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# Changes occurring in the nasal mucociliary transport in patients with one-sided septum deviation*

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SUMMARY

*Septum deviation is the most commonly seen nasal pathology. Mucociliar activity can be affected by septum deviation that can be detected in many nasal pathologies. This study was aimed to compare the changes occurring in the mucociliary activities in both the nasal cavities of 20 patients with one-sided septal deviation and 20 healthy young individuals without septal deviation. The mucociliary activity of the right nasal cavity in healthy human beings and the mucociliary activity of the concave and convex sides of nasal cavities in patients with septal deviation were measured. Mucociliary clearance was measured by means of the rhinoscintigraphy technique. The mucociliary transport speed on the concave side was found to be significantly increased compared to the convex side and the control group. As a result, the mucociliary activity was within normal limits in patients with septum deviation who didn't have a nasal mucosal disease. Furthermore, the mucociliary activity was found to be increased on the concave side where the air flow was higher.*

*Key words: mucociliary transport, rhinoscintigraphy, septal deviation*

## INTRODUCTION

The first defensive barrier against biological and physical insults in the nasal fossae is the nasal mucociliary system [1]. The nasal mucosa is also responsible for humidifying, warming and filtering the air. Many of the diseases of the upper respiratory tract affect the nasal mucosa, which in return worsens the prognosis, or the primary impairment of the nasal mucosa itself leads to certain diseases. It is to the advantage of the clinician if she/he is aware of the changes that occur in this system.

There are two different arguments over the role of septal deviations in the ethiology of sinusitis. One of the arguments is that deviation narrows the osteomeatal complex, and the other is that it gives rise to some changes in the mucociliary activity [2-5]. While some studies in the literature report delayed mucociliary transport, some other radiological and endoscopic studies show that septal deviations narrow the osteomeatal structure [4-7].

The location, the shape and the severity of a deviated septum, all have effect on the flow and resistance of air passing through the nasal cavities [5]. This study was aimed to compare the changes occurring in the mucociliary activities in both the nasal cavities of 20 patients with one-sided septal deviation and 20 young individuals without septal deviation.

## PATIENTS AND METHODS

### *Patients*

This study was carried out in the II. ENT Clinic, Sisli Etfal Teaching and Research Hospital, between April 2002 and 2003. It included 20 patients with septal deviation and 20 healthy young individuals without septal deviation. Rhinoscintigraphic measurements were taken by the staff of the Nuclear Medicine Department at the Turkish Heart Foundation. The patients with septal deviations had an average age of $26.42 \pm 5.35$, ranging from 17 to 42. The healthy people had an average age of $21.24 \pm 8.75$ ranging from 15 to 37. These two groups were relatively homogenous in terms of age and sex composition and did not correlate significantly ($p<0.05$). The groups consisted of 24 males (60%) and 16 females (40%).

### *Clinical evaluation*

The patients were examined endoscopically and by means of rhinomanometry. Patients with a C-shaped and one-sided deviations extending from the front to the back were included in the study group. Those with a spurred, S-shaped one-sided minor deviation, and two-sided deviations were excluded from the study. The detailed patient history was taken; anterior rhinoscopy, nasal endoscopy and rhinomanometry were undertaken in the control group. No mucosal or anatomical sinonasal disease was detected.

The other criterions for exclusion were as follows: local pathologies like allergic rhinitis (detected by skin tests), sinusitis and polyps; smoking; being on drugs; such environmental factors such as being exposed to irritants due to one's profession; a systemic disease that may affect the nose.

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*Rhinomanometric and rhinoscintigraphic evaluation*

Active anterior rhinomanometric measurements were taken by means of a device with the brand name of Erich Janeger Rhinoscreen. Cases with a level higher than 0.3 Pa/ml/sec were considered normal and those lower than 0.3 Pa/ml/sec were included in the group with septal deviation [8].

