The Evaluation of Nasal Mucociliary Activity After Septoplasty and External Septorhinoplasty

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Abstract The aim of this study was to evaluate the nasal mucociliary activity after septoplasty (SP) and external septorhinoplasty (eSRP). Twenty patients who had SP operation (group 1) and 15 patients who had eSRP operation (group 2) were enrolled in the study. On each case, mucociliary clearance (MCC) measurement was performed by saccharine test before surgery, and on the first and third months of postoperative period. Saccharine clearance time (SCT) of 28 healthy volunteers were measured to establish control values. The mean SCT in control group was 8.79 ± 2.63 min, in group 1 patients before surgery was 14.03 ± 1.68 min, in group 2 patients before surgery was 14.34 ± 1.70 min. The preoperative SCT values of the group 1 and group 2 were significantly higher than healthy controls ($p < 0.05$). While there were statistically significant differences between preoperative and postoperative third month SCT values of group 1 patients, and postoperative first month and postoperative third month SCT values of group 1 patients ($p < 0.05$), there was no statistically significant difference between preoperative and postoperative first and third months SCT values of group 2 patients. Nasal septal deviation impairs the nasal mucociliary activity. Septoplasty operation positively affects the MCC mechanism. On the other hand, we observed no significant effect of eSRP operation on mucociliary activity on the first and third months of postoperative period as compared with preoperative.

Keywords Septal deviation · Septoplasty · External septorhinoplasty · Mucociliary clearance · Saccharine test

Introduction

Mucociliary clearance (MCC) mechanism protects the upper and lower respiratory tracts and delicate alveoli. Particularly, nasal MCC is a physiological response of the upper respiratory tract to clear locally produced debris, excessive secretions or unwanted inhaled particles [1]. This MCC mechanism can be easily impaired by the structural abnormalities of the nose like nasal septal deviation (NSD). As a result of disturbance in MCC mechanism causes to stasis of secretions and secondary infections [2]. There are several methods to evaluate MCC either directly or indirectly methods, the saccharine test is a simple, safe, reliable and cheap method which is used by many researchers to measure the MCC. In a study, it has been stated that normal saccharine clearance time (SCT) is 7–15 min, higher than 20 min is pathologic [3].

In many studies, it has been shown that NSD impaired the nasal MCC mechanism due to ciliary loss, increased inflammation and decreased density in glandular acini [4]. Polat et al. [5] demonstrated that nasal mucociliary transport rates (NMTRs) of patients with a deviated septum were significantly lower than the NMTRs of the healthy controls on both the convex and concave sides. Furthermore, it has been demonstrated that septoplasty, turbinectomy and nasal polyp operations have improved the MCC [6]. Septoplasty (SP) and external septorhinoplasty (eSRP) operations are commonly performed in otorhinolaryngology practice. Septoplasty operation is performed in the treatment of NSD, and eSRP operation is performed in the treatment of nasal deformity that included the correction of NSD and nasal framework.

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The purpose of this study is firstly to determine the normal values of MCC in our own region, and then to compare the changes in mucociliary activity in patients who underwent SP and eSRP before and after surgery by saccharine test. To our knowledge, there is no investigation involving nasal MCC in patients who underwent eSRP.

Methods

Twenty patients who underwent SP between the age of 18 and 51 years (13 males and 7 females, mean $\pm$ SD 31.9 ± 10.37 years) and 15 patients who underwent eSRP between the age of 18 and 36 years (nine males and six females, mean $\pm$ SD 27.46 ± 6.74 years) at Elazığ Training and Research Hospital Otorhinolaryngology Clinic between August 2010 and April 2011 were included to the study. A total of 35 patients (who underwent 20 patients SP + 15 patients eSRP) and 28 healthy controls were enrolled in the study. In study groups, the patients who underwent SP (group 1) and eSRP (group 2) have the complaints of chronic nasal obstruction and they were diagnosed with NSD by means of anterior rhinoscopy and endoscopic nasal examination by the otorhinolaryngologists (first and second authors).

