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SEPTAL DEVIATION AND EAR HEALTH: EVALUATING THE ROLE OF SEPTOPLASTY PROSPECTIVE OBSERVATIONAL STUDY.

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Abstract

Background

The Eustachian tube (ET) is essential for maintaining middle ear pressure and ventilation. ET dysfunction is a known contributor to middle ear pathologies and may be influenced by nasal anatomical variations such as deviated nasal septum (DNS). Septoplasty, the surgical correction of DNS, has been proposed to improve ET function and hearing outcomes. This study aimed to evaluate the impact of septoplasty on ET function and hearing levels in patients with DNS.

Methods

A prospective observational study was conducted on 50 patients (35 males and 15 females) aged 15–60 years undergoing septoplasty for symptomatic DNS. Patients with other nasal or middle ear pathologies were excluded. All participants were assessed using tympanometry and pure tone audiometry (PTA) preoperatively, and postoperatively at 4 weeks and 6–8 weeks. Statistical analysis was performed SSPS Version 2.0.

Results

Preoperatively, 39% of ears showed conductive hearing loss (CHL) and 27% demonstrated Type C tympanogram, indicating poor middle ear pressure. At 6–8 weeks postoperatively, ears with CHL reduced significantly to 27%, and those with Type C tympanogram reduced to 9%, suggesting improved ET function and middle ear ventilation. The improvement was more pronounced on the side of the septal deviation. Notably, the initial postoperative assessment at 4 weeks showed transient worsening in CHL, likely due to postoperative mucosal edema, which resolved by the second follow-up.

Conclusion

Septoplasty leads to significant improvement in ET function and hearing, especially on the side of the septal deviation. The findings highlight the importance of considering septoplasty not just for nasal obstruction, but also for managing associated middle ear dysfunction.

Recommendation

Septoplasty should not only be used for dealing with nasal obstruction in DNS patients but also for improving ET function and CHL. Further multicentric studies with longer follow-ups are recommended to validate these results.

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Introduction

The Eustachian tube (ET) plays a vital role in maintaining middle ear health by equalizing pressure, clearing secretions, and protecting against nasopharyngeal pathogens and loud sounds. Since its first anatomical description by Eustachius in 1563, the understanding of the ET has evolved considerably from being considered a simple conduit to now being recognized as a complex "organ" with intricate structural and functional relationships[1]. Proper Eustachian tube function (ETF) is critical for optimal sound conduction through the tympanic membrane (TM) and ossicular chain. Dysfunction of the ET can result in symptoms such as hearing loss (HL), aural fullness, otitis media, and even cholesteatoma formation.

Recent studies have shown that nasal anatomical variations, particularly a deviated nasal septum (DNS), may impact ETF and middle ear ventilation[8-11]. A DNS can obstruct the nasal cavities, compromise nasopharyngeal airflow, and affect ET patency, especially on the ipsilateral side. Septoplasty is a commonly performed surgical procedure used to rectify

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DNS and has been seen to enhance nasal airflow and potentially restore normal ETF.

This study was conducted to evaluate the effect of septoplasty on ETF and middle ear functions. It explores whether relieving nasal obstruction through surgical correction leads to measurable improvements in middle ear pressure and ET performance, using tympanometry and Pure tone audiometry (PTA).

Methods

Study design

This was a prospective observational study, designed to evaluate changes in ETF and hearing levels following septoplasty in patients with DNS. The study included preoperative and postoperative evaluations over a follow-up period of 6–8 weeks.

Study Setting

The study was conducted in the Department of ENT, NMCH, Patna, a tertiary healthcare center located in India, between October 2018 and September 2020. The hospital is a well-equipped teaching institution offering specialized services in otolaryngology and caters to a large patient population from both urban and rural areas.

Participants

Inclusion Criteria

- Patients aged between 15 and 60 years.
- Diagnosed with symptomatic DNS requiring septoplasty.
- Willing to provide written informed consent and comply with follow-up visits.

Exclusion Criteria

- Patients aged less than 15 years and more than 60 years
- History of ear discharge, allergic rhinitis, or nasal polyps.
- Previous nasal/ear surgeries (septoplasty, FESS, tympanoplasty).
- Tympanic membrane perforation or active middle ear disease.
- Other nasal pathologies, like nasal tumors.

