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The Effect of Adenoid Hypertrophy on Middle Ear Resonance Frequency

Adenoid Hipertrofisinin Orta Kulak Rezonans Frekansına Etkisi

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This study was presented as a oral presentation at "9. Solunum Zirvesi", 13-15 June 2019, Isparta, Turkey.

ABSTRACT Objective: The aim of this study is to evaluate whether or not adenoid hypertrophy had a change in middle ear resonance frequency (RF) values. **Material and Methods:** The study included children with adenoid hypertropy who were scheduled for operation and healthy childen with similar age and gender. The tympanometry and multifrequency tympanometry results of the children who had and had no adenoid hypertrophy were examined. **Results:** The study included 28 children, while no significant difference was found between the study and the control group in terms of age and gender. No significant difference was found between right and left ear RF values of the participants. Mean RF value of right ear was determined as 679.29in the study group and 964.29 in the control group. The mean RF value of the left ear was 610.71 in the study group and 989.29 in the control group. Mean RFvalue of study group was 645 and 976.79 in control group. Accordingly, there was a statistically significant difference between the study and control groups in terms of RF values ($p<0.01$). **Conclusion:** In our study, a significant decrease in middle ear RF values in children with adenoid hypertrophy suggests that adenoid hypertrophy is a condition that should be considered as a factor decreasing the RF values such as otitis media with effusion.

Keywords: Ear, middle; acoustic impedance tests; adenoids

ÖZET Amaç: Bu çalışmanın amacı adenoid hipertrofisinin orta kulak rezonans frekansı değerlerinde bir değişiklik yaratıp yaratmadığını değerlendirmektir. **Gereç ve Yöntemler:** Çalışmaya, adenoid hipertrofisi için ameliyat planlanan ve benzer yaş ve cinsiyette sağlıklı çocuklar dahil edildi. Adenoid hipertrofisi olan ve olmayan çocukların timpanometri ve multifrekans timpanometri sonuçları incelendi. **Bulgular:** Çalışmaya 28 çocuk dahil edildi. Çalışma grubu ile kontrol grubu arasında yaş ve cinsiyet açısından anlamlı bir fark yoktu. Katılımcıların sağ ve sol kulak RF değerleri karşılaştırıldığında anlamlı fark bulunmadı. Sağ kulak ortalama RF değeri çalışma grubunda 679.29, kontrol grubunda 964.29 olarak tespit edildi. Sol kulak ortalama RF değeri çalışma grubunda 610.71, kontrol grubunda 989.29 idi. Çalışma grubunun ortalama RF değeri 645, kontrol grubunun ise 976.79 idi. Buna göre çalışma grubu ile kontrol grubu arasında RF değerleri açısından istatistiksel olarak anlamlı bir fark vardı ($p<0.01$). **Sonuç:** Çalışmamızda, adenoid hipertrofisi olan çocuklarda orta kulak RF değerlerindeki anlamlı düzeydeki azalma, adenoid hipertrofisinin de efüzyonlu otitis media gibi RF değerlerini azaltan bir faktör olarak değerlendirilmesi gereken bir durum olduğunu göstermektedir.

Anahtar Kelimeler: Kulak, orta; akustik direnç testleri; adenoidler

Tympanometry is known as a sensitive, cost-effective, non-invasive and simple method used in the differential diagnosis of middle ear disorders. In conventional tympanometry, 226 Hz probe tone is used. Multifrequency tympanometry (MFT) is a method of acoustic immitance measurement using probe tones in frequencies from 250 to 2000 Hz. MFT is fast, comprehensible, objective and more sensitive than classical tympanometry. The resonance frequency (RF) is one of the important parameter of MFT. RF is the frequency in which mass and stiffness elements of the middle ear system are in balance.[1-3]

Structural properties of the ear vary according to environmental and genetic factors. These differences affect the immitance of the middle ear and lead to variations in the normal RF values. However it is well known that pathologies such as otosclerosis and otitis media with effusion (OME) changes mechanoa-

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coustical properties of the middle ear and therefore the RF value. It has been proven that RF values declined in patients with OME.[1-4]

The most common pathology causing upper airway obstruction in childhood is adenoid hypertropy. Even if the adenoid hypertrophy does not obstruct the nasopharynx, it can cause eustachian dysfunction by disrupting eustachian lymphatic drainage and increasing pathogen colonization.

Adenoid hypertrophy is known to play a role in the development of OME, but the presence of adenoid hypertrophy alone may also alter the mechanoacoustical properties of the middle ear.