This study was performed in accordance with Helsinki Declaration of the World Medical Association, and was approved by local ethics committee. The informed consents were obtained from all patients. Detailed ear, nose, throat and systemic examinations were performed in all cases (either healthy controls or study groups patients). Patients with systemic disease, upper respiratory tract infection in the preceding 6 weeks, smoking, allergic rhinitis and chronic sinusitis were excluded to the study. In addition, the patients in whom happened any septal mucosal tears during surgical procedure were excluded too.

Mucociliary clearance was measured by saccharine clearance test. The SCT of 28 healthy volunteers between the age of 14 and 51 years (13 males and 15 females, mean $\pm$ SD 33.96 ± 10.64 years) were used as the control to determine the normal values of MCC in our own region. Mucociliary clearance values of all patients who underwent SP (group 1) and eSRP (group 2) operations were measured preoperatively (1 day before surgery) and also on the first and third months of postoperative period. $\frac{1}{4}$ saccharine tablet was placed 1 cm behind anterior end of the inferior turbinate of the patients in a sitting position. The patients were asked to breath through the nose normally, but not to sniff, sneeze, eat and drink. When the patients perceived a sweet taste, SCT was recorded in minutes and seconds using chronometer. After the mean and standard deviation (SD) of SCT values were determined, these datas were compared between group 1 and group 2 preoperatively, and on the first and third months of postoperative period.

All SP and eSRP procedures were performed under intubation general anaesthesia by the first author. For SP procedure, hemitransfixion incision was applied to 1/3 caudal end of the septum at skin-mucosa junction always on the left side. Then, mucoperichondrium and mucoperiosteum were elevated. Deviated bony septum was removed as necessary, deviated cartilage septum was limitedly excised and repositioned. After completing the SP procedure, antibiotic soaked nonabsorbable packs (Merocel, Medtronic Xomed) were put into the nose bilaterally. For eSRP procedure, an interrupted, broken line midcolumellar skin incision (Goodman's incision) was applied to the columellar skin. This incision was connected to bilateral marginal incisions. The nasal skin was elevated over the medial cruses of lower lateral cartilage extending until nasal bony dorsum. To the caudal edge of the quadrangular cartilage was reached via between medial cruses of lower lateral cartilage by dissection of the septocolumellar connections. After mucoperichondrium of caudal septum was incised, mucoperichondrium and mucoperiosteum were elevated. Deviated bony septum was removed as necessary, deviated cartilage septum was limitedly excised and repositioned as in SP procedure. Then, the necessary excisions from the cartilage and bony nasal dorsum, medial and lateral osteotomies, lower lateral cartilage excisions and suturation technics were performed as the surgical steps of eSRP. After completing the eSRP procedure, antibiotic soaked nonabsorbable packs (Merocel, Medtronic Xomed) were put into the nose bilaterally. On the contrary to SP procedure, no nasal septal mucosal incision was applied in the eSRP procedure. The packs of all patients were removed on the second postoperative day. All patients were given the same antibiotics (amoxicilline 1 g twice in a day during 10 days) and the same analgesics (parasetamol four times in a day during 10 days), but no topical nasal medication.

SPSS 11.00 was used for all statistical analysis. Values of SCT were expressed as mean $\pm$ standard deviation (mean $\pm$ SD). The statistical comparisons between preoperative and postoperative SCT in the study groups and control group were analysed by using two independent samples *t* test. The comparisons between groups were made by using the repeated-measures analysis of variance (ANOVA). $p < 0.05$ was considered as statistically significant.

Results

In the control group, we found that the average SCT was 8.79 ± 2.63 min (mean $\pm$ SD). For the patients who underwent SP (group 1), the preoperative SCT average was 14.03 ± 1.68 min and for the patients who underwent eSRP (group 2), the preoperative SCT average was

14.34 ± 1.70 min (Fig. 1; Table 1). There was no significant difference between the preoperative SCT values of the group 1 and group 2 ($p > 0.05$). We found that the

preoperative SCT values of the group 1 and group 2 were significantly higher than healthy controls ($p < 0.05$). On the postoperative first month, the average SCT of group 1

Fig. 1 Saccharine clearance time (SCT) of the patients and controls in minutes

Table 1 Saccharine clearance time of healthy controls, patients of group 1 and group 2

