## **Original Research Article**

DOI: http://dx.doi.org/10.18203/issn.2454-5929.ijohns20181868

# A comparative study of effect of deviated nasal septum on nasal mucociliary clearance and to comprehend the effect of septal and turbinate surgeries on restoring the mucociliary clearance

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Received: 14 February 2018 Revised: 29 March 2018 Accepted: 30 March 2018

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### **ABSTRACT**

**Background:** One of the important functions of nose is mucociliary transport by its epithelium. Any structural abnormalities of nose like deviated nasal septum, turbinate hypertrophy and polyps can easily damage the mucociliary clearance. This can lead to increased inflammation leading to osteomeatal complex obstruction and sinusitis. The purpose of the study is to determine the nasal mucociliary clearance time (NMC) in patients with deviated nasal septum. And to compare the changes in nasal mucociliary clearance time before and after septoplasty and septoplasty with turbinectomy.

**Methods:** Nasal mucociliary clearance time was measured preoperatively in patients with deviated nasal septum on concave and convex side. Post operatively it was again recorded after septoplasty in group A and septoplasty with turbinectomy in group B. These values were compared with the control group C.

**Results:** Postoperatively group A patients NMC time was 11.11±2.76 on convex side, 14.01±2.39 on concave side. In group B patients NMC time was 11.18±1.91 on convex side and 12.62±1.42 on concave side.

**Conclusions:** Nasal septal deviation and hypertrophied inferior turbinates can cause considerable impairment of nasal mucociliary clearance. Septoplasty combined with partial inferior turbinateony of compensatory hypertrophied inferior turbinate on concave side preserves the normal NMC mechanism on both the sides of nasal cavity than just septoplasty.

**Keywords:** Deviated nasal septum, Inferior turbinate hypertrophy, Nasal mucociliary clearance time, Septoplasty, Partial inferior turbinectomy

### **INTRODUCTION**

The nasal septum is an important structure of nose which supports the nasal framework and also regulates the airflow inside the nose. The turbinates along with the septum help in maintaining the normal nasal physiology of nose, by humidification, filtration, temperature alteration to suit the body temperature and creating the pressure variation by offering resistance to the airflow which would aid in proper nasal circulation. <sup>1-3</sup>

Another important function of nose is mucociliary transport, which is by the pseudo stratified ciliated columnar epithelium. This mucosa is the first line of defense in aerodigestive tract. Each cell bears 300-400 microvilli which increase the surface area of nasal mucosa to propel mucous backward into nasopharynx. The beat frequency of these cilia is between 7 to 16 Hz at body temperature. The normal mucociliary clearance time measured by various studies is between 5 to 16 minutes. This mucociliary activity depends on number

of cilia, their beat frequency and the viscosity of the mucous.<sup>7</sup> Any structural abnormalities of nose like deviated nasal septum, turbinate hypertrophy and polyps can easily damage the mucociliary clearance.<sup>9</sup> In deviated nasal septum the resistance offered to the airflow is altered, as a response to this there is compensatory hypertrophy of inferior turbinate on other side of nasal cavity. This is also reported to alter the nasal mucociliary clearance leading increased inflammation and reduced glandular activity leading to osteomeatal complex obstruction and sinusitis.<sup>10-13</sup> Polat et al have shown the nasal mucociliary clearance rates were significantly low in patients with deviated nasal septum compared to normal individuals.<sup>14</sup>

The purpose of the study is to determine the nasal mucociliary clearance time (NMC) in patients with deviated nasal septum. And to compare the changes in nasal mucociliary clearance time before and after septoplasty and septoplasty with turbinectomy.

#### **METHODS**

The present study was conducted in our ENT department between April 2014 to January 2015. The study involves total of 40 patients having nasal obstruction and 20 subjects without any nasal symptoms as control group. Age group of the study and control population was between 18-45 years. Patients with nasal obstruction as predominant symptom were included in the study. Patients with allergic rhinitis, nasal polyposis, chronic sinusitis or other systemic disease were excluded from the study. The study was explained to all the patients and control group in detail and informed consent was obtained from all. All the patients and subjects of control group underwent thorough ENT and systemic examination. Diagnostic nasal endoscopy was performed for the study population to rule out any other cause of nasal obstruction and to confirm the diagnosis. Routine blood investigations and x-ray paranasal sinuses were done for all the study group as a part of pre-operative work-up.