The aim of this study is to determine the possible effects of adenoid hypertrophy on tuba eustachii dysfunction and/or lymphatic drainage and middle ear system by MFT.

MATERIAL AND METHODS

This study was approved by ethics committee of University's Institutional Review Board (Project no: KA16/196) and was supported by the university research fund. In the biostatistical power analysis, the number of samples should be at least 14 for the study group and control group in order to be able to have the power of the study at 0.95 and above.

The results of tympanometry and multi-frequency tympanometry of children with adenoid hypertrophy, and age and gender matched controls without adenoid hypertrophy were compared. All of the participants and their parents or caregivers provided written informed consent. An otorhinolaryngological examination and flexible endoscopic nasopharyngoscopic examination were performed for all participants by an Ear Nose Throat (ENT) specialist.

Subjects with external ear canal and tympanic membrane pathology detected in otoscopic examination,acute upper respiratory tract infection, and known systemic or autoimmune, disease were excluded from the study.

The presence of type A tympanogram and middle ear pressure within ±50 daPa with classical tympanometry was concluded as precondition for all participation in the study. The study group consisted of individuals with obstructive (at least %75) adenoid hypertrophy in the endoscopic examination and the control group consisted of individuals without obstructive adenoid hypertrophy confirmed with flexible endoscopic nasopharyngoscopic examination(less than %50).

The immitansmetric measurements of all the participants were performed using Grason Stadler (GSI) Tympstar Version 2 electroacoustic immitansmeter. First, standard tympanometry parameters were investigated and reflected in tympanograms. The pressure was maintained at a constant level and the middle ear resonance frequencies were determined by giving stimuli at 50 Hz intervals in the frequency range of 250-2000 Hz separately to both ears of the participants.

STATISTICAL ANALYSIS

SPPS 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0, Armonk, NY: IBM Corp.) statistical package program was used for the evaluation of the data. Descriptive statistics are given for categorical and continuous variables. The homogenity of variances was checked with the Levene test. The assumption of normality was tested with "Shapiro-Wilk" test. To compare the differences between the two groups, the Student's t-test was used when the parametric test prerequisites were fulfilled, and the Mann Whitney-U-test was used when such prerequisites were not fulfilled.If the differences between two dependent groups satisfied the preconditions of parametric tests, they were evaluated by the matched-pair t-test; otherwise, they were evaluated using the Wilcoxon test. A p value of <0.01 was considered statistically significant.

RESULTS

Twenty-eight individuals, 14 boys and 14 girls, were included in the study. While there were an equal number of individuals in the study group and in the control group, the mean age of the participants was x 8.36±2.405 in the control group and 7.14±2.107 in the study group (14). There was no significant difference between the study and control groups in terms of gender and age.

TABLE 1: Mean, right and left RF values of study and control group.

Group	Study group $\bar{x}$±S.S median (min-max)	Control group $\bar{x}$±S.S median (min-max)	p
Right ear RF	679.29±198.086 700 (260-1050)	964.29±147.32 960 (650-1200)	0.001**
Left ear RF	610.71±185.39 637 (305-1050)	989.29±228.017 925(750-1400)	0.001**
p	0.170	0.605	
Mean RF	645±185.38 637.5 (305-1050)	976.79±170.54 912.5 (700-1250)	0.001**

**P<0.01, RF: resonance frequency.

No significant difference was found between right and left ear RF values of the participants. Mean RF value of right ear was determined as 679.29 in the study group and 964.29 in the control group. The mean RF value of the left ear was 610.71 in the study group and 989.29 in the control group. Mean RF value of the study group was 645, and 976.79 in control group. Accordingly, there was a statistically significant difference between the control and study groups in terms of mean, right ear and left ear RF values ($p<0.01$).

RF values of the groups are summarized in Table 1 and shown in Figure 1.

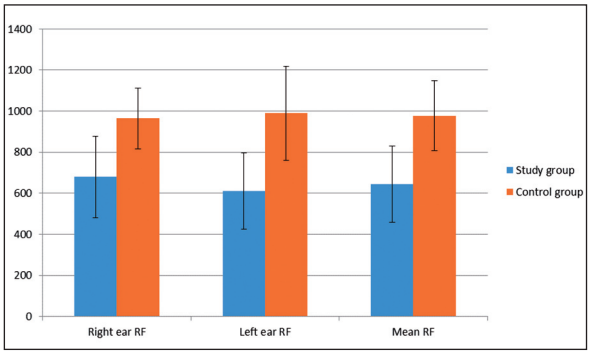

FIGURE 1: Distribution of RF values of groups.