Participant Selection

Eligible participants were selected from the outpatient department of ENT who presented with symptomatic DNS. All patients underwent thorough clinical, endoscopic, and audiological evaluation before enrolment.

Bias

To minimize selection bias, strict inclusion and exclusion criteria were applied. All patients were evaluated by the same set of clinicians using standardized protocols for examination and audiological testing. Data analysis was performed by a blinded statistician.

Study Size

The study included 50 participants, selected based on feasibility during the two-year study period.

Data Collection/Measurement

Institutional ethics committee permission was obtained, and subjects were recruited for the study after obtaining written informed consent. Clinical data were collected through detailed clinical history taking, general examination, diagnostic nasal endoscopy, otoscopy, and ear examination under a microscope. The Sino-Nasal Outcome Test (SNOT-22) Questionnaire was used to assess all the patients included in the study. Tympanometry evaluation for ETF was performed using an Interacoustics AT 235 Impedance audiometer. PTA was done for hearing assessment using Interacoustics AC 40. The selected patients were taken for Septoplasty under General Anaesthesia. All the tests were done preoperatively as well as postoperatively at four weeks and 6-8 weeks.

Statistical Analysis

Data were analyzed using SPSS Version 21.0. A p-value of <0.05 was considered statistically significant.

Results

A total of 72 patients were initially assessed for eligibility based on symptoms suggestive of DNS. After clinical evaluation, 65 patients met the preliminary inclusion criteria. Of these, 15 were excluded: 6 due to chronic ear discharge or tympanic membrane perforation, 4 with allergic rhinitis or nasal polyps, 3 with a history of prior nasal or ear surgeries, and 2 who declined participation. Ultimately, 50 patients were enrolled after providing informed consent. All 50 completed the postoperative follow-ups at 4 and 6–8 weeks, and their data were included in the final analysis.

Most of the patients in this study belonged to the age group 15-30 years, comprising 36 patients(72%), followed by 31-45 years of age, comprising 12 patients (24%), and 46-60 years of age, comprising only 2 patients(4%). Out of the 50 patients, 35 were male (70%) and the rest 15 were female (30%).

Coming to symptomatology, nasal obstruction was the most common symptom seen in almost all the patients (48), followed by post-nasal drip (25), anosmia (5), nasal discharge (24), epistaxis (4), sneezing (3) and facial pain/headache (2). The same has been depicted in Figure 1.

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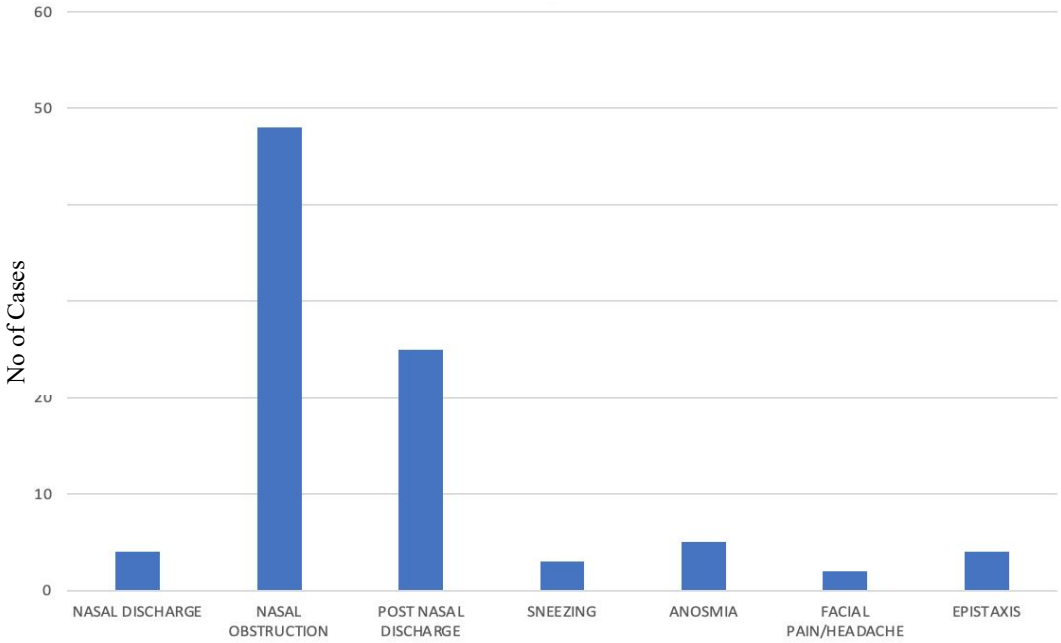