Control group (<i>n</i> = 28: 13 M, 15 F)		Group 1 (underwent SP) (<i>n</i> = 20: 13 M, 7 F)				Group 2 (underwent eSRP) (<i>n</i> = 15: 9 M, 6 F)			
Age/sex	Healthy controls	Age/sex	Preop SP	Postop first month	Postop third month	Age/sex	Preop eSRP	Postop first month	Postop third month
35/M	7.44	37/M	12.44	18.34	9.06	21/M	13.38	15.11	18.01
50/F	3.42	38/M	14.42	20.06	11.06	34/M	13.55	12.44	7.44
47/F	11.18	22/M	13.18	15.31	10.44	26/M	14.26	13.06	11.44
30/F	9.42	19/M	12.42	9.54	11.42	18/F	16.24	18.36	13.52
31/F	6.41	29/M	17.02	7.54	10.06	30/F	17.05	19.24	21.02
45/F	9.36	24/M	11.41	14.32	11.44	36/M	15.44	14.08	14.03
22/F	6.41	51/F	15.21	22.02	9.41	21/M	11.33	11.33	9.36
23/F	9.38	37/M	13.36	15.04	10.11	19/F	11.07	11.38	11.35
19/M	8.26	49/F	15.18	8.44	9.44	18/M	14.35	14.12	16.06
19/M	9.38	31/M	16.24	13.33	12.13	26/F	15.42	13.40	9.35
51/F	13.30	21/M	15.44	11.41	13.11	29/F	15.21	12.06	13.22
17/M	11.33	45/F	12.26	16.34	9.41	29/M	14.18	13.36	11.32
37/M	10.07	45/F	16.24	19.06	8.56	34/M	16.36	17.24	19.21
14/M	9.35	19/F	15.05	14.31	9.34	36/F	14.14	15.08	16.04
35/M	10.38	18/M	12.42	7.54	10.44	35/M	13.22	12.33	11.44
35/M	6.41	31/M	15.21	9.54	11.42				
31/F	4.51	35/M	13.36	15.32	10.06				
31/F	14.36	35/M	15.18	20.02	11.44				
45/F	9.38	31/F	13.14	14.04	9.41				
44/F	11.22	21/F	11.44	9.44	10.11				
50/F	9.35								
37/M	12.42								
35/M	6.41								
31/M	7.32								
30/F	9.42								
24/M	6.41								
46/F	9.36								
37/M	4.51								

Table 2 The results of saccharine test of each group before and after surgery

	Saccharine clearance time (min) Mean $\pm$ SD (%95 CI)
Preoperative	
Group 1	14.03 $\pm$ 1.68 (7.76–9.81)
Group 2	14.34 $\pm$ 1.70 (13.40–15.29)
Postoperative first month	
Group 1	14.04 $\pm$ 4.43 (11.97–16.12)
Group 2	14.17 $\pm$ 2.44 (12.81–15.52)
Postoperative third month	
Group 1	10.39 $\pm$ 1.16 (9.85–10.93)
Group 2	13.52 $\pm$ 3.88 (11.36–15.67)
Control	8.79 $\pm$ 2.63 (7.76–9.81)

Group 1: the patients who underwent SP and group 2: the patients who underwent eSRP. *CI* confidence interval

was 14.04 ± 4.43 min and the average SCT of group 2 was 14.17 ± 2.44 min. There was no significant difference between the postoperative first month SCT values of group 1 and group 2 ($p > 0.05$). On the postoperative third month, the average SCT of group 1 was 10.39 ± 1.16 min and the average SCT of group 2 was 13.52 ± 3.88 min. But, there was statistically significant difference between the postoperative third month SCT values of group 1 and group 2 ($p < 0.05$) (Table 2).

On the postoperative first and third months, SCT values of the group 1 and group 2 were significantly higher than healthy controls too ($p < 0.05$). When the preoperative and postoperative first month SCT values of group 1 patients were compared, we found no significant difference ($p > 0.05$). But, there were significant differences between preoperative and postoperative third month SCT values of

group 1 patients, and postoperative first month and postoperative third month SCT values of group 1 patients ($p < 0.05$). When the preoperative and postoperative first month SCT values of group 2 patients, and postoperative first and third months SCT values of group 2 patients were compared, we found no significant difference ($p > 0.05$) (Table 3).

