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AUDIOLOGIC PROFILE OF PRESCHOOL CHILDREN WITH ADENOID HYPERTROPHY AND HEARING LOSS

Original scientific paper

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ABSTRACT

The aim of the study was to compare pre-treatment and post-treatment pure tone thresholds and tympanometric findings in preschool children with adenoid hypertrophy and hearing loss. This retrospective study included 63 children, 40 males (63.5%) and 23 females (36.5%), aged 4 to 6 years (mean age of 5.5±0.6 years). A total of 21 children (33.3%) had tympanostomy tube placement in addition to adenoidectomy or adenotonsillectomy. All children had mild conductive hearing loss. Pure tone average (PTA) was lower after adenoidectomy and adenotonsillectomy (p<0.0001). Type B tympanogram was predominant before treatment (62.7%), and type A tympanogram after treatment (81%). Preoperative mean PTA in children with adenoidectomy was 28 dB HL and in children with adenotonsillectomy was 27 dB HL. In both subgroups postoperative mean PTA was 16 dB HL. In children with adenoid hypertrophy and conductive hearing loss, hearing thresholds after adenoidectomy or adenotonsillectomy are significantly lower than preoperative hearing thresholds.

Keywords: *adenoidectomy, adenotonsillectomy, children, hearing loss*

INTRODUCTION

The most common type of hearing impairment in childhood is transient conductive hearing loss due to middle ear effusion (Zahnert, 2011). Otitis media with effusion (OME) is the presence of fluid in the middle ear without signs or symptoms of acute ear infection (Schilder et al., 2016). Adenoid hypertrophy can cause recurrent acute otitis media in addition to OME as a result of Eustachian tube dysfunction and primary infection focus (Durgut & Dikici, 2019). The adenoid is a mass of lymphoid tissue in the postero-superior wall of the nasopharynx (MacKeith et al., 2022). Chronic OME is OME persisting for 3 months or longer from the date of onset, if known or from the date of diagnosis if onset is unknown (Rosenfeld et al., 2016). There are a number of potential theories for the etiopathogenesis of OME including Eustachian tube dysfunction, subclinical bacterial infection and middle ear effusion as a sequelae of acute otitis media (Atkinson et al., 2015). Up to 80% of children have been affected by OME by the age of 4 years, but prevalence declines beyond 6 years of age (Williamson, 2011). Congenital, permanent, bilateral hearing loss

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is much rare, with a prevalence of 1.2 per 1000 children (Zahnert, 2011). There is a bimodal peak of incidence at two and five years of age, with 50% of episodes of OME resolving spontaneously within three months (Robb & Williamson, 2016). Children with chronic OME may develop structural changes of the tympanic membrane, hearing loss, and speech and language delay. Untreated persistent middle ear effusion would place the child at high risk for hearing loss from suboptimal conduction of sound through the middle ear, which could interfere with subsequent speech and language progress (Rosenfeld et al., 2022). The hypothesis that OME disrupts a child's language processing is based on the premise that children who have had history of OME may have difficulty with the rapid rate of language processing. During language processing, an individual analyzes an acoustic waveform for known phonemes; searches in long-term memory for words corresponding to the identified phoneme sequences; analyzes sequences of words for grammatical structures; and identifies the representation of the form. Frequent and persistent mild to moderate hearing loss that interferes with or prevents completion of these processing operations in a timely fashion could possibly cause a loss of language information. Delays in such aspects of language development as speech perception, grammatical comprehension, and word learning could result (Roberts et al., 2004). Sensory, physical, cognitive, or behavioral factors that place children who have otitis media with effusion at increased risk for developmental difficulties are the following: permanent hearing loss independent of OME; suspected or confirmed speech and language delay or disorder; Autism spectrum disorder and other pervasive developmental disorders; syndromes (eg, Down) or craniofacial disorders that include cognitive, speech, or language delays; blindness or uncorrectable visual impairment, cleft palate, with or without associated syndrome; and developmental delay (Rosenfeld et al., 2016). Some authors' findings suggest that ~25% of bilateral childhood hearing loss is postnatal (Weichbold et al., 2006). Such continuous hearing screening is important because even a perfect newborn hearing screening program will never identify late-onset permanent hearing loss or identify fluctuating hearing loss as a result of otitis media (Johnson et al., 2005). Any parental concern about hearing loss requires an objective hearing screening. Hearing impairment is often identified when parents express concern regarding their child's behavior, performance at school, or language development (Williamson, 2011). The benchmark for hearing loss due to bilateral OME is hearing in the better ear of 25-30 dB HL or worse, averaged at 0.5, 1, 2 and 4 kHz. Tympanometry will typically demonstrate reduced middle ear compliance, with Jerger type B (flat) or C (negative pressure) traces (Robb & Williamson, 2016). A systematic review of hearing loss in children with diagnosed OME showed mostly bilateral mild to moderate hearing loss (average 18-35 dB HL) in the most important frequencies for speech perception. The air conduction configuration is roughly flat with a slight elevation at 2000 Hz and a slope at 8000 Hz (Cai & McPherson, 2017). Acoustic immitance measures, including tympanometry and acoustic reflex thresholds can provide important information about specific aspects of auditory system functioning (Johnson, 2002). Objective middle-ear assessment can best be performed by tympanometry (Harlor et al., 2009). Tympanogram is an objective measure of how easily the tympanic membrane vibrates and at what pressure it does so most easily. If the middle ear is filled with fluid (eg, OME), vibration is impaired and the tracing will be flat; if the middle ear is filled with air but at a higher or lower pressure than the surrounding atmosphere, the peak on the graph will be shifted in position based on the pressure, to the left if negative, and to the right if positive (Rosenfeld et al., 2022). Surgical management of children with OME includes tympanostomy tube insertion or adenoidectomy, alone or with myringotomy and tube insertion. Adenoidectomy is surgical removal of the adenoid and it is performed under general anaesthesia (Capaccio et al., 2016). Tympanostomy tube insertion is surgical placement of a tube through a myringotomy incision for purposes of temporary middle ear ventilation. Tympanostomy tubes generally last several months to several years, depending on tube design and placement location in the tympanic membrane. Synonyms include ventilation tubes, pressure equalization tubes, and grommets (Rosenfeld et al., 2022). The aim of the study was to compare pure tone thresholds and tympanometric findings in preschool children with adenoid hypertrophy and hearing loss before and after adenoidectomy or adenotonsillectomy.

