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Correlation Between Tympanometry Pattern of Infants with Complaints of Ear Pulling: A Case-Control Study

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Abstract

Background: One of the most common concerns expressed by parents is the act of their infants pulling on their ears, which they often associate with otitis media.

Objectives: The present study aimed to assess the patterns of tympanometry in infants presenting with complaints of ear pulling and to evaluate potential associations with demographic and clinical factors.

Methods: A case-control study was conducted involving 88 infants under 12 months old (48 males, 40 females). The case group included infants with ear-pulling complaints (n = 44), and the control group comprised infants without ear-pulling (n = 44). Tympanometry was performed on all participants.

Results: Out of the 88 participants included in the study, 48 were male and 40 were female. The tympanogram patterns for the right ear were as follows: Fifty-three individuals (60.2%) had an A-type pattern, 20 individuals (22.7%) had a B-type pattern, and 15 individuals (17%) had a C-type pattern. For the left ear, the tympanogram patterns were as follows: Forty-six individuals (52.3%) had an A-type pattern, 26 individuals (29.5%) had a B-type pattern, and 16 individuals (18.2%) had a C-type pattern. Statistical analysis was conducted using SPSS software version 22. Tests included the Mann-Whitney test, Shapiro-Wilk test, descriptive statistics, chi-square test, and independent *t*-tests.

Conclusions: Based on the findings of this study, no significant association was observed between a history of recent respiratory tract infection, gender, age, and the tympanogram patterns in the two groups.

Keywords: Tympanogram, Ear Pulling, Infant

1. Background

Otitis media is a commonly observed middle ear infection that frequently leads to referrals to medical facilities (1). The Eustachian tube plays a significant role in the pathogenesis of otitis media, as it facilitates the accumulation of fluid in the middle ear, creating an environment conducive to bacterial or viral infections (2). Symptoms prompting medical consultation include earache, hearing loss (1), fever, ear rubbing, cough, anorexia, restlessness, vomiting, and more (3). Ear rubbing has been observed in 7% of Danish children under seven years of age with middle ear infections (4), with studies reporting a sensitivity of 42% and specificity of 87% for this symptom in diagnosing middle ear infection (2). In the context of diagnostic tools, tympanometry has emerged as a reliable method for detecting middle ear effusion, a hallmark of OM. Studies have demonstrated its accuracy, with an estimated overall accuracy of 83.76%, sensitivity of 85.85%, and specificity of 72.22% (5). However, ear rubbing is not exclusive to OM and can also be associated with other conditions such as teething, eczema, or foreign body

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insertion, necessitating careful differential diagnosis (6).

In Iran, research has further validated the utility of tympanometry in pediatric populations. For example, a study conducted in Tehran reported the effect of different modes of age groups, gender, and ear side on resonance frequency, absorbance, and ear canal volume. Therefore, it can be concluded that using separate norms for males and females in different modes may increase the sensitivity and specificity of the test and have diagnostic value (7). Another Iranian study emphasized the role of tympanometry in differentiating OM from other causes of hearing loss in children, underscoring its importance in regions with limited access to advanced diagnostic tools (8).

Despite the availability of diagnostic methods like tympanometry, the differential diagnosis of ear rubbing remains challenging. Ear rubbing can be a symptom of various conditions. Ear rubbing in children, including Iranian children, can be a common behavior and may be due to various reasons. Here are some potential causes: Tiredness or sleepiness, ear infection, teething, earwax buildup, allergies, foreign object, skin conditions, and habit (9).

This highlights the need for a comprehensive diagnostic approach that combines clinical evaluation with diagnostic tools like tympanometry. Complications of untreated or poorly managed OM can be severe, including mastoiditis, seventh cranial nerve palsy, abscess formation, empyema, fistula, and hearing loss. Hearing loss, in particular, can have long-term consequences on speech development and learning in children, making early and accurate diagnosis critical (10).

Given the frequent presentation of ear-pulling as a sole complaint, alongside the prevalence of conditions like respiratory infections, allergies, and gastroesophageal reflux disease that may influence middle ear function, further investigation into this behavior is warranted.