Discussion

The MCC system is an important defense mechanism of the upper and lower respiratory tract. In a previous study, it has been shown that the patients with NSD have a prolonged mucociliary transit time as compared with postoperative [7]. Septoplasty and eSRP are the most commonly performed nasal surgical procedures in otorhinolaryngology practice. Even though SP has been shown to impair MCC at immediate postoperative period, significantly improved MCC after septal surgery supports the role of SP in improving nasal MCC [5, 8]. There are several methods to assess the MCC activity. In this study, we used the SCT to measure the MCC. Because the saccharine test is a reliable, easy and harmless method to assess the MCC activity.

Polat et al. [5] observed that NMTRs of patients with NSD were significantly lower than the healthy controls on both the convex and concave sides. In addition, they have determined no statistically significant difference between the convex and concave sides before surgery. Singh et al. [2] measured the nasal mucociliary transit time (NMCT) preoperatively and postoperatively, and they have reported that NMCT had improved significantly after functional endoscopic sinus surgery. Süslü et al. [9] reported that buffered hypertonic solutions used after endonasal surgery had been advantageous effects on MCC. Kula et al. [7] performed SP in

Table 3 The preoperative and postoperative mean SCT of the study groups

	Preoperative (mean $\pm$ SD)	Postoperative first month (mean $\pm$ SD)	<i>p</i> value ^a
Group 1	14.03 $\pm$ 1.68	14.04 $\pm$ 4.43	0.987
Group 2	14.34 $\pm$ 1.70	14.17 $\pm$ 2.44	0.670
	Preoperative (mean $\pm$ SD)	Postoperative third month (mean $\pm$ SD)	<i>p</i> value ^a
Group 1	14.03 $\pm$ 1.68	10.39 $\pm$ 1.16	0.000*
Group 2	14.34 $\pm$ 1.70	13.52 $\pm$ 3.88	0.349
	Postoperative first month (mean $\pm$ SD)	Postoperative third month (mean $\pm$ SD)	<i>p</i> value ^a
Group 1	14.04 $\pm$ 4.43	10.39 $\pm$ 1.16	0.003*
Group 2	14.17 $\pm$ 2.44	13.52 $\pm$ 3.88	0.340

SD standard deviation

* $p < 0.05$ is statistically significant

^a ANOVA

48 adult patients. They assessed the nasal MCC by rhinoscintigraphy in all patients before surgery and 6 weeks after surgery. They have found no significant difference between groups regarding MCC before and after surgery. But, they have observed that the patients with NSD had a prolonged mucociliary transit time as compared with postoperative. Shone et al. [6] showed that septal surgery, turbinectomy and nasal polyp operations had improved MCC. Significantly improved MCC after septal surgery supports the role of SP in improving nasal MCC. On the other hand, Naxakis et al. [10] reported that nasal polyp has no effect on MCC. Cingi et al. [11] showed that impaired nasal mucociliary activity might result in dysfunction of the eustachian tube and middle ear ciliary activity, which plays an important role in the etio-pathogenesis of chronic otitis media. Deniz et al. [12] assessed the nasal mucociliary activity of 39 total laryngectomized patients by saccharine test. They observed that in total laryngectomy patients, hypersecretory phase was produced in early period and nasal mucosal clearance was increased. However, the smoking and diabetes mellitus also damaged the MCC. Pandya et al. [13] declared that mucociliary transport time in normal adults was (18–60 years) 5.6–13.4 min (mean 9.5) and in patients (18–60 years) with NSD was 1.6–44.3 min (mean 30.2). They concluded that the MCC is hampered in almost all pathological conditions affecting the nose like chronic sinusitis, allergic rhinitis, atrophic rhinitis, chronic sinusitis, nasal packing and surely NSD. We observed that SCT values in healthy controls (14–51 years) were 3.42–14.36 min (mean 8.79), and in group 1 patients (18–51 years) and in group 2 patients (18–36 years) with NSD were 11.41–17.02 min (mean 14.03) and 11.07–17.05 min (mean 14.34) respectively.