Mucociliary clearance was assessed in all study and control group using saccharine test. A small pellet of saccharine tablet was placed 1 cm behind the anterior end of inferior turbinate on one side of the nose in patients in sitting position. The patients were asked to breath normally and not to sneeze, sniff, eat or drink anything. They were informed to immediately report when they felt the sweet taste in their mouth. The time duration between the placement of tablet to perceiving the sweet taste was recorded in minutes and seconds using stopwatch in mobile phones. The same procedure was repeated on other side of nose after a gap of 30 minutes. <sup>15,16</sup>

Pre-operative preparations were same for all the 40 patients and all cases were done under general anesthesia. Twenty of the 40 patients had deviated nasal septum who underwent endoscopic septoplasty, and the rest 20 had deviated septum and compensatory inferior turbinate

hypertrophy who underwent endoscopic septoplasty with partial inferior turbinectomy. Freer's Incision was placed on convex side for all the patients. Mucoperichondrium and mucoperiosteum flaps were elevated and deviated cartilaginous portion of septum was excised. Flaps were sutured by using 3-0 vicryl in all cases. Group B patients underwent partial inferior turbinectomy using Hayman's scissor. Bilateral merocel nasal packs soaked in soframycin ointment were kept in all patients which were removed after 48 hours. Postoperatively all patients received same intravenous antibiotics (taxim 1gm with sulbactum 500mg twice daily) for 48 hours, with oral antihistaminics and analgesics for 7 days added with oral antibiotics from 3<sup>rd</sup> postoperative day for 5 days.

All patients were followed up thoroughly. The symptomatic improvement and nasal mucociliary clearance time was assessed on 1<sup>st</sup> and 3<sup>rd</sup> month respectively for all patients.

#### Statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean±SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients, Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale with in each group. Student t test (two tailed, Independent) has been used to find the significance of study parameters on continuous scale between two groups. <sup>17,18</sup>

Statistical software: The statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs and tables.

### **RESULTS**

### **Demographics**

There were 40 patients in the study group who were randomized into two groups A and B. The mean age of the patients in study group was 32.4±7.5 years and there were 23 female and 17 male patients in study group. In the control group with 20 subjects mean age was 32.8±10.2, there were 9 female subjects and 11 male subjects.

### Study results

The NMC time in control group on right side was  $11.84\pm2.47$  and on left side was  $11.72\pm1.95$  minutes. As there was no much difference between the values mean value of  $11.78\pm2.21$  was taken for comparison. The preoperative mean NMC of group A on concave side was  $14.41\pm2.50$  and on convex side was  $15.23\pm2.84$  minutes.

The post-operative mean NMC of group A after 1 month of surgery on concave side was 14.48±2.19 and on convex side was 14.72±2.71 minutes. The post-operative

mean NMC of group A after 3 months of surgery on concave side was 14.01±2.39 and on convex side was 11.11±2.76 minutes.

Table 1: Nasal mucociliary clearance time in Group A- concave side.

Nasal mucociliary clearance time	Min-Max	Mean±SD	Difference	t value	P value
Pre op Concave	10.83-20.45	14.41±2.50	-	-	-
Postop1Concave	11.00-19.90	14.48±2.19	-0.069	-0.242	0.811
Postop3Concave	9.98-19.64	14.01±2.39	0.397	2.527	0.021*

Student t test (Two tailed, Paired); Significant figures: + Suggestive significance (P value:  $0.05 ); * Moderately significant (P value: <math>0.01 ); ** Strongly significant (P value: <math>p \le 0.01$ )

Table 2: Nasal mucociliary clearance time in Group A- convex side.

Nasal mucociliary clearance time	Min-Max	Mean±SD	Difference	t value	P value
Pre op Convex	10.54-19.80	15.23±2.84	-	-	-
Postop1 Convex	10.98-21.89	$14.72\pm2.71$	0.514	1.019	0.321
Postop3 Convex	7.23-18.80	11.11±2.76	4.123	9.173	<0.001**

Student t test (Two tailed, Paired)

Table 3: Nasal mucociliary clearance time of Group B – concave side.