Rhinoscintigraphic examination was carried out as follows: the cases were asked to lie in the supine position and once a week 40 ÌCi (1.48 MBq) Technetium 99m-macroaggragated albumin (Tc99m-MAA) in a 0.03 ml isotonic solution was dripped with a micropipette onto the front of the inferior concha in both nasal cavities. Each drop consisted of 200-2500 particles of Tc99m-MAA. Immediately following the application, a Siemens Orbiter gamma camera started to take measurements. Sixty images were taken at an interval of 30 sec for half an hour. The area where measurements and images were taken was between the points where the liquid was dripped and where it reached the nasopharynx. The time-activity curve was, thus, obtained within the limits of this area. The last step was the measurement of mucociliary velocity (NMCV) by using an ICON computer. Detailed information on rhinoscintigraphical techniques was given to the patients and to the control group. Unabsorbed, low-grade radioactive material was applied to the patients who were previously informed about it. Approval was granted by the ethical committee.

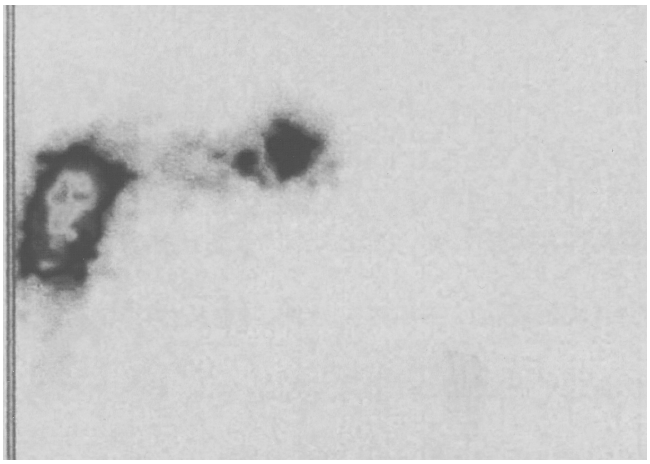

Figure 1. The rhinoscintigraphic examination of the mucociliary transport pattern in the control group.

*Outcome evaluation*

According to the results of the endoscopic examination and active anterior rhinomanometry, two groups of cases were formed: Group 1 consisted of healthy individuals (control group) and Group 2 consisted of those with septal deviations (study group). The latter was divided into two new groups of concave (Group 2a) and convex (Group 2b) according to the situation of the nasal cavity. Rhinoscintigraphic examination was performed on the right nasal cavities of the control group and on both cavities of the cases with septal deviation. The measurements of each group were compared with those of the others in order to find out if there existed any statistically significant differences.

*Statistical analysis*

All the data obtained from this study were analysed by means of the SPSS (Statistical Package for Social Sciences) for Windows 10.0 program. Along with definitive statistical methods (average, standard deviation), Student's t-test was used in analysing quantitative parameters with a normal distribution. Qualitative data were subjected to the chi-square test. The results of the analyses were considered to have an error probability of 5% and a correlation of $p<0.05$ was considered to be statistically significant.

## RESULTS

The average values for mucociliary transport time were 10.62 mm/min in the control group (Group 1) (Figure 1), 14.49 mm/min in the concave group (Group 2a) (Figure 2), and 8.63 mm/min in the convex group (Group 2b) (Figure 3). Mucociliary transport took a longer time in Group 2a than in the other two groups, and the difference was statistically significant ($p<0.05$) (Table 1-2). The correlation between the convex group

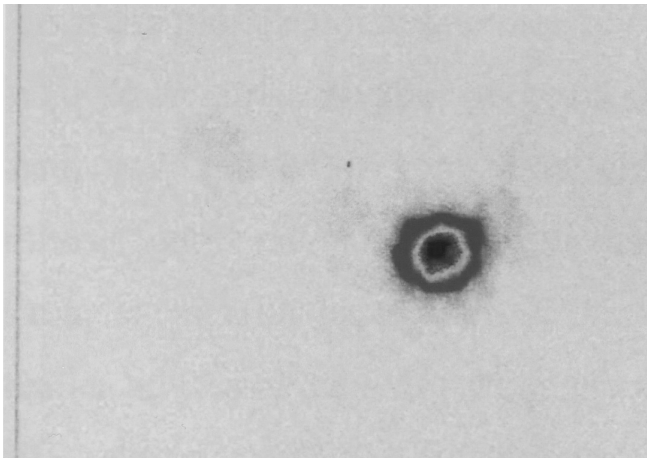

Figure 2. The rhinoscintigraphic examination of the mucociliary transport pattern in the concave group.