Ohashi et al. [8] reported that complete regeneration had been observed at sixth weeks after mechanical injury of the nasal mucosa. Therefore, nasal surgical procedures like SP impairs the MCC during immediate postoperative period. Coste et al. [14] observed that the radiofrequency thermal ablation surgery have preserved the nasal mucociliary functions after only one application. Ulusoy et al. [15] observed that before the septal surgery, the nasal mucociliary clearance velocity (NMCV) of concave (10.24 ± 3.96 mm/min) and convex sides (10.78 ± 3.53 mm/min) of the patients were significantly lower than the control group (17.94 ± 2.89 mm/min). They determined no statistically significant difference between the NMCV of the concave and convex sides. After septal surgery, the NMCVs of the concave (16.34 ± 4.40 mm/min) and convex sides (17.21 ± 3.43 mm/min) were not significantly different from control groups (17.94 ± 2.89 mm/min). Postoperative NMCVs of the concave and convex sides were significantly better than preoperative NMCVs. They concluded that NSD significantly impaired NMCVs in both sides and that SP significantly improved NMCVs in both sides.

Yiğit et al. [16] investigated the mucociliary transport speed by means of the rhinoscintigraphy technique in 20 patients with on sided NSD. They reported that the mucociliary transport speed on the concave side was found to be significantly increased compared to the convex side and the control group. Furthermore, the mucociliary activity was found to be increased on the concave side where the airflow was higher. Uslu et al. [17] investigated the effect of septal pathology and surgery on nasal MCC. Nasal MCC of 15 patients with NSD and ten healthy volunteers were measured before and 2 months after septal surgery using rhinoscintigraphy. They determined that the clearance values obtained from the preoperative period (26.25 ± 9.45 min) were significantly higher than those of the postoperative period (15.05 ± 6.35 min). The values obtained of control group (13.30 ± 3.15 min) were not significantly different from the postoperative values of the patient group. We determined that the preoperative average SCT of group 1 was 14.03 ± 1.68 min. On the postoperative first month, the average SCT of group 1 was 14.04 ± 4.43 min and on the postoperative third month, the average SCT of group 1 was 10.39 ± 1.16 min. In the control group, we found that the average SCT was 8.79 ± 2.63 min. Besides, we determined that the preoperative average SCT of group 2 was 14.34 ± 1.70 min. On the postoperative first month, the average SCT of group 2 was 14.17 ± 2.44 min and on the postoperative third month, the average SCT of group 2 was 13.52 ± 3.88 min. We found no significant difference between the preoperative and postoperative first month SCT values of group 2 patients, and postoperative first and third months SCT values of group 2 patients. On the postoperative first month in group 1 patients, we observed no significant difference as compared with preoperative. But, on the postoperative third month in group 1 patients, there was significant improvement in MCC as compared with preoperative.

Sapci et al. [18] compared the effects of radiofrequency tissue ablation, CO₂ laser ablation and partial turbinectomy applications on nasal mucociliary functions. Nasal mucociliary transport time of study patients were measured using rhinoscintigraphy before and 12 weeks after surgical procedures. They observed that laser ablation of the turbinate technique disturbed the mucociliary function significantly, despite the partial turbinectomy and radiofrequency tissue ablation techniques preserved the nasal mucociliary function. Inanlı et al. [19] measured the mucociliary activity of patients who undergone endoscopic sinus surgery before and 12 weeks after surgery by saccharine test. They found the period of preoperative saccharine test has been 12.15 min, whereas the period of the postoperative saccharine test has been 9.08 min. The improvement has been significant, but both results have been also significantly longer compared to the controls.

In conclusion, our study showed that the patients with NSD have a prolonged SCT as compared to healthy

controls. Septoplasty operations have positive effects on MCC mechanism. On the other hand, eSRP operations have no significant influence the MCC mechanism on the first and third months of postoperative period. Even though no septal mucosal incision is performed in eSRP procedure, it has no significant effect on MCC mechanism at least postoperative early period. We think that in order to determine if the eSRP procedure has any positive effect on the MCC mechanism, the further studies with longer postoperative follow-up periods are needed.

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Conflict of interest None.

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