Nasal mucociliary clearance time	Min-Max	Mean±SD	Difference	t value	P value
Pre op Concave	10.93-21.76	14.15±2.79	-	-	-
Postop1Concave	13.43-25.64	16.81±3.19	2.660	-9.092	<0.001**
Postop3Concave	10.54-15.54	12.62±1.42	-1.530	3.121	0.006**

Student t test (Two tailed, Paired)

Table 4: Nasal mucociliary clearance time of Group B – convex side.

Nasal mucociliary clearance time	Min-Max	Mean ± SD	Difference	t value	P value
Pre op Convex	11.67-22.50	15.54±3.14	-	-	-
Postop1 Convex	10.21-23.57	15.43±3.38	0.117	0.224	0.825
Postop3 Convex	7.34-14.91	11.19±1.91	4.349	7.932	<0.001**

Student t test (Two tailed, Paired)

Table 5: Nasal mucociliary clearance time - comparison in three groups on concave side.

Nasal mucociliary clearance time	Group A	Group B	P value (A vs B)	Group C	Over all p value
Pre op Concave	14.41±2.50	14.15±2.79	0.754	11.78±2.21	0.003**
Postop1Concave	14.48±2.19	16.81±3.19	0.011*	-	<0.001**
Postop3Concave	14.01±2.39	12.62±1.42	0.030*	-	0.004**

ANOVA test.

Table 6: Nasal mucociliary clearance time - comparison in three groups on convex side.

Nasal mucociliary clearance time	Group A	Group B	P value (A vs B)	Group C	Over all p value
Pre op Convex	15.23±2.84	15.54±3.14	0.742	11.78±2.21	<0.001**
Postop1 Convex	14.72±2.71	15.43±3.37	0.468	-	<0.001**
Postop3 Convex	11.11±2.76	11.19±1.91	0.907	-	0.607

ANOVA test

### Group A: with in group analysis

Post-operatively at 1<sup>st</sup> month the NMC time on concave side in group A was similar to pre-operative value. But at 3<sup>rd</sup> month there was a moderate significant difference with p value being 0.021 as shown in Table 1.

In group A on convex side there was no significant difference between the NMC time at pre-operative and 1<sup>st</sup> month of post-operative period. But at 3<sup>rd</sup> month post-operatively NMC time was considerably reduced which was statistically significant as in Table 2.

### Group B: With in group analysis

In group B who underwent septoplasty with partial inferior turbinectomy on concave side, the preoperative mean NMC on concave side was 14.15±2.79 and on convex side was 15.54±3.14 minutes respectively. The NMC time at 1<sup>st</sup> month post-operatively was significantly longer compared to pre-operative NMC time, with p<0.001. But at 3<sup>rd</sup> month the NMC time reduced significantly low to the pre-operative NMC time as depicted in Table 3.

On convex side in group B NMC time at 1<sup>st</sup> month postop had no much difference from the pre-operative NMC time, with p value being 0.825. But at 3<sup>rd</sup> month the NMC time was reduced significantly with p value being <0.001 as shown in Table 4.

On comparing the NMC time of control group and the subjects pre-operatively on concave side using ANOVA test there was statistically significant difference between the mean values with P value being 0.003. But there was no significant difference between the groups A and B NMC time. At 1<sup>st</sup> month post-operatively NMC time was considerably prolonged in group B as compared to group A. But post-operatively at 3<sup>rd</sup> month the NMC time of group B on concave side was significantly reduced as in Table 5.

The NMC time of control group and the subjects preoperatively on convex side showed significant difference with p<0.001. But between group A and B there was no significant difference. At 1<sup>st</sup> month post-operatively NMC time was considerably prolonged in group B as compared to group A. But post-operatively at 3<sup>rd</sup> month the NMC time between the two groups did not show any statistically significant difference as depicted in Table 6.