Figure 1: Presenting symptoms

The nasal deviation was seen more commonly on the left side in 28 patients (56%) and comparatively less commonly on the right side in 22 patients (44%). MLADINA'S CLASSIFICATION of septal deviation was used to classify deviations, and types II (32%) and III (26%) were predominant. However, there were no patients with type VII septum in our study. Table 1 shows the distribution of patients according to the type of deviation.

	SIDE				TOTAL
TYPE OF DNS	LT DNS		RT DNS		
TYPE I	2	7.1%	2	9.1%	4
TYPE II	9	32.1%	7	31.8%	16
TYPE III	8	28.6%	5	22.7%	13
TYPE IV	1	3.6%	2	9.1%	3
TYPE V	6	21.4%	3	13.6%	9
TYPE VI	2	7.1%	3	13.6%	5

Table 1: Distribution of patients as per Mladina's Classification of DNS

PTA findings involving both ears separately in 50 patients were assessed, representing 100 ears. In our study, it was found that, preoperatively, 51% of patients had a hearing threshold within normal limits(up to 25 dB), 39% with mild to moderate Conductive Hearing Loss (CHL) (hearing threshold between 25- 55 dB), while 10% had mixed HL.

At 4 weeks postoperatively (after septoplasty), there was no improvement in hearing; rather, there was an increase in the number of patient ears with CHL from 39 to 44 (44%). However, the study noticed significant changes in hearing at 6-8 weeks postoperatively, where there was a noticeable decrease in the number of ears with CHL from 44 to 27 (27%), which was statistically significant ($p<0.05$). The McNemar-Bowker test was used as the test of significance.

No worsening or Improvement was seen in patient ears with mixed HL. Table 2 displays the PTA findings of the study.

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	PRE-OP		4 WEEKS		6-8 WEEKS	
PTA	**N**	**N (%)**	**N**	**N (%)**	**N**	**N (%)**
WNL	51	51.0%	46	46.0%	63	63.0%
MILD CHL	22	22.0%	27	27.0%	14	14.0%
MOD CHL	17	17.0%	17	17.0%	13	13.0%
MILD MIXED HL	6	6.0%	6	6.0%	6	6.0%
MOD MIXED HL	4	4.0%	4	4.0%	4	4.0%
TOTAL N	100	100.0%	100	100.0%	100	100.0%
P-VALUE	MCNEMAR-BOWKER TEST		0.025		0.0001	

Table 2: Comparison of preoperative and postoperative PTA findings (N=100, considering all ears of 50 patients separately)

Next, the study compared the tympanometry findings and observed that preoperatively, 73 out of 100 patient ears showed normal type A tympanogram indicating normal middle ear pressure while the rest 27 patient ears showed type C tympanogram indicating poor middle ear pressure and function.

At 4 weeks, there was a decrease in the number of patient ears with type C tympanogram from 27 to 20 (20%) and further improvement was observed at 6-8week follow-up, where no of patient ears with type C tympanogram reduced to 9 (9%).

Postoperative follow-ups done at 4 weeks and 6-8 weeks showed improvement in middle ear function, which was statistically significant ($p<0.05$). Tympanometry findings are depicted in Table 3.

