Research Article

Effect of Septal and Turbinate Surgery on Middle Ear Function

Montasr A. Hafez*, Mohammed M. El Badry, Ahmed A. Sadek*, and Alaa M. Desoky***

* Department of Otorhinolaryngology, Faculty of Medicine, Minia University.

** Department of Audiology, Faculty of Medicine, Minia University.

Abstract

Objective: Nasal obstruction is a frequent complaint seen by otolaryngologists and have a strong relation with middle ear dysfunction. The objective of this study to investigate the effect of septoplasty and inferior turbinate surgery on Eustachian tube function and middle ear ventilation. **Participants and Methods:** This was a prospective study carried out at the E.N.T outpatient clinic of Minia University Hospital on ٥٠ patients complaining of unilateral or bilateral nasal obstruction. All patients were subjected to full E.N.T examination. Tympanometry and Eustachian tube tests (Valsalva and Toynbee) were done pre- and post-operatively. **Results:** Twenty three patients underwent bilateral partial inferior turbinectomy, seven patients underwent sub mucous resection (SMR) and the remaining ٢٠ patients underwent both operations. Preoperatively, ٤٠ patients (٨٠.٠٪) had nasal obstruction. However, the obstruction decreased significantly (P≤ ٠.٠١) to ٢ cases (٤.٠٪) postoperative. On the other hand, ١٠ patients complained Tinnitus preoperatively, and, also, the number decreased significantly (P≤ ٠.٠١) to one case (٢.٠٪) postoperatively. Right ear preoperative tympanometry was: type A (٤١ cases, ٨٢.٠٪), type B (٢ cases, ٤.٠٪) and type C (٧ cases, ١٤.٠٪) and differed significantly (P <٠.٠٥) postoperatively to be type A (٤٧ cases, ٩٤.٠٪), type B (١ case, ٢.٠٪) and type C (٢ cases, ٤.٠٪). The results showed that preoperative Eustachian tube function for right ear were normal in ٢٩ patients (٥٨.٠٪). However, they were dysfunctioning in ٢١ cases (٤٢.٠٪). Postoperatively, the number of cases who were normal increased significantly (P<٠.٠١) to be ٤٧ cases (٩٤.٠٪) and ٣ cases (٦.٠٪) only were still dysfunctioning. For left ear tympanometry and Eustachian tube function, the same trend of improved results was found postoperatively. Postoperative mean ear pressure (Type C tympanogram) decreased (improved) significantly (P<٠.٠١) for both ears. **Conclusion:** Nasal obstruction had a strong relation with Eustachian tube dysfunction and can lead to middle ear hypoventilation. Nasal obstruction surgeries improved Eustachian tube function and middle ear pressure.

Keywords:

Nasal obstruction, Eustachian tube, Septoplasty, turbinate surgery, middle ear function

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Introduction

The Eustachian tube (ET) is a bony and fibrocartilagenous tube extending from the antero-inferior part of middle ear cleft to lateral wall of the nasopharynx and its main functions are ventilation of middle ear to equalize the middle ear pressure with atmospheric pressure and mucociliary clearance and also ET functioning has a direct impact on normal middle ear function[١]. Nasal, paranasal sinuses, and nasopharyngeal diseases can disrupt the functions of the ET[٢]. Also, ET function can be disrupted by masses in the nasopharynx, such as hypertrophic adenoid or neoplasia[٣]. Additionally, dysfunction of ET can cause effusion, infection, and chronic inflammation in the middle ear[٤].

Nasal obstruction is a common complaint seen by otolaryngologists and is defined as patient discomfort manifested as a sensation of insufficient airflow through the nose. The etiology of nasal obstruction is generally divided into mucosal and

anatomical causes[٥]. Deviation of the nasal septum is the most common anatomical cause of nasal obstruction[٦]. Severe nasal septal deviation leads to complete nasal obstruction and disturbs air passage from the nostrils[٧].

Inferior turbinate is a bony and soft tissue projection that protrude into the nasal passages, which serve to filter, humidify and warm the air we breathe and play a role in the ability to smell. Mucosal enlargement (hypertrophy) of the inferior turbinate is a common reason for nasal obstruction, followed by structural deformity of the nasal airway (septal deviation, bony inferior turbinate hypertrophy)[٨]. Treatment options for enlarged turbinates include medication, injection, freezing and/or partial removal with inferior turbinate reduction surgery.

