The Association of Otalgia with Nasal Septum Deviation: A Prospective Study

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Abstract

Objectives: There has been anecdotal evidence that otalgia and ear fullness are associated with a deviated nasal septum (DNS). The goal of this novel, pilot study is to evaluate if eustachian tube dysfunction (ETD) is associated with a DNS and improved following septoplasty. Design: Prospective comparative pilot study Setting: Tertiary hospital at an academic institution Participants: Twenty-five patients with septal deviations (16 with otalgia and 9 controls) underwent septoplasty with inferior turbinate reduction between November 2016 and May 2018. Main Outcome Measures: ETDQuestionnaire (ETDQ-7), Sino-nasal Outcome Test (SNOT-22), and Nasal Obstruction Symptom Evaluation (NOSE) assessed quality of life pre and post operation. Results: Mean SNOT-22 scores decreased significantly for both groups ($p< 0.05$). The results of the ETDQ-7 showed aural symptoms significantly decreased for case patients at 6 weeks (-17.4, $p=0.016$) which continued through week 12. Symptoms of ear fullness and pain were significantly reduced in the case group ($p<0.05$). With both groups experienced a reduction in all questionnaires, decreased SNOT-22 scores correlated with ETDQ-7 ($p=0.0012$) and NOSE ($p<0.036$) improvements while the control group did not see test correlations. Conclusions: Overall, our study demonstrated otalgia or ear fullness could be associated with a DNS. The data suggests significant correlations between all three questionnaires in evaluating patients with nasal obstruction and aural symptoms, and that they are reasonable tools in evaluating ETD outcomes concerning septoplasty. Thus, we propose that nasal septum deviation be evaluated and included in any algorithm for the diagnosis and management of patients with ETD.

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Conclusions : Overall, our study demonstrated otalgia or ear fullness could be associated with a DNS. The data suggests significant correlations between all three questionnaires in evaluating patients with nasal obstruction and aural symptoms, and that they are reasonable tools in evaluating ETD outcomes concerning septoplasty. Thus, we propose that nasal septum deviation be evaluated and included in any algorithm for the diagnosis and management of patients with ETD.

Keywords: Otalgia, septum deviation, eustachian tube dysfunction, ear pain, quality of life, SNOT, ETDQ, septoplasty

Key Points

- Our study suggests otalgia or ear fullness could be associated with a DNS.
- Patients may have a significant reduction in aural pain post septoplasty.
- Post septoplasty, ETDQ-7 showed a significant reduction in aural symptoms of patients.
- Patients who have aural symptoms concomitate with nasal obstruction may be attributable more due to the inability to equalize middle ear pressures.
- Septum deviation should also be evaluated in the diagnosis and management of ETD, and a treatment algorithm is proposed.

Introduction

Otalgia is a common reason for patients of all ages to be referred to the otolaryngology clinic. The etiology of otalgia can be derived from the history and physical exam; however, a subset of patients with otalgia experience non-otogenic pain referred from distant sites within the head and neck termed secondary otalgia. Secondary otalgia has been suggested to be responsible for up to half of all visits related to ear pain.[1,2] Among other pathologies, secondary otalgia is frequently considered the result of eustachian tube dysfunction (ETD), particularly with accompanying sinonasal symptoms.[3,4,5] ETD may be due to variety of etiologies that ultimately result in a diminished ability to equalize middle ear pressures through the eustachian tube; however, the exact pathophysiology of ETD is not fully understood nor is there a gold standard test for the diagnosis of ETD.[6,7] Some small retrospective studies have suggested that nasal obstruction alone can influence eustachian tube function, and regardless, symptoms of ETD are well established aspects of diseases causing chronic nasal obstruction.[8,9,10]

Symptom assessment instruments such as the Sino-nasal Outcome Test (SNOT-22) for chronic rhinosinusitis (CRS) feature questions regarding ear pain and fullness. Otalgia and aural fullness are some of the common symptoms of ETD, along with tinnitus and temporary hearing loss.[6,8] Due to this inclusion and the lack of objective diagnostic criteria in ETD, many otolaryngologists attribute aural symptoms in CRS to ETD. Currently, medical treatments for ETD aim to improve mucosal conditions of the nasal cavity and the eustachian tube with varying efficacy.[6] More recently, procedural interventions such as eustachian tube balloon dilation have emerged as a treatment option for reducing symptoms; however, no study has prospectively examined the effect of septoplasty with inferior turbinate reduction (ITR) on symptoms related to ETD.[6,10]

