were included and neither was age or sex found to affect the MCT. Our study demonstrated a difference in the MCT readings between the nostrils, a phenomenon of the nasal cycle, first described in 1885. It has been shown that 70-80% of adults manifest this cycle [21]. Anderson demonstrated areas of the turbinate where clearance could be slow hence the inter-individual differences in the MCT [5]. This could justify our findings. There were cases where there was complete obstruction of the nasal cavity by a hypertrophied inferior turbinate which impeded proper placement of the saccharine granule as described by Anderson. This could have possibly affected the MCT. In unison with other studies such as

that by Lale et al[5] and Stanley et al[16], our study did not show any detrimental effect after use of topical steroids or antihistamines.

Patients included in our study had intervals when they were not using the antihistamines or nasal steroids. These intervals were not standardized neither were the types of drugs used considered. Patients who had used topical vasoconstrictors for duration longer than 2 weeks were excluded from the study to avoid the confounding condition of rhinitis medicamentosa over the MCT. Nonetheless, studies have showed that ephedrine sulphate (0.5% solution) does not affect ciliary action[12, 13, 14].

Prolonged MCT in patients with rhinosinusitis and atrophic rhinitis is attributed to the changes in the rheology of mucus including oedema. Changes in the ultrastructure of cilia have also been reported [5, 17]. It has been documented that bacteria release toxins that disrupt epithelial cells resulting in loss of a confluent ciliary field. Also of interest is that neutrophils gather at the site of purulent infection to produce an elastase that is directly toxic to respiratory epithelium thus delaying the MCT [15]. In our study, cases with thick mucus had significantly prolonged MCT some extending even beyond 60 minutes. Immunodeficiency has been shown extensively to be associated with deranged mucociliary transport. Patients with immunodeficiency have slower nasal mucociliary transport and more extensive mucosal damage and rhinitis is a common presentation in this group[30]. Patients with overt immunosuppression were excluded in our study but no attempts were made to establish the serostatus of the cases or the controls. It is therefore possible that some of the included subjects could have had a degree of immunosuppression.

Conclusion

Our study included subjects in the age range of 18 to 40 years. MCT was not affected by age neither was sex showed to affect it. Presence or absence of sneezing, headache, hypertrophy of the turbinates, nasal obstruction or postnasal drip does not affect MCT. The rheology of mucus significantly affects the MCT. Patients with thick mucus have delayed MCT as compared to those with watery mucus. Patients with nasal crusting have extremely delayed MCT possibly suggestive of atrophic rhinitis. The normative values of MCT remain debatable with overlap between the cases and controls.

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