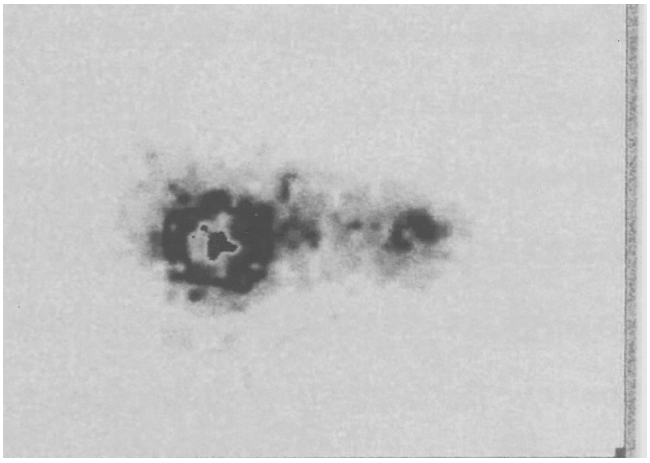

Figure 3. The rhinoscintigraphic examination of the mucociliary transport pattern in the convex group.

and the control group was not of any statistical significance (Table 3).

## DISCUSSION

Septal deviations play an important role in the ethiology of diseases of the paranasal sinuses. While some authors argue that septal deviations have a narrowing effect on the osteomeatal complex, others hold them responsible for delayed mucociliary transport [2-4,6,7]. Although our study did not deal with the ethiology of sinusitis, we found that septal deviations did not lead to a decrease in the velocity of the mucociliary transport. The function of an intact mucosa is not adversely affected by a septal deviation, which shows its protective nature in the case of conditions predisposing to various diseases.

So far many different methods have been employed for measuring mucociliary clearance. In these methods, ciliary movements are either directly observed, or the velocity of the mucociliary transport is indirectly measured. Roentgenography, stroboscope and photo electronic allow the nasal mucosa to be directly observed, but they are not suitable for routine studies [9]. Indirect methods, on the other hand, serve to determine the velocity of the mucous layer that changes place as a result of ciliary movements. A wide range of substances are used in the indirect methods, some of which are talcum powder, Indian ink, methylene blue, barium sulphate, saccharine, and radioactive substances. What determines the results in the indirect methods, though with limited reliability, are these substances, the observers, the patients themselves, or the devices used [10]. The indirect method that best correlates with the results of any direct method is rhinoscintigraphy, which can measure the movement of a radioactive substance [11]. No absorbable, easy to prepare, more reliable and cost-effective low-grade radioactive macro albumin particles marked with Tc99 are used for rhinoscintigraphic assessment [10]. This explains the reason why rhinoscintigraphy was made use of in this study.

Di Guida et al. [10] examined in their study with the radioisotope the nasal mucociliary clearance in patients with total and subtotal nasal obstruction. They concluded that mucociliary transport was impaired in patients with nasal polyposis. They also concluded that rhinoscintigraphy proved to be reliable, easily reproducible and harmless method, so it may be used for follow-up examinations in patients who have had surgery of the nose and paranasal sinuses.

The negative point of this test is that the patient is subjected to repeated radiographical exposure [12]. Prior et al. [13] performed SCT and RLT (radiolabelled transit) at the scintigraphy time in patients with chronic sinusitis. They concluded that, SCT is a simple effective way to measure mucociliary transport, but when patients have a delayed transit or when symptoms are suggestive of mucociliary problems, radio-labelled transit should be contemplated.