Another lesser characterized etiology of secondary otalgia involves pain that originates from the nasal cavity. The concept of pain from the nasal cavity referring to other sites within the head was first described in 1942.[11,12,13] Contact points between the nasal septum and the lateral nasal wall have been shown to cause referred ipsilateral pain in the distribution of trigeminal branches.[13,14,15] Some retrospective literature suggests septoplasty as an effective treatment in reducing pain in these patients.[16,17] Recent case reports have proposed a similar rhinogenic mechanism responsible for patients with unexplained otalgia; however, this association has not been examined prospectively.[18,19] Specifically, there has been minimal investigation into the benefits of septoplasty as it relates to improvement of referred otalgia in which a contact point is not present.

1.1 Objectives

Our aim in this prospective study is to examine the association between septoplasty with ITR and ear pain or fullness in patients with chronic nasal obstruction. Through the use of middle ear symptom assessment instruments before and after surgery, we postulate whether aural symptoms in chronic nasal obstruction are a direct sequela of ETD and will have resolution post septal deviation correction.

Methods

2.1 Ethical Considerations

This prospective study was approved by the Institutional Review Board at <blinded for review>. All subjects were patients of the principal investigator. Proper informed consent of all patients was obtained for the collection and use of data for analysis using STROBE reporting guidelines.

2.2 Participants

This prospective pilot study utilized data from a small cohort of 25 patients over 18 years old within a single institution at <blinded for review>. Patients were recruited into the study between November 2016 to May 2018 during their preoperative evaluation for routine septoplasty with ITR. All patients underwent endoscopic septoplasty and ITR. It was noted that all patients had compensatory hypertrophy of the nasal turbinate and turbinate hypertrophy as well. All participating subjects had a CT scan of the sinuses as part of the preoperative workup. Only those without evidence of sinus disease were consented to participate in the surgery. Patients with a previous history of septoplasty or a history of other sinonasal surgeries were excluded from this study. Similarly, patients with previous middle ear surgeries or a known etiology for aural symptoms were excluded from the study. Patients were included in the case group if they reported symptoms of otalgia or aural fullness at the time of preoperative evaluation and were scheduled for septoplasty. The control group had indications for routine septoplasty without any preoperative aural complaints. Neither group had adenoidal tissue that further contributed to the obstruction of the post nasal space.

2.3 Data

Subjects were asked to complete three symptom assessment questionnaires during their preoperative visit: ETDQuestionnaire (ETDQ-7), SNOT-22, and Nasal Obstruction Symptom Evaluation (NOSE). SNOT-22 includes shared components from both the ETDQ-7 and the NOSE instruments. These questionnaires were completed prior to surgery and again at their routine postoperative visits at 6 and 12 weeks. Primary endpoints of the study were the ETDQ-7 questionnaire scores at the 6-week postoperative visit. In addition to demographics and primary outcomes, secondary outcomes were collected including the severity and laterality of the deviated nasal septum through endoscopic and CT scan measurements.

2.4 Statistical Analysis

Accurate power analysis cannot be done since studies of this kind have not been performed before; however, sample size was inferred based on an estimated difference in the mean SNOT-22 scores of 8.9 (clinically significant). Calculations were based on an effect size of 0.45 and a power of 0.8. Stratified groups and postoperative changes within groups were compared using the Wilcoxon two-sample test. P-values were considered significant if less than or equal to 0.05. Analysis was done on selected questions within the SNOT-22 and ETDQ-7 questionnaires that related to ear pain or ETD. All three instruments were analyzed for correlation of change between the preoperative and 6-week postoperative visit. Pearson correlation coefficients were calculated for SNOT-22, NOSE, and ETDQ-7 instruments for all groups.

Results

3.1 Demographics

Patient demographic information, pressure abnormalities, and septum presentation for all patients were reported on **Table 1** . A total of 25 patients were in the study. Nine of these patients served as controls without aural symptoms. Patient demographic variables did not show significant difference in age or sex

between groups. The mean age of the patients was 44.2 years old with 14 of the patients being male and 11 being female.