METHODS

This retrospective study included a sample of 63 children, 40 males (63.5%) and 23 females (36.5%), aged 4 to 6 years (mean age of 5.5±0.6 years), examined at the Department of

Otorhinolaryngology, Division of audiology, City General Hospital "8th September", Skopje, during the period from January 2018 to December 2022. Inclusion criteria were: audiological assessment before and after adenoidectomy or adenotonsillectomy in preschool children with adenoid hypertrophy cooperative for pure tone audiometry, preoperative unilateral or bilateral hearing loss, and at least one month postoperative follow-up. Both, children with and without tympanostomy tubes placement were included. Children with preoperative normal hearing were excluded. Findings from ENT examination, pure tone audiometry and tympanometry were analyzed. Pure tone audiometry was performed with MADSEN Astera[2] audiometer (GN Otometrics, Denmark) and Sennheiser HDA 300 circum-aural headphones (Sennheiser electronic, Germany) in sound proof booth. Hearing threshold was obtained at frequencies from 125 to 8000 Hz using the modified Hughson-Westlake technique. Normal hearing was defined as thresholds ≤ 20 dB hearing level (HL) at audiometric frequencies from 250 to 8000 Hz. Tympanometry with 226 Hz probe tone was performed with Amplaid A756 tympanometer (Amplifon, Italy). For statistical data analysis we used Paired t test and Chi-square test with level of significance $p<0.05$. The Protocol number of Ethical approval is 628-2/2023.

RESULTS

Our study included 63 preschool children (a total of 126 ears were analyzed). Baseline demographic and clinical characteristics of children are displayed in Table 1. A total of 20 children (31.7%) had adenoidectomy and 43 children (68.3%) had adenotonsillectomy.

Table 1. Baseline demographic and clinical characteristics of the patients (n=63)

Characteristics	No (%)
Age (Years)	4-6 (mean 5.5±0.6)
Gender	40 (63.5)
Male	23 (36.5)
Female	
Preoperative diagnosis	
Adenoid hypertrophy	20 (31.7)
Adenoid and tonsil hypertrophy	43 (68.3)
Side of hearing loss	
Unilateral right	15 (23.8)
Unilateral left	6 (9.5)
Bilateral	42 (66.7)
Degree of hearing loss (126 ears)	
Normal hearing (0-20 dB HL)	21 (16.7)
Mild hearing loss (21-40 dB HL)	105 (83.3)
Type of hearing loss (105 ears)	
Conductive	105 (100)

In addition to the adenoidectomy or adenotonsillectomy, there was ventilation tubes placement in some children. Number of children with different surgical intervention and tympanostomy tubes placement is displayed in Table 2.

Table 2. Number of children with different surgical intervention and tympanostomy tubes placement

Surgical intervention	**With ventilation tubes**	**Without ventilation tubes**	**Total**
	No (%)	**No (%)**	**No (%)**
Adenoidectomy	7 (11.1)	13 (20.6)	20 (31.7)
Adenotonsillectomy	14 (22.2)	29 (46)	43 (68.3)
Total	21 (33.3)	42 (66.7)	63 (100)

Postoperative outcomes in cases of preoperative hearing loss in terms of the surgery were analyzed (Table 3). A statistical analysis with Chi-square test shows that there is no statistically significant difference between the postoperative outcomes in cases of preoperative hearing loss in terms of the surgical intervention ($\chi^2 = 0.146$, df = 1, p = 0.702).

Table 3. Postoperative outcomes in cases of preoperative hearing loss in terms of the surgery

Surgical intervention	**Normal hearing**	**Hearing loss**	**Total**	**p**
	No (%)	**No (%)**	**No (%)**	0.702
Adenoidectomy	31 (29.5)	3 (2.9)	34 (32.4)	
Adenotonsillectomy	63 (60)	8 (7.6)	71 (67.6)	
Total	94 (89.5)	11 (10.5)	105 (100)	

Figure 1 shows tonal audiogram and tympanogram in child with adenoid hypertrophy and otitis media with effusion.