TYMP	PRE-OP		4 WEEKS		6-8 WEEKS	
	N	**N (%)**	**N**	**N (%)**	**N**	**N (%)**
TYPE A	73	73.0%	80	80.0%	91	91.0%
TYPE C	27	27.0%	20	20.0%	9	9.0%
TOTAL N	100	100.0%	100	100.0%	100	100.0%
P-VALUE	MCNEMAR TEST		0.039		0.0001	

Table 3: Comparison of preoperative and postoperative Tympanometry findings (N=100, considering all ears of 50 patients separately)

Tympanometry findings further showed that out of a total of 28 patients with left DNS, type C tympanogram was seen more on the left side in 10 patients (35.7%) as compared to the right side in 5 patients (17.9%). Similarly, out of a total of 22 patients with right DNS, there was more type C tympanogram on the right side in 8 patients (36.4%) as compared to the left side in 4 patients (18.2%).

We concluded that post septoplasty there was more improvement in ETF on the same side of DNS as compared to the opposite side. These findings are shown in Table 4.

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Table 4: Tympanometry findings of both ears and their association with the laterality of DNS

	TYMP	PRE-OP				4 WEEKS				6-8 WEEKS			
		R/E		L/E		R/E		L/E		R/E		L/E	
LT DNS	TYPE A	23	82.10 %	18	64.30 %	24	85.70 %	21	75.00 %	26	92.90 %	25	89.30 %
	TYPE C	5	17.90 %	10	35.70 %	4	14.30 %	7	25.00 %	2	7.10%	3	10.70 %
TOTAL		28	100%	28	100%	28	100%	28	100%	28	100%	28	100%
RT DNS	TYPE A	14	63.60 %	18	81.80 %	16	72.70 %	19	86.40 %	20	90.90 %	20	90.90 %
	TYPE C	8	36.40 %	4	18.20 %	6	27.30 %	3	13.60 %	2	9.10%	2	9.10%
TOTAL		22	100%	22	100%	22	100%	22	100%	22	100%	22	100%

Discussion

Middle ear ventilation problems are frequently observed in patients with nasal obstruction, and a DNS remains the most common cause according to [2]. Any blockage in the nasal cavity can affect ETF by three mechanisms. Altered nasal airflow can lead to the accumulation of microbes and airborne particles near the ET opening, triggering local inflammation and physical blockage. Additionally, changes in airflow may dry the mucosa, increasing mucus thickness and surface tension, which can raise the pressure required to open the ET. Altered air currents may stimulate the post-nasal mechanical receptors around the ET, leading to a reflex alteration in tubal function. This study aimed to evaluate the impact of DNS on ET and middle ear function and assess changes following septoplasty.

There are various studies about the alterations of ET and middle ear functions after septoplasty. Jacob J *et al* studied post-septoplasty effect on both hearing and ETF, and Akyildiz MY *et al* reported an improvement in ETF alone postoperatively [3,4]. This study observed improvement in both ET, hearing, and middle ear functions postoperatively.

In our study, most patients were male and between 15–30 years of age, which aligns with earlier research. This may be attributed to the early onset of nasal symptoms associated with DNS, which typically prompts medical attention during this stage of life. Males comprising a larger proportion in the study can be a result of high traumatic exposure of males as compared to females. Nasal obstruction was more commonly present on the left side in our study. The most common symptom was nasal obstruction (96%), followed by post-nasal discharge (50%), anosmia (10%), nasal discharge (8%), epistaxis (8%), sneezing (6%), and facial pain with headache (2%). This was by the study done by Amer S. *et al* and Rao J.J. *et al,* who observed above mentioned symptoms in patients with DNS [5,6].

MLADINA'S CLASSIFICATION was chosen for the depiction of the type of DNS. Type II and III septal deviations were most common in our study, suggesting their impact on the nasal valve area plays a crucial role in ventilation impairment. This was by the study conducted by Prasad S. *et al,* who found type II DNS predominant in their study [7]. However, the study conducted by Rao J.J. *et al* observed type V and type VI in the majority of the patients (63%) and type III in a limited number of patients (8%) [6].

Significant improvements in tympanometric and PTA findings were noted postoperatively, particularly at 6–8 weeks, supporting earlier work by Nanda *et al* and Low and Willatt, who observed similar timelines for functional recovery.

In this study, post septoplasty as a result of correction of DNS, an improvement was found in ETF and hearing which were assessed by significant changes in tympanometry and PTA at 4 weeks and 6-8 weeks follow up.