Septoplasty is a surgical procedure that aims to straighten the deviated nasal septum to improve nasal airflow[٦]. The turbinate reduction surgery or inferior turbinate reduction surgery is a procedure performed to correct nasal obstruction where the inferior nasal turbinates are examined and reduced in size to provide improved nasal airflow[٩]. Its goal is to improve nasal breathing and reduce nasal drainage and post-nasal drip, which can improve the patient's quality of life by decreasing headache, snoring and sleep apnea[١٠]. Inferior turbinate reduction surgery can be combined with other nasal surgeries such as septoplasty - for deviated septum, and rhinoplasty for nasal reconstruction and/or cosmetic enhancements[١١].

The aim of this study was to investigate the effect of septoplasty and inferior turbinate surgery on ET function and middle ear ventilation.

Patients and Methods

This study was a prospective study carried out at the E.N.T outpatient clinic of Minia University Hospital during the period from August ٢٠١٥ to April ٢٠١٦. This study included ٥٠ patients (٢٥ males and ٢٥ females) complaining of unilateral or bilateral nasal obstruction. The study protocol was approved by the Clinical Research Ethics Committee and the Institutional Review Board of the Faculty of Medicine, Minia University.

Adult patients, age > ١٨ years old, patients without history of middle ear trouble and patients with normal otoscopic findings on both ear sides were included in this study. On the other hand, patients with tympanic membrane perforation, acute rhinitis and patients with recent history of middle ear infection were excluded.

Methods

All patients were subjected to the following:

١) Full history taking (name, age, sex….).

٢) Pre-operative routine laboratory investigation (CBC, RBS, ...).

٣) E.N.T. history in terms of: Nasal obstruction, Tinnitus and its duration, Sensation of ear fullness, ear pain and diminution of hearing and its duration.

٤) Full E.N.T. examination including:

- Nasal examination and inferior and middle turbinates were examined.
- Ear examination: Full otoscopic examination including tests for mobility of the drum using the pneumatic otoscopy and detection of tympanic membrane abnormalities.

٥) Preoperative evaluation tests:

A. Tympanometry: One day before the surgery, patients were examined by tympanometry A and C types of curves were obtained and the normal level of middle ear pressure was considered to be from + ٥٠ dapa to -٥٠ dapa as described[١٢]. Then, the value of middle ear pressure was recorded.

B. Eustachian tube function (ETF) tests:

١. Valsalva: Patients were instructed to pinch the nose and inflate the checks through forced expiration with the mouth closed until a sensation of fullness was achieved in the ears to evaluate the ability to inflate the middle ear actively and another instructions to complete the test. A tympanometric peak pressure shift (generally positive) between baseline and experimental tympanogram <١٠ daPa indicated poor ETF, whereas a tympanometric peak pressure shift >١٠ daPa indicated a good ETF[١٣].

٢. Toynbee: Toynbee maneuver was used to evaluate the capacity to equalize the middle ear pressure and the rhinopharyngeal pressure. Patients were asked to swallow while pinching the nose. Patients were, then, instructed to release the nose and refrain from further swallowing and mandibular movement, and an experimental tympanogram was obtained from each ear. Tympanometric peak shift (generally negative) between baseline and experimental tympanogram <١٠ daPa indicated poor ETF, whereas a tympanometric peak pressure shift of >١٠ daPa indicated a good ETF[١٢].
Middle ear analyzer (Zodiac ٤٠١, Madson-Zodiac ٤٠١, GN. Otometrics, Denmark) was used.

٦) Postoperative follow up of patients:
A. Medication: Patients were treated with systemic antibiotics for one weak, systemic anti-inflammatory for one weak and analgesic for three days and were instructed to avoid water entering nose, ear, sneezing, constipation and vigorous blowing of the nose.

B. Tympanometry: Tympanometry was performed to all patients at ٣٠ days after the removal of nasal packs.
C. Eustachian tube function (ETF) tests: ETF tests (Valsalva and Toynbee maneuvers) together also were performed at ٣٠ days after the removal of nasal packs.

Case #(١), Figure (١), presents a view of hypertrophied turbinate before the surgery. Figure (٢) shows the case during surgery (medicalization of turbinate) and Figure (٣) represents the case after partial inferior turbinectomy.