Jang et al. [5] have studied some cases with one-sided septal deviation and reported delayed saccharin transport times in the concave group, but no change in the convex group when compared with the healthy individuals. The results of these authors show that the function of the mucosa on the deviated side was maintained; yet, that of the mucosa on the open side was impaired. In our study, the measurements were taken by means of the rhinoscintigraphy technique and different results were achieved with regard to the changes occurring in the nasal mucociliary transport in patients with one-sided septal deviation. Our results revealed that mucociliary transport was faster on the concave side than on the convex side of the study group and than that of the control group. Mucociliary transport was slower on the obstructed side than on the opposite side, but when compared to the control group, no difference was observed. We think that the airflow on the open side allows more agents to enter, and thus, mucociliary activity increases in order to keep these agents away from the environment. The results of our measurements suggested that the mucociliary system is not adversely affected in septal deviations, and thanks to its compensatory mechanism, this system rules out mucosal causes when probable pathologies are concerned.

The reason for the decrease in mucociliary transport in cases with chronic sinusitis is not clear [14]. Majima et al. [15] have reported that it are not qualitative or quantitative alterations of the cilia, but it is the different interaction between mucus and ciliary activity that underlies this occurrence. Changes that occur in the mucin content (viscosity, elasticity, adhesion) affect the cilia and decrease mucociliary transport. Following the release of mediators of inflammation, there is an increase in the viscoelasticity of the mucus, which, in return, causes the symp-

Table 1. Comparison of mucociliary transport times on the concave and convex sides.

| | Nasal cavity number | Mucociliary velocity (mm/min) | Standard deviation | p |
|---|---|---|---|---|
| Concave | 20 | 14.49 | 5.84 | 0.011* |
| Convex | 20 | 8.63 | 7.41 | |

*$p<0.05$

Table 2. Comparison of mucociliary transport times on the concave side and in the control group.

| | Nasal cavity number | Mucociliary velocity (mm/min) | Standard deviation | p |
|---|---|---|---|---|
| Control(right) | 20 | 10.62 | 6.47 | 0.044 |
| Concave | 20 | 14.49 | 5.84 | |

Table 3. Comparison of mucociliary transport times on the convex side and in the control group.

| | Nasal cavity number | Mucociliary velocity (mm/min) | Standard deviation | p |
|---|---|---|---|---|
| Control(right) | 20 | 10.62 | 6.47 | 0.390 |
| Convex | 20 | 8.63 | 7.41 | |

toms of sinusitis to arise [16]. However, this is not the case merely with obstructive pathologies like septal deviations: although such pathologies affect the airflow, they do not give rise to the release of mediators that are typical of inflammatory responses [14].

Ginzel et al. [7] have reported delayed saccharin transport times in cases with septal deviation and slow mucociliary activity, which returned to normal 3 months following septoplasty. By contrast, Passali et al. [14] have found out that saccharin transport times in cases with septal deviation were not different from those in the control group. The different results achieved by these two groups of authors might be attributed to the fact that one nasal cavity was not investigated independent of the other. We took our measurements in both the nasal cavities and found that the activity increased on the open side, but it remained the same on the deviated one.

The mucociliary activity does not change because mucosa function is not impaired. In a study by Piatti et al. [17] it was observed that the mucociliary activity was not impaired by septovalvular splints after septal surgery.

Although there is a minimal trauma to the nasal mucosa it didn't change the ciliary beat frequency. Among the tests analysing the nasal mucociliar function, the saccharin test is the most commonly used, especially for screening purposes. With this method, the so called nasal transit time is obtained. It is the easiest and most inexpensive technique to evaluate nasal ciliary function. [9,18].

Although the saccharin clearance time is a good screening test, it does have a significant false positive rate. Even so, it is well correlated to more objective methods obtained by radiolabelled tracer methods [19].

With radioisotopic techniques using either insoluble particles or macro aggregated human serum albumin as a carrier are more accurate than the saccharin test and they give the exact mucociliary transport rate in millimetres per minute [18].

In conclusion, if the function of the mucosa is maintained, mucociliary activity is not adversely affected in the cases with septal deviation. On the contrary, mucociliary activity increases on the open side where the air flow is normal, compensating for the loss of the obstructed side.

Although the radiolabelled transit technique requires the use of specialized equipment, the use of radioisotopes has been shown to be an excellent method of obtaining detailed information about the clearance pathways in healthy and the patients discussed.

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