When examining the relationship between the laterality of ear pain and direction of deviation or presence of a septal spur, there was no significant difference between case and control groups. From the results of the CT scans and the operations, 9 case patients had a septal deviation ipsilateral to the side of pain and 6 had a deviation contralateral to the pain. One patient had an s-shaped deviation with no stronger direction of laterality. When looking at the side of pain and a bone spur, four patients had a spur ipsilateral to their pain and four with a spur on the opposite side of the pain. Eight patients had no bone spur. Laterality of pain was not related to the actual septal deviation or the side of the spur.

3.2 Middle Ear Pressures

Tympanometry data considered each ear independently. A total of 24 middle ear pressures were measured preoperatively. Sixteen ears had abnormal middle ear pressures before surgery. Patients in the case group were found to have mean pressures of -64.2 and -77.0 daPa in the left and right ears respectively before surgery compared to 5.43 and 0.29 daPa in the controls (**Table 1**). The case group experienced a mean increase in pressures in the immediate postoperative period (Δ left: 49.5, Δ right: 36.5); however, this change was not significant ($p>0.05$). Overall no significant difference was observed between groups for all middle ear pressure variables pre- and postoperatively.

We further explored the pressure change in patients with pain ipsilateral to the deviation or septal spur (n=4). Two patients had both a deviation and spur on the same side of pain. One patient had ipsilateral pain to a spur, but contralateral to deviation, and another had the deviation and pain contralateral to the spur. For ipsilateral pain and deviation, the mean change was -74.7 daPa on the pain side and -51.0 daPa for the side without pain. For cases that involved ipsilateral spur pain, the pressures changed on the affected and unaffected side -62.33 and -57.5 daPa respectively.

3.3 SNOT-22

Of the 25 patients enrolled in the study, 20 patients were able to complete the SNOT-22 questionnaire preoperatively with 6 lost to follow-up by the 6-week postoperative visit. Mean SNOT-22 scores (**Table 2**) were higher in the case group (62.7±7.0) compared to the control group (41.3±8.8), but this difference was not statistically significant. Following surgery, all subjects reported a significant decrease in sinonasal symptoms (-23.2±10.4, p=0.018), which was similar between both groups. Individual SNOT-22 items were analyzed separately on **Table 2** : cough (Q5), ear fullness (Q8), ear pain (Q10), hyposmia/hypogeusia (Q12), and embarrassment (Q22). Cough, ear fullness, and ear pain scores were significantly higher prior to surgery in the case group compared to the control ($p <0.05$). Patients in the case group reported significant relief of these symptoms following surgery (ΔQ5 -1.71±0.6; ΔQ8 -2.14±0.7; ΔQ10 -1.71±0.7; $p <0.05$). Questions 12 and 22 regarding hyposmia/hypogeusia and embarrassment showed relief of symptoms in both groups; however, the case group still reported greater change in symptoms following surgery (ΔQ12 -1.57±0.3; ΔQ22: -1.43±0.5; $p <0.05$).

*3.4 ETDQ-7*A total of 21 patients completed both preoperative and postoperative ETDQ-7 questionnaires (**Table 2)** . Preoperative scores were significantly higher in the case group (31.8±9.2) compared to the control group (12.2±1.5; $p<0.05$). Patients in the case group experienced a significant decrease (Δ-17.4±5.1; p=0.016) in aural symptoms following septoplasty with ITR. Results were sustained through the second postoperative period (Δ-20.6±6.2). The control group did not experience the same decrease in symptoms related to ETD in the postoperative follow-up (Δ5.0±3.0, p=0.125). Unlike their preoperative values, patients within the case group (16.0±3.4; 12.8±3.0) had ETDQ-7 values similar to the control group (18.0±4.3; 11.0±2.0; $p>0.05$) in postoperative periods.

Only the first five questions in the ETDQ-7 instrument were considered for individual analysis. Questions addressed ear pressure (Q1), ear pain (Q2), ear fullness (Q3), ear symptoms with cold/sinusitis (Q4), and crackling/popping sensation (Q5). Average symptom severity was 4.47 for cases and 1.49 for controls. For

every symptom including ear pain/fullness, the case group reported a significant decrease in symptom severity compared to the controls.