### **DISCUSSION**

Nasal mucociliary clearance of nose and paranasal sinuses is an important defense mechanism which protects them from any physical and biological insults. Any structural abnormalities of nose like deviated nasal septum, turbinate hypertrophy and polyps can easily damage the mucociliary clearance. Impairment of this

defensive mechanism can lead to obstruction of osteomeatal complex and hence rhinosinusitis. 16

There are various methods to assess NMC time like stroboscopy, roentgenography, photoelectron techniques, rhinoscintigraphy which are direct methods but costly and inconvenient. Indirect methods like charcoal and saccharine test are easy, safe and fast. <sup>9,19</sup> Of all the test saccharine test is very simple, inexpensive, repeatable and reliable method to perform routinely. <sup>20</sup>

The control group in our study did not show much difference in NMC time of right and left side of nasal cavity. And hence mean value of NMC time of right and left nasal cavity was taken for comparison. The preoperative NMC time in both groups A and B were prolonged compared to control group especially on convex side than concave side of nasal cavity. Similar prolonged NMC time in patients with deviated nasal septum was recorded by Polat et al and Pandya et al. <sup>21,5</sup> Ulusoy et al observed NMC velocity was significantly lower in both concave and convex groups compared to control group. However there was no significant difference between convex and concave sides. <sup>22</sup> Yong Ju et al study also showed increased NMC time on convex side rather than concave side. <sup>23</sup>

Post-operatively at 4 weeks follow-up, the NMC time was reduced in group A and B on convex side. But on concave side in group A it was slightly increased, whereas in group B it was considerably increased. This could be because of the crusting and edema after partial inferior turbinectomy. Ohashi et al also observed nasal surgical procedures impaired NMC during immediate postoperative period. Ohashi et al studied the regeneration of nasal mucosa following mechanical injury and concluded that recovery of nasal mucosa occurs within 5 days if basal cells are intact. But when entire nasal mucosa is damaged it takes a minimum of 6-8 weeks for complete regeneration. Hence in our study next follow-up was conducted at 3<sup>rd</sup> month post-operatively.

At 3<sup>rd</sup> month postoperatively in group A there was significantly reduced NMC time on convex side which was congruous with the control group. But on concave side there was only mild improvement. Similar results were observed by Oner et al in their study of evaluation of nasal mucociliary activity after septoplasty. <sup>15</sup> Yigit et al investigated the effect of septoplasty on NMC time using radioscintigraphy. In their study the NMC time preoperatively was significantly higher than the control group. But at post-operative 2<sup>nd</sup> month it was not significantly different from the control group. <sup>25</sup> Reduction in NMC time in patients undergoing septoplasty for deviated nasal septum at 3<sup>rd</sup> month post-operatively was also seen by Yong Ju et al. <sup>23</sup>

At 3<sup>rd</sup> month post-operatively patients in group B who underwent partial inferior turbinectomy on concave side

showed considerable reduction in NMC time, which emulated the normal NMC time. Concordant results were observed by Rajeshwary Aroor et al, who studied the effect of different nasal surgeries on mucociliary clearance. Sapci et al compared the effects of radiofrequency tissue ablation, CO<sub>2</sub> laser ablation and partial inferior turbinectomy on nasal mucociliary clearance for hypertrophied inferior turbinates. They observed partial inferior turbinectomy and radiofrequency ablation restored normal NMC after 12 weeks post-operatively as against laser application. <sup>27</sup>

#### CONCLUSION

The results of our study suggest that nasal septal deviation and hypertrophied inferior turbinates can cause considerable impairment of nasal mucociliary clearance which can lead to rhinosinusitis. Septoplasty alone has a positive outcome on NMC mechanism on convex side only. But septoplasty combined with partial inferior turbinectomy of compensatory hypertrophied inferior turbinate on concave side preserves the normal NMC mechanism on both the sides of nasal cavity. The NMC post-operatively should be assessed at no less than 12 weeks, as this is the time period required for mucosal repair. Hence septoplasty combined with partial inferior turbinectomy on concave side has a better outcome in terms of restoring normal physiology of nose.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

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Cite this article as: Chandra SBC, Bylappa K. A comparative study of effect of deviated nasal septum on nasal mucociliary clearance and to comprehend the effect of septal and turbinate surgeries on restoring the mucociliary clearance. Int J Otorhinolaryngol Head Neck Surg 2018;4:764-9.