2. Objectives

The present study aimed to evaluate tympanometry patterns in infants with ear-pulling complaints in southern Iran, where acute otitis media is highly prevalent and contributes significantly to pediatric morbidity. By examining the diagnostic value of ear-pulling as a clinical symptom and tympanometry as a diagnostic tool, the study seeks to improve the accuracy and management of acute otitis media in young children.

3. Methods

3.1. Participants

This case-control study included 44 infants with ear-pulling complaints (case group) and 44 infants without ear-pulling complaints (control group) who were referred to the hospital between 2020 and 2021. The sample size was calculated based on previous studies reporting the prevalence of ear rubbing in children with otitis media. Participants were selected using a convenience sampling method from infants presenting to the pediatric outpatient and emergency departments. Infants were included if they were under 12 months of age.

Inclusion criteria for the case group: Ear rubbing behavior without visible signs of acute distress or evident ear infection (defined as repeated touching, pulling, or rubbing of the ear by the infant, most commonly a normal behavior in the age range of 4 - 12 months).

Exclusion criteria for the case group: Prior history of tympanic membrane rupture, hardened masses in the ear canal, evidence of otitis media, or other conditions that could explain ear rubbing (e.g., eczema, teething, or foreign body insertion).

Inclusion criteria for the control group: Infants without any history or observation of ear rubbing, matched for age and sex to the case group.

3.2. Study Design

A convenience sampling method was used to select participants. Tympanometry was performed on all participants, and data were collected using a questionnaire covering demographic and clinical variables, including age, gender, recent upper respiratory tract infections (URTIs), allergic rhinitis, type of nutrition, and ear-pulling.

3.3. Data Collection and Statistical Analysis

Statistical analyses were conducted using SPSS version 22, with chi-square tests used to compare categorical variables (tympanogram types: A/B/C) between groups. The normality of data was assessed via the Shapiro-Wilk test, and Mann-Whitney U tests were used for non-parametric comparisons. Measures of

association were reported as odds ratios (ORs) with 95% confidence intervals (CIs). A P-value < 0.05 was considered statistically significant.

3.4. Ethical Considerations

The study adhered to the Declaration of Helsinki and received ethical approval from the Ethics Committee of Hormozgan University of Medical Sciences (IR.HUMS.REC.1397.083).

4. Results

The study analyzed tympanogram patterns in 88 infants (48 males, 54.5%; 40 females, 45.5%) presenting with or without ear-pulling complaints at Bandar Abbas Children's Hospital.

4.1. Tympanogram Distribution

4.1.1. Right ear

- Type A: Fifty-three infants (60.2%)
- Type B: Twenty infants (22.7%)
- Type C: Fifteen infants (17%)

4.1.2. Left ear

- Type A: Forty-six infants (52.3%)
- Type B: Twenty-six infants (29.5%)
- Type C: Sixteen infants (18.2%) (Table 1)

4.2. Demographics and Variables

4.2.1. Gender

No significant association was found between tympanogram patterns and gender (right ear: P = 0.316 for males, P = 0.154 for females; left ear: P = 0.685 for males, P = 0.264 for females) (Table 2).

4.2.2. Age

No significant association was observed across age groups (subdivided into < 5 months, 5 - 10 months, > 10 months) for both ears (right ear: P = 0.679, P = 0.126, P = 0.179; left ear: P = 0.173, P = 0.696, P = 0.819).

4.2.3. Feeding Type

No significant association was found between feeding type (breastfeeding, formula, mixed) and tympanogram patterns (right ear: P = 0.148, P = 0.462, P = 0.751; left ear: P = 0.456, P = 0.219, P = 0.571).

4.2.4. Recent Respiratory Infection

No significant association was noted (right ear: P = 0.375; left ear: P = 0.283).

4.2.5. Allergic Rhinitis

No significant association was observed (right ear: P = 0.710; left ear: P = 0.769).

No significant association was found between tympanogram patterns and variables such as gender, age, feeding type, recent respiratory infections, or allergic rhinitis in infants with or without ear-pulling complaints. The majority exhibited type A tympanograms, suggesting normal middle ear function.