DISCUSSION

Acoustic immittance is a term that expresses the acoustic impedance (Z_a, in acoustic ohms) and acoustic admittance (Y_a, in acoustic mmhos) and their components.Acoustic admittance can be defined as the ability of the middle ear system to transmit acoustic energy to the inner ear. Acoustic impedance is reciprocal of admittance and describes the total opposition of the middle ear system to the acoustic energy. Acoustic immitancemetry instruments in clinical use typically measure admittance. Admittance has two components; susceptance (B_a) and conductance (G_a). Acoustic susceptance includes mass and stiffness components whereas conductance includes only friction component. Both mass susceptance (B_m) and stiffness susceptance (B_s) are frequency dependent. Near RF, total susceptance (sum of mass and stiffness) is equal to zero and system is under the control of conductance. In other words, RF is the frequency at which the maximum energy is transmitted to the cochlea by the middle ear. The high RF value indicates that the system is under the influence of stiffness, while low RF values indicate that the system is under the influence of mass. In a healty adult, RF is located approximately between 900 and 1000 Hz.Otosclerosis is an example of diseases that increase middle ear stiffness and RF, while effusion otitis media (OME) is an example of diseases in which the middle ear acoustic system is under mass control and characterized by low RF values.[1,5-9]

RF values can vary depending on many factors. Etnical differences, alterations in body weight affect RF values but effect of age and gender differences on RF is not clear. In some studies, age and gender-related changes were reported, while in other studies it was reported that age and gender did not change RF-values.[10,11]

In recent studies RF value of middle ear for healty children was reported between 650 to 1400 Hz.[1,2]

Ferekidis et al. showed that mean RF value of the ears with acute otitis media on the day of the diagnosis was 380 Hz which increased 680 Hz on 10th day and 749 Hz after 1 month period.[1] Öztürk et al. found that mean value of RF was 570 Hz in patients with OME whereas 1043 Hz in healty controls. The authors considered 650 Hz as a cut-off value in terms of the RF for the diagnosis of OME. However in this study all patients underwent adenoidectomy with ventilation tube insertion. Therefore it is not possible to determine the effect of adenoid vegetation on RF values in addition to OMA.[3] However in adult patients with OME decrease of RF values have also been demonstrated so that there is no doubt that OME causes a decrease in RF value.[6] Furthermore, it is possible to say that the deterioration in RF values of patients with otitis media persists even when conventional tympanograms return to normal in the light of the findings obtained in these studies. However effect of adenoid vegetation on RF values is not demonstrated yet.

Adenoids are lymphoid tissue located in the nasopharynx. Adenoid hypertropy can cause mouth breathing, nasal discharge, snoring, sleep apnea and hyponasal speech. It is also associated with pathogenesis of rhinosinusitis, recurrent otitis media, and OME. Adenoidectomy is one of the most performed surgical procedure for children. It is well known that children with adenoid hypertropy are more likely to have OME and beneficial effects of adenoidectomy on OME is also demonstrated.[10,11]

The role of adenoid vegetation in OME is complex. Mechanical obstruction of the Eustachian tube with large adenoids is thought to be associated with OME, although small adenoids may also lead to OME by serving as reserve of pathogens causing tube edema and dysfunction.[12]

Decrease of RF values in adenoidectomy group in this study can be interpreted as that adenoid hypertropy may change mechanoacoustical properties of the middle ear due to the obstruction of Eustachian tube or effecting opening of the tubes. These findings are also useful for describing the relationship between OME and adenoid vegetation. However for detecting the effect of adenoidectomy on RF values of patients without OME confirmed with conventional tympanometry, prospective studies evaluating RF values before surgery and early and late postoperative period is essential.

CONCLUSION

In the light of this study, it can be speculated that the patients with adenoid hypertrophy with normal otoscopy and Tip A tympanograms in conventional tympanograpy may also have some alterations in middle ear acoustic properties due to the Eustachian tube disfunction caused by adenoids. However, in order to confirm these findings, prospective studies evaluating RF values after adenoidectomy are needed.

Informed consent

Informed consent was obtained from parents and caregivers of individuals included in this study.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Design:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Control/Supervision:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Data Collection and/or Processing:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Analysis and/or Interpretation:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Literature Review:*** *O. Murat Menteş, M. Volkan Akdoğan;* ***Writing the Article:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Critical Review:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***References and Fundings:*** *O. Murat Menteş, M. Volkan Akdoğan, A. Fuat Büyüklü;* ***Materials:*** *O. Murat Menteş, A. Fuat Büyüklü.*

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