*3.5 NOSE*Total scores for the NOSE instrument are shown in **Table 2** . The questionnaire was completed by 21 patients preoperatively with 10 lost to follow-up. Preoperative NOSE scores did not differ between the case group (14.92±1.3) and controls (15.00±1.1). All groups reported a decrease in symptoms following surgery though changes in scores were not significant within any group (All Δ-6.0±2.8; Case Δ-9.0±3.4; Control Δ2.0±4.2). The postoperative changes were not significantly different between groups.

3.6 Overall SNOT-22 Scores

All patients reported an increase in quality of life (QOL) measures following surgery using the SNOT-22 questionnaire (-23.2, p=0.018).[20] Correlation using Pearson coefficients were calculated to analyze the relationship between the changes in SNOT-22 scores with both ETDQ-7 and NOSE. For all patients, improvement in SNOT-22 scores strongly correlated with ETDQ-7 changes (r=0.92, p=0.001). However, SNOT-22 scores correlated with ETDQ-7 in the case group (r=0.96, p=0.012), and not in the control group (r=0.43, p=0.72). ETDQ-7 also showed significant correlation to NOSE in all groups and cases (r=0.80, p=0.009; r=0.90, p=0.036), but not in the control group (r=0.37, p=0.63).

4 Discussion

Referred otalgia is often attributed to ETD, particularly in the presence of chronic nasal symptoms.[5] Association of aural symptoms in CRS and nasal obstruction has led to its inclusion in symptom assessment tools such as SNOT-22; however, the etiology of these symptom correlations remains poorly understood. A number of interventions have aimed at relieving chronic nasal obstruction refractory to medical management such as balloon dilation, but response to these interventions remains difficult to predict.[6,21] Septoplasty with ITR is a well-established procedure for relief of nasal obstruction; however, to our knowledge no previous study has prospectively examined the effect of septoplasty on the ear pair or aural fullness.

Patients in this study experienced significant relief of aural symptoms following septoplasty compared to controls. Preoperative ETDQ-7 scores were greater than 28, suggestive of ETD among the case group.[21] Mean ETDQ-7 scores were higher among the case group (31.8±9.2) compared to controls (12.2±1.5), and ETDQ-7 scores decreased 17.4 (p=0.016) in the case group without a significant decrease in middle ear pressures. Overall presence of aural symptoms was not predictive of negative pressures in the middle ear. These findings suggest that the secondary aural symptoms experienced in patients with nasal obstruction may be attributed to more than the inability to equalize middle ear pressures.

Secondary outcomes for the study included QOL assessments using SNOT-22 questionnaires. As SNOT-22 contains a nasal congestion, sleep questions, and two ear complaints, the results have shown that total scores were high. We do not believe that this was related to allergies but related to the deviated nasal septum and turbinate hypertrophy that did not respond originally to the nasal steroid sprays. Overall patients in this study reported significant improvement in QOL measures following septoplasty in nasal obstruction (-23.2, p=0.018). Our data corroborated previous studies[22,23,24], showing correlation between SNOT-22 and ETDQ-7 in QOL measures; however, when analyzing the groups separately, correlation was only seen in patients presenting with severe aural symptoms.[24] This suggests ETDQ-7 as a valid tool for patient recorded outcome measure for patients with referred otalgia who undergo septoplasty.

It appears that ETD can be induced by a deviated nasal septum, and furthermore this could affect the pressure in the middle ear. It is, therefore, suggested that patients with ETD be evaluated for nasal obstruction prior to entertaining eustachian balloon dilation. We believe that septoplasty with possible turbinate reduction should be considered prior to balloon dilation in these patients (**Figure 1**). Further studies that look specifically at the role of balloon dilation in patients with deviated nasal septum are also needed. Due to the small sample size, more studies are needed to investigate the role of septoplasty and balloon dilation in patients with ETD. Likewise, further understanding is needed for the etiology of aural symptoms in patients with chronic nasal obstruction before directing interventions towards improving eustachian tube function.