5. Discussion

This study aimed to investigate the association between ear-pulling behavior in infants and tympanometry patterns indicative of middle ear pathology. The findings revealed that while abnormal tympanometry patterns (types B and C) were present in a significant proportion of participants, no significant correlation was found between these patterns and ear-pulling behavior. Below, the results are discussed variable by variable, with comparisons to previous literature and an exploration of the study's limitations.

Abnormal tympanometry patterns (types B and C) were observed in 39.7% of right ears and 47.7% of left ears, with a slightly higher prevalence in the left ear. These findings align with previous studies by Ashrafi and Mohammadzadeh (11) and Daneshmandan et al. (12), who reported abnormal tympanometry patterns in 20.4% and 33% of cases, respectively. However, our study found a higher prevalence of type B patterns, consistent with the findings of Taziki et al. (13). In contrast, another study reported a higher incidence of type C patterns, which may be attributed to differences in study populations, including sample size and age distribution.

This discrepancy may reflect anatomical or behavioral factors. Infants' supine positioning during sleep or unilateral head preference could predispose the left ear to fluid retention. Alternatively, asymmetrical Eustachian tube function or regional environmental factors (e.g., allergen exposure) might contribute, though further research is needed.

Table 1. Tympanogram Distribution by Ear [a]

Ear	Type A	Type B	Type C	Total
Right	53 (60.2)	20 (22.7)	15 (17)	88 (100)
Left	46 (52.3)	26 (29.5)	16 (18.2)	88 (100)

[a] Values are expressed as No. (%).

Table 2. Association Between Variables and Tympanogram Patterns

Variables	Right Ear (P-Value)	Left Ear (P-Value)
Gender	0.316 (m), 0.154 (f)	0.685 (m), 0.264 (f)
Age	0.679 - 0.179	0.173 - 0.819
Feeding type	0.148 - 0.751	0.219 - 0.571
Recent respiratory infection	0.375	0.283
Allergic rhinitis	0.710	0.769

The predominance of type A tympanograms in both ears suggests that normal middle ear function is common in infants, regardless of ear-pulling behavior. However, the presence of type B and C patterns in a substantial proportion of participants highlights the need for careful evaluation of middle ear function in this age group.

Among the participants, 53 (60.2%) exhibited pattern A, 20 (22.7%) exhibited pattern B, and 15 (17%) exhibited pattern C in the right ear. For the left ear, 46 (52.3%) exhibited pattern A, 26 (29.5%) exhibited pattern B, and 16 (18.2%) exhibited pattern C. This indicates that 39.7% of participants had abnormal patterns in the right ear, while 47.7% had abnormal patterns in the left ear. Previous studies by Ashrafi and Mohammadzadeh (11) and Daneshmandan et al. (12) reported abnormal pattern prevalence of 20.4% and 33%, respectively. In our study, the most common abnormal tympanogram pattern was type B, which aligns with the findings of Taziki et al. (13). However, our results contradict those of Nwosu et al., who reported a higher incidence of both type B and C patterns (14). This discrepancy may be attributed to differences in study populations, including variations in sample size and age distribution. Furthermore, we found no significant associations between tympanogram types and sex, age, recent URTIs, or allergic rhinitis in either group.

Type A tympanograms, indicative of normal middle ear pressure and function, were the most prevalent pattern in both groups. However, a considerable percentage of infants exhibited type B and C tympanograms, suggesting middle ear effusion or negative middle ear pressure, respectively. Type B patterns, associated with fluid in the middle ear, were the most common abnormal finding, consistent with studies by Ashrafi and Mohammadzadeh and Taziki et al. (11, 13).

No significant differences in tympanometry patterns were observed between males and females, consistent with findings from previous studies (11). This suggests that sex is not a determining factor in middle ear pathology among infants.

No significant association was found between age and tympanometry patterns. This contrasts with some studies that have reported age-related variations in middle ear function, possibly due to differences in sample characteristics or environmental factors.