For case #(٢), Figure (٤) presents a view of hypertrophied turbinate before the surgery while Figure (٥) shows the case during surgery and Figure (٦) represents the case after partial inferior turbinectomy.

Statistical analysis of the data was performed by using SPSS version ٢٢ software package. Data was presented in the form of frequency and percentage. Paired sample *t*-test was used to test the significance between pre- and post-operative means of variables. Comparison in categorical data was performed by chi-square (χ^2) test. Probability level (P-value) was considered significant if less than ٠.٠٥.

Figure (١): Case #(١) hypertrophied turbinate before surgery

Figure (٢): Case #(١) during surgery (medicalization of turbinate)

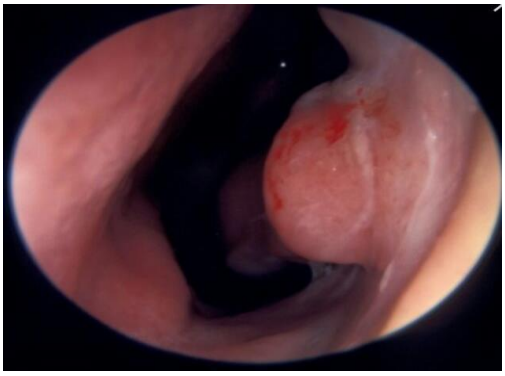

Figure (٣): Case# (١) after partial inferior turbinector

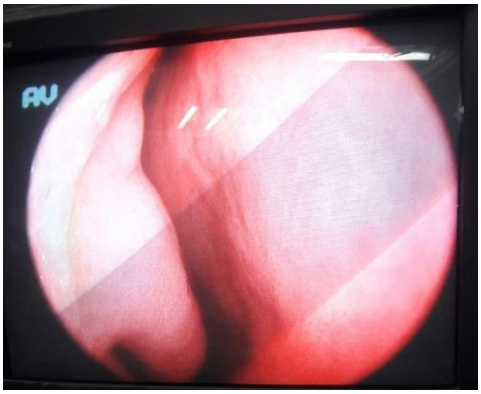

Figure (٤): Case #(٢) hypertrophied turbinate before surgery

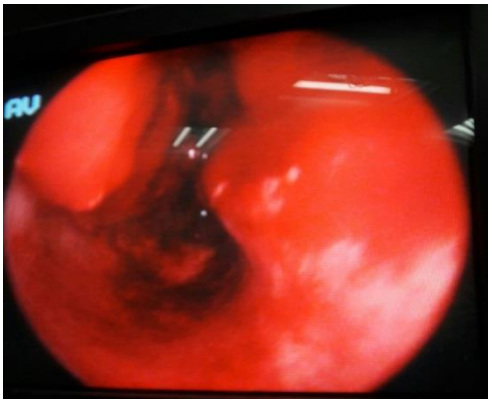

Figure (٥): Case #(٢) during surgery

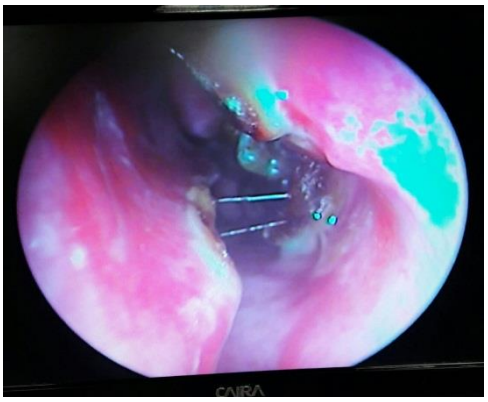

Figure (٦): Case# (٢) after partial inferior turbinectomy

Results

The mean age of all studied patients was ٣١.٣ years ranging from ١٨ to ٦٢. Males represented ٥٠٪ (٢٥ cases) and females represented ٥٠٪ (٢٥ cases) of the patients. Regarding preoperative complaints, ٤٠ patients (٨٠.٠٪) of the total patients had nasal obstruction and the rest (١٠ cases; ٢٠.٠٪) complained of tinnitus. Also, the results showed that all patients had normal pre-operative and post-operative pure-tone averages (PTA).