Our study had several limitations. Primarily the study was small, featuring a limited cohort of patients from within a single academic practice. Due to the prospective nature of this study, we experienced loss to follow-up particularly in the tympanometry readings. Third, patients with any previous intranasal or middle ear surgery were excluded despite whether their septum was corrected. Lastly the study was dependent on questionnaires administered during follow-up visits, which might alter the response of patients who would answer differently to someone not involved in their care.

5 Conclusion

ETD secondary to nasal septum deviation is a reasonable addition to any differential diagnosis for secondary otalgia and should be particularly considered in cases of chronic nasal obstruction. As the understanding of ETD evolves, patients should be counseled that symptoms could resolve following septoplasty either in conjunction with or prior to other interventions such as eustachian tube dilation.

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The authors have no conflicts of interest to declare. Data is available for review.

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TABLES

Table 1. Patient Demographics, Pressure Abnormalities, and Septum Presentation Abbreviations: Pre-op = pre-operation; Post-op = post-operation.

There is no significant difference between case and control for all variables in Table 1.

[a] Wilcoxon signed-rank test was used to test the change between Pre-op and Post-op visit 1 within group

Table 2. Analysis of SNOT-22, ETDQ-7, and NOSE scores

Abbreviations: SNOT-22 = Sino-Nasal Outcomes Test; ETDQ-7 = Eustachian Tube Dysfunction Questionnaire; NOSE = Nasal Obstruction Symptom Evaluation; Pre-op = pre-operation; Post-op = post-operation.

[a] $p<0.05$ for comparison between Pre-op and Post-op visit 1 within group with Wilcoxon signed-rank test.

[b] $p<0.05$ for comparison between case and control with Wilcoxon two-sample test.

Figure Legends

Figure 1. Management algorithm for suspected eustachian tube dysfunction.

Abbreviations: ETDQ-7 = Eustachian Tube Dysfunction Questionnaire; ETD = Eustachian Tube Dysfunction; SNOT-22 = Sino-Nasal Outcomes Test; NOSE = Nasal Obstruction Symptom Evaluation.

[a] Medical management includes: Nasal steroid spray, oral antihistamines, and Valsalva

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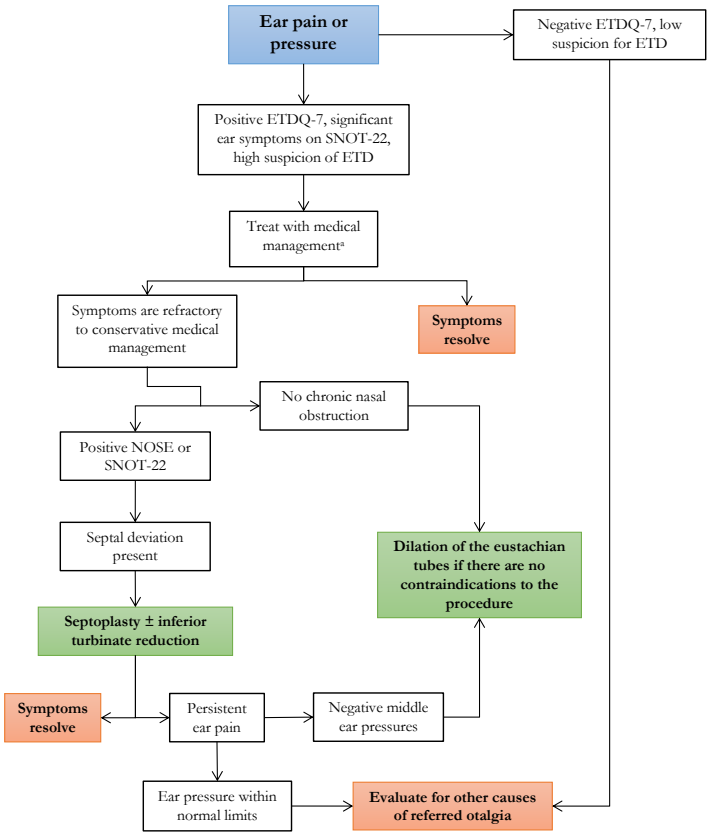
Figure 1. Management algorithm for suspected eustachian tube dysfunction



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