These clinical factors showed no significant correlation with tympanometry patterns or ear-pulling behavior. This finding contradicts some earlier studies that suggested a link between URTIs and middle ear effusion. The discrepancy may be due to differences in diagnostic criteria or the timing of assessments relative to infection episodes.

Allergic rhinitis, whether seasonal or perennial, adversely affects Eustachian tube function, which in turn may lead to an increased incidence of middle ear effusion and otitis media (15). The absence of an

association between recent respiratory infections/allergies and tympanogram patterns may relate to timing. Infections resolved prior to testing might not affect middle ear status at the time of tympanometry. Similarly, allergies may have been underdiagnosed in infants, as symptoms like rhinitis are often non-specific. Seasonal variations in infection rates, unaccounted for in this study, could also obscure correlations.

No significant differences were observed in tympanometry patterns between the ear-pulling group (cases) and the non-ear-pulling group (controls). Both groups had a similar prevalence of normal tympanograms (type A), suggesting that ear-pulling is not a reliable indicator of middle ear pathology. This finding is consistent with studies by Taziki et al. (13) and others, which have emphasized the non-specific nature of ear-pulling behavior.

The lack of association between feeding type (breastfeeding, formula, mixed) and tympanogram patterns contrasts with prior studies suggesting that breastfeeding may reduce the risk of middle ear effusion. This discrepancy could stem from differences in feeding practices (e.g., duration, exclusivity) or cultural factors influencing maternal nutrition. Additionally, our sample size may have limited the power to detect subtle associations (16).

Our findings are congruent with previous studies that reported a high prevalence of type A tympanograms in infants, regardless of ear-pulling behavior. However, discrepancies in the distribution of abnormal patterns (e.g., higher prevalence of type C in some studies) may be attributed to variations in study design, population characteristics, and regional differences in environmental factors such as allergens and respiratory infections.

Ear-pulling is often perceived by parents and caregivers as a sign of otitis media. However, the lack of a significant relationship between ear-pulling and tympanometry findings in our study suggests that this behavior may not be a reliable indicator of middle ear pathology. Instead, ear-pulling may be influenced by non-pathological factors such as teething, external ear irritation, or typical developmental exploration. Ear-pulling is often associated with otitis media by parents and caregivers. However, the lack of a significant relationship between ear-pulling and tympanometry findings in our study suggests that this behavior may not be a reliable indicator of middle ear pathology. Ear-pulling can be a non-specific symptom influenced by factors such as teething, irritation of the external ear, or typical behavioral exploration during developmental stages in infants.

These findings underscore the necessity for careful evaluation of ear-pulling complaints. Relying solely on this behavior as an indicator of middle ear pathology could lead to overdiagnosis or unnecessary treatments. Tympanometry remains an essential tool for assessing middle ear function, but clinical judgment should consider a broader range of symptoms and diagnostic tools. Significant impairments in auditory function can hinder communication and adaptation to the environment (17). Fortunately, many causes of hearing loss are treatable (10). Therefore, it is essential to identify patients effectively through screening for preventive purposes, facilitating early intervention (18).

5.1. Conclusions

Our findings suggest that while tympanometry is an essential tool for assessing middle ear function, ear-pulling alone is not a reliable predictor of middle ear pathology in infants. A thorough clinical evaluation incorporating multiple diagnostic methods remains crucial in pediatric otology. Further studies are needed to better understand the complex interplay between infant behavior and middle ear conditions.

5.2. Limitations

This study has several limitations. First, the sample size, though adequate, may not fully capture the diversity of infant populations. Second, the cross-sectional design limits the ability to establish causal relationships between ear-pulling and middle ear pathology. Third, environmental factors such as seasonal variations in respiratory infections or allergen exposure were not accounted for, which could influence tympanometry results. Finally, the study relied on parental reporting of ear-pulling behavior, which may be subject to recall bias.

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Footnotes

Authors' Contribution: M. B. R. and F. R. developed the original idea and the protocol, abstracted, and wrote the manuscript. M. B. R. and F. R. are supervisor and guarantor. M. B. R., F. R., and S. H. T. contributed to developing the protocol, abstracting data, and preparing the manuscript. During the preparation of this work the authors used ChatGPT. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

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