In this study, ٢٣ patients underwent bilateral partial inferior turbinectomy, seven patients underwent sub-mucous resection (SMR) and the remaining ٢٠ patients underwent both operations and all patients were operated under general anesthesia (Table, ١).

Table (٢) presented a comparison between pre- and post-operative complaints. Preoperatively, ٤٠ (٨٠.٠٪) of the patients were complaining of nasal obstruction.

However, this number decreased significantly (P≤ ٠.٠١) to two cases (٤.٠٪) postoperatively. Regarding tinnitus, ١٠ patients complained of tinnitus pre-operatively, and also this number decreased significantly (P≤ ٠.٠١) to one case (٢.٠٪) postoperatively.

Regarding pre-operative tympanometry for right ear (Table ٣), it was type A (٤١ cases, ٨٢.٠٪), type B (two cases, ٤.٠٪) and type C (seven cases, ١٤.٠٪) and differed significantly (P <٠.٠٥) postoperatively to be type A (٤٧ cases, ٩٤.٠٪), type B (one case, ٢.٠٪) and type C (two cases, ٤.٠٪). Regarding the results of the effect of surgery on ETF, the results showed that preoperative ETF for right ear were normal in ٢٩ patients (٥٨.٠٪). On the other hand, they were dysfunctioning in ٢١ cases (٤٢.٠٪), while postoperatively, the number of cases who were normal increased significantly (P<٠.٠١) to be ٤٧ cases (٩٤.٠٪) and were still dysfunctioning in only three cases (٦.٠٪).

For left ear pre- and post-operative tympanometry (Table, ٤), the same trend of results of the right ear was observed. Type A (٤٠ cases, ٨٠.٠٪), type B (three cases, ٦.٠٪) and type C (seven cases, ١٤.٠٪) were recorded and differed significantly (P<٠.٠٥) postoperatively to type A (٤٧ cases, ٩٤.٠٪), type B (one case, ٢.٠٪) and type C (two cases, ٤.٠٪). These data revealed that surgery improved significantly (P <٠.٠٥) postoperative tympanometry for both ears. Regarding the results of the effect of surgery on ETF of the left ear, similar results of the right ear were found. Preoperative ETF were normal in ٢٩ patients (٥٨.٠٪) while ٢١ cases (٤٢.٠٪) were dysfunctioning. On the other hand, postoperatively, normal cases increased significantly (P<٠.٠١) to ٤٨ cases (٩٦.٠٪) while only two cases (٤.٠٪) were still dysfunctioning. Taken together, it is obvious that the surgery improved significantly ETF postoperatively.

The data shown in Table ٥ illustrate that postoperative mean ear pressure (Type C tympanogram) decreased significantly (P<٠.٠١) for both ears. Right preoperative mean ear pressure was -٩٢.١ daPa and decreased significantly (P<٠.٠١) postoperative to -٣٢.٨ daPa. Also, for left ear, preoperative mean ear pressure was -٩٢.٨ daPa and decreased significantly (P<٠.٠١) postoperatively to -٢١.٤ daPa. These results indicated that surgery significantly improved middle ear pressure for both ears postoperatively.

Discussion

Generally, the most common cause of nasal obstruction is mucosal hypertrophy of the inferior turbinate, followed by structural deformity of the nasal airway (septal deviation, bony inferior turbinate hypertrophy)[٨].

The data presented herein revealed that ٨٠٪ of studied patients were complaining of nasal obstructions and the rest (٢٠٪) of studied cases were complaining of tinnitus. The number of cases who had complaints decreased significant postoperatively (two cases; ٤.٠٪; for nasal obstruction and one case; ٢.٠٪; for tinnitus). The present results revealed that surgeries affected significantly in treating complaints in patients with nasal obstruction and tinnitus. These results coincides with that of Ahmed[١٤], who studied the effect of nasal obstruction surgeries on ETF and middle ear ventilation. He found that all (٣٠) patients complained from nasal obstruction preoperatively and were four patients at ٣٠ days after the surgery and were two patients at ٦٠ days postoperatively. He concluded that the surgery done to relief nasal obstruction was successful and the relief of nasal obstruction was the cause of improvement of middle ear pressure postoperatively. Also, Gandomi et al.,[١٥], reported that septoplasty and inferior turbinate surgery have obvious improvement in patients with nasal obstruction.

The present data indicated that preoperative tympanometry for right ear was type A (٤١ cases, ٨٢.٠٪), type B (two cases, ٤.٠٪) and type C (seven cases, ١٤.٠٪) and differed significantly (P <٠.٠٥) postoperatively to be type A (٤٧ cases, ٩٤.٠٪), type B (one case, ٢.٠٪) and type C (two cases, ٤.٠٪). Also, the same trend of results was observed in the left ear. These results

revealed that surgery significantly improved (P <٠.٠٥) postoperative tympanometry for both ears. These data are in line with those of Ahmed[١٤], who studied the effect of nasal obstruction surgeries on ETF and middle ear ventilation. He found that the type of tympanometry became less negative (changed from C to A) with relief of nasal obstruction due to the effect of surgery, i.e. the type of tympanometry became less negative than the preoperative values. Also, similar results were found by Gandomi et al.,[١٥].

Table (١): Type of surgeries underwent.

Type of surgery	Description N (%)
Sub mucous resection (SMR)	٢٣ (٤٦.٠٪)
Bilateral partial inferior turbinectomy	٧ (١٤.٠٪)
Both operations	٢٠ (٤٠.٠٪)

Table (٢): Pre- and post-operative complaints.

Complain	Pre-operative (N=٥٠)	Post-operative (N=٥٠)	P. value (Sig.)
N. obstruction	٤٠ (٨٠.٠٪)	٢ (٤.٠٪)	<٠.٠٠١**
Tinnitus	١٠ (٢٠.٠٪)	١ (٢.٠٪)	

**Significant difference at p. value (P≤ ٠.٠١).

Table (٣): Right ear pre- and post-operative tympanometry.

Parameter		Preoperative (N=٥٠)	Postoperative (N=٥٠)	P. value (Sig.)
Type	**A**	٤١ (٨٢.٠٪)	٤٧ (٩٤.٠٪)	٠.٠٤٩*
	B	٢ (٤.٠٪)	١ (٢.٠٪)	
	C	٧ (١٤.٠٪)	٢ (٤.٠٪)	
ET function	**Normal**	٢٩ (٥٨.٠٪)	٤٧ (٩٤.٠٪)	<٠.٠٠١**
	Dysfunctioning	٢١ (٤٢.٠٪)	٣ (٦.٠٪)	

*Significant (p<٠.٠٥).

Table (٤): Left ear pre- and post-operative tympanometry.

Parameter		Preoperative (N=٥٠)	Postoperative (N=٥٠)	P. v. (Sig.)
Type	**A**	٤٠ (٨٠.٠٪)	٤٨ (٩٦.٠٪)	٠.٠٣٩*
	B	٣ (٦.٠٪)	٠	
	C	٧ (١٤.٠٪)	٢ (٤.٠٪)	
ET function	**Normal**	٢٩ (٥٨.٠٪)	٤٨ (٩٦.٠٪)	<٠.٠٠١**
	Dysfunctioning	٢١ (٤٢.٠٪)	٢ (٤.٠٪)	

Table (٥): Pre and post-operative mean ear pressure of both ears (Type C tympanogram).

Ear	Pre-operative (M ± SD)	Post-operative (M ± SD)	Mean diff.	P. v. (Sig.)
Right ear	-٩٢.١ ± ٢٩.٣	-٣٢.٨ ± ٢٦.٧	٥٩.٣	<٠.٠٠١**
Left ear	-٩٢.٨ ± ١٩.٠٩	-٢١.٤ ± ١٣.٢	٧١.٤	<٠.٠٠١**
Total	-٩٢.٥ ± ٢٣.٩	-٢٧.١ ± ١٨.٦	٦٥.٤	<٠.٠٠١**

The data presented herein showed that postoperative ETF for both ears improved significantly. These results agreed with that of Osama et al.,[١٦], who reported that the number of patients and ears with poor ETF post-operatively decreased with relief of nasal obstruction after surgery. Also, similar results were obtained by Salvinelli et al.,[٢], who demonstrated that the number of patients with a "good" ETF tests was significantly (P<٠.٠٠١) higher post-operatively in comparison with the preoperative conditions, in particular, before nasal surgery. On the other hand, in another study conducted by Şahin et al.,[٤], the authors found that septoplasty does not cause any changes in ETF. Also, Davari and Behnoud[٧], did not find a significant difference in ETF before and after septoplasty.

The presented results indicated that surgery, postoperatively, improved significantly middle ear pressure for both ears. These data are in agreement with the results of Osama et al.,[١٦], who studied the role of nasal surgeries in changing ETF and middle ear ventilation. They found that the middle ear pressure became less negative with relief of nasal obstruction due to the effect of surgery. Also, Salvinelli et al.,[٢], investigated the effect of nasal obstruction surgery on ETF and middle ear ventilation. They found that postoperative middle ear ventilation was significantly (P<٠.٠١) better than preoperatively. Similarly, Low and Williat[١٧], discussed the relationship between middle ear pressure and nasal obstruction surgeries in ٥٥ patients. They found that in the ear on the side of nasal blockage, the middle ear pressure was abnormal preoperatively and following surgery with relief of nasal obstruction, the middle ear pressure increased significantly to approach the normal values. Additionally, similar results were obtained by Şereflican et al.,[١٨]. Also, Duran et al.,[١٩], reported an approximately ٣٠٪ improvement in the middle ear pressure after septoplasty.

Earlier, it was reported that negative ear pressure must exceed - ١٧٠ daPa to be considered truly abnormal[٢٠]. However, Jerger[١٢], and Buchman et al.,[٢١], recommended that -١٠٠ daPa be used as the border line between normal and abnormal pressure in the middle ear.

Some studies indicated that the ear drum examination changed from retracted to normal with relief of nasal obstruction due to the effect of surgery, and this indicated improvement in middle ear pressure postoperatively[١٤]. Also, nasal obstruction causes marked increase in total nasal resistance that causes more pronounced changes in the nasopharyngeal pressure[٢٢].

On the other hand, the results of Eyigör et al.,[٢٣], revealed that septoplasty operation does not significantly affect the ventilation and pressure of the middle ear. Also, in a study conducted by Şahin et al.,[٤], the authors found that septoplasty does not cause any change in middle ear pressure. In addition, Davari and Behnoud[٧], did not find a significant difference in the mean ear pressure before and after septoplasty. Furthermore, Salvinelli et al.,[٢], and Eyigör et al.,[٢٣], reported that the effect of septoplasty on ETF and middle ear pressure is controversial.

Conclusion

Our results revealed that nasal obstruction is a frequent cause and have a strong relation with ET dysfunction which can

lead to middle ear hypoventilation and suffering. Nasal obstruction surgeries significantly improved ETF and middle ear pressure. The complete evaluation of nasal air flow is mandatory before middle ear surgery in order to asses the hypoventilation of the middle ear.

References

١. Chauhan Bhushan, Komal Chauhan.: A Comparative Study of Eustachian Tube Functions in Normal and Diseased Ears with Tympanometry and Videonasopharyngoscopy. Indian J Otolaryngol Head Neck Surg (٢٠١٣), ٦٥(Suppl ٣): S٤٦٨–S٤٧٦.

٢. Salvinelli F, Casale M, Greco F, et al. Nasal surgery and Eustachian tube function: effects on middle ear ventilation. Clin Otolaryngol ٢٠٠٥; ٣٠:٤٠٩–٤١٣.

٣. Redaelli de Zinis LO, Parrinello G, Schreiber A, Nicolai P.: Middle ear effusion in patients with sinonasal cancer treated by surgery with or without radiotherapy. Otolaryngol Head Neck Surg; (٢٠١٣), ١٤٨(٤): ٦١٩-٢٤.

٤. Şahin Mehmet İlhan, Şafak Güleç, Ümit Perişan, İsmail Külahl.: Does Septoplasty Affect Middle Ear Pressure and Eustachian Tube Function? Erciyes Med J (٢٠١٤), ٣٦(٣): ١١٥-٨.

٥. Erickson Bree , Robert Hurowitz, Caroline Jeffery, Khalid Ansari, Hamdy El Hakim, Erin D. Wright, Hadi Seikaly, Sam R. Greig and David W. J. Côté.: Acoustic rhinometry and video endoscopic scoring to evaluate postoperative outcomes in endonasal spreader graft surgery with septoplasty and turbinoplasty for nasal valve collapse. Journal of Otolaryngology - Head & Neck Surgery (٢٠١٦) ٤٥:٢.

٦. van Egmond MM, Rovers MM, Hendriks CT, van Heerbeek N.: Effectiveness of septoplasty versus non-surgical management for nasal obstruction due to a deviated nasal septum in adults: study protocol for a randomized controlled trial. Trials. (٢٠١٥), Nov ٤;١٦:٥٠٠.

٧. Davari R, Behnoud F.: Study the Effect of Nasal Obstruction Surgery (Septoplasty) on Eustachian Tube Function and Middle Ear Pressure. Journal of Ardabil University of Medical Sciences (٢٠١٤), Vol.١٤, No.٤, Winter, Pages ٣٢٢-٣٣٠.

٨. Gindros G, Kantas I, Balatsouras DG, Kaidoglou A, Kandiloros D.: Comparison of ultrasound turbinate reduction, radiofrequency tissue ablation and submucosal cauterization in inferior turbinate hypertrophy. Eur Arch Otorhinolaryngol. (٢٠١٠) Nov. ٢٦٧(١١):١٧٢٧-٣٣.

٩. Goyal Parul. Septoplasty & Turbinate Surgery. http://care.american-rhinologic.org/septoplasty_turbinates (٢٠١٥)

١٠. ENT institute: Surgery Descriptions, Nasal and Sinus. http://www.entinstitute.com/surgery-descriptions/ (٢٠١٥).

١١. Washington university sinus institute: Inferior Turbinate Reduction. http://sinus.wustl.edu/details.aspx?ID=٢٩٩ (٢٠١٥).

١٢. Jerger, J.: clinical experience with impedance audiometry Arch. Otolaryngol., (١٩٧٠), ٩٢:٣١١-٣٢٤.

١٣. Jonathan DA. (١٩٨٩): Sonotubometry: its role in childhood glue ear. Clin Otolaryngol; ١٤:١٥١–١٥٥.

١٤. Ahmad A. M. Effect of nasal obstruction surgery on Eustachian tube function and middle ear ventilation. MS. C Thesis, (٢٠١٢), Ear, Nose and Throat Dept. Minia university.

١٥. Gandomi Behroz, Akbar Bayat, Tayebe Kazemei.: Outcomes of septoplasty in young adults: the Nasal Obstruction Septoplasty Effectiveness study. (٢٠٠٩)

١٦. Osama G. Abdel-Naby Awada, Yehia M. Salamaa, Mohammed El-Badry.: Effect of nasal obstruction surgery on middle ear ventilation. Egypt J Otolaryngol (٢٠١٥): ٣٠:١٩١–١٩٥.

١٧. Low, W.K. and Williatt, D.J.: The relation between middle ear pressure and deviated nasal septum. Clin .Otolryngol; (١٩٩٣), ١٨:٣٠٨-٣١٠.

١٨. Şereflican M١, Yurttaş V, Oral M, Yılmaz B, Dağlı M.: Is Middle Ear Pressure Effected by Nasal Packings

after Septoplasty?. J Int Adv Otol. (٢٠١٥), Apr;١١(١):٦٣-٥.
١٩. Duran K١, Fatih Y, Doğan M.: Middle ear pressure after septoplasty. J Craniofac Surg.(٢٠١٤), Jan; ٢٥(١):e١٩-٢١.
٢٠. Brooks, D.N.: The use of electro acoustic impedance bridge in the assessment of middle ear function. Acta Otolaryngol., (١٩٦٩), ٩٢: ٤٨٨.
٢١. Buchman, C.A., Doyle, W.J., Swarts, J.P., and Bluestone, C.D.: Effects of nasal obstruction on Eustachian tube function and middle ear pressure. Acta. Otolaryngol. (Stockh.) (١٩٩٩)١١٩:٣٥١-٤٥٥.
٢٢. Buchman, C.A., Doyle, W.J., Swarts, J.P., and Bluestone, C.D.: Effects of nasal obstruction on Eustachian tube function and middle ear pressure. Acta. Otolaryngol. (Stockh.) (١٩٩٩) ١١٩: ٣٥١-٤٥٥.
٢٣. Eyigör H, Osma Ü, Yılmaz MD, Aygener N, Buyruk A.: Nazal septum deviyasyonlu hastalarda ameliyat başarısının orta kulak ventilasyonu üzerine etkisi. Kulak Burun Bogaz Ihtis Derg; (٢٠١٣), ٢٣(١): ٢٦-٣١.