When PTA findings were considered, the mean air-bone gap was calculated for both ears separately in patients. There was an initial worsening of HL at the first post-op visit (at 4 weeks), which could be attributed to post-op mucosal edema and inflammation. However, this was followed by a marked improvement at the second follow-up (at 6-8 weeks). Similar findings were observed in a study conducted [8].

Regarding tympanometry findings, a type A tympanogram was considered normal, type C tympanogram was indicative of poor ETF. At 4 weeks postoperatively, not much improvement in middle ear pressure was seen; more significant improvement was seen at the second post-op follow-up (at 6-8 weeks), where the majority of patients had with type C tympanogram type A tympanogram. The delayed

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improvement in middle ear pressure observed at 6–8 weeks, rather than at 4 weeks post-septoplasty, may be attributed to the time required for postoperative mucosal healing and resolution of inflammation near the ET orifice. This is to the study done by Nanda et al and Osama S et al, which also demonstrated improvement in middle ear pressure after 8-12 weeks postoperatively [8,9]. However, studies by Salvinelli et al. and Davari and Behnoud reported that septoplasty did not lead to any statistically significant changes in middle ear pressure [10,11].

In our study, we aimed to evaluate ETF on the side of DNS and compare it to the opposite side to determine the effect of septoplasty on ipsilateral ETF. We found there was more improvement in ETF and middle ear pressure, along with improvement in hearing on the same side of DNS as compared to the other side. The greater improvement on the same side as the DNS suggests that the mechanical obstruction caused by DNS plays a significant role in ipsilateral ET dysfunction. On the other hand, Osama et al. reported no meaningful association between the side of nasal blockage and variations in middle ear pressure or Eustachian tube function [9]. These findings align with those reported who also observed no significant relationship between the laterality of nasal obstruction and tympanometric outcomes [10].

This study's findings apply to adult patients with isolated DNS undergoing septoplasty. However, generalizability to broader populations is limited due to the exclusion of patients with comorbid nasal or otologic conditions. Other than septum deviation, paranasal and pharyngeal diseases, such as allergic rhinitis, conchal hypertrophy, and adenoid hypertrophy, should also be taken into consideration in studies that evaluate the effects of septoplasty on ETF. In this study, we aimed to see the effects of only septal deviation and septoplasty on ETF by excluding patients with pathologies other than septal deviation. The presence of such a disease can lead to further disruption of the ETF post-septoplasty.

Conclusion

This study highlights a significant association between DNS and ETF, with evidence showing that DNS adversely affects middle ear ventilation and function. Our findings demonstrate that septoplasty not only alleviates nasal symptoms but also leads to substantial improvement in ETF, TM status, and CHL, especially on the side of the septal deviation. The results affirm that septoplasty can play a pivotal role in managing chronic otitis media and other middle ear pathologies associated with ET dysfunction.

Limitation

One key limitation of this study was the relatively short follow-up period of only 8 weeks. This duration may not capture long-term outcomes, including potential recurrence of ET dysfunction or delayed complications. A longer follow-up would be necessary to evaluate the sustained impact of septoplasty on middle ear function and hearing levels.

Recommendation

ENT practitioners should consider thorough preoperative evaluation of ETF in patients undergoing septoplasty, especially those presenting with aural symptoms. Additionally, incorporating ETF testing and middle ear evaluation in the follow-up period post-septoplasty is essential for monitoring recovery and ensuring optimal patient outcomes.

Further, longitudinal and multicentric studies with larger sample sizes are warranted for further validation of our findings.

List of abbreviations

ET	Eustachian Tube
DNS	Deviated nasal septum
PTA	Pure tone audiometry
CHL	Conductive hearing loss
ETF	Eustachian tube function
TM	Tympanic membrane
HL	Hearing loss
FESS	Functional Endoscopy Sinus Surgery
SNOT-22	Sino-Nasal Outcome Test-22

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No Source of funding

Conflict of interest

The authors declare that there is no conflict of interest.

Author contributions

SK and RR created the study's manuscript and reviewed the earlier research. RKP read and approved the final manuscript.

Data availability

The data used in the current study are available from the corresponding author upon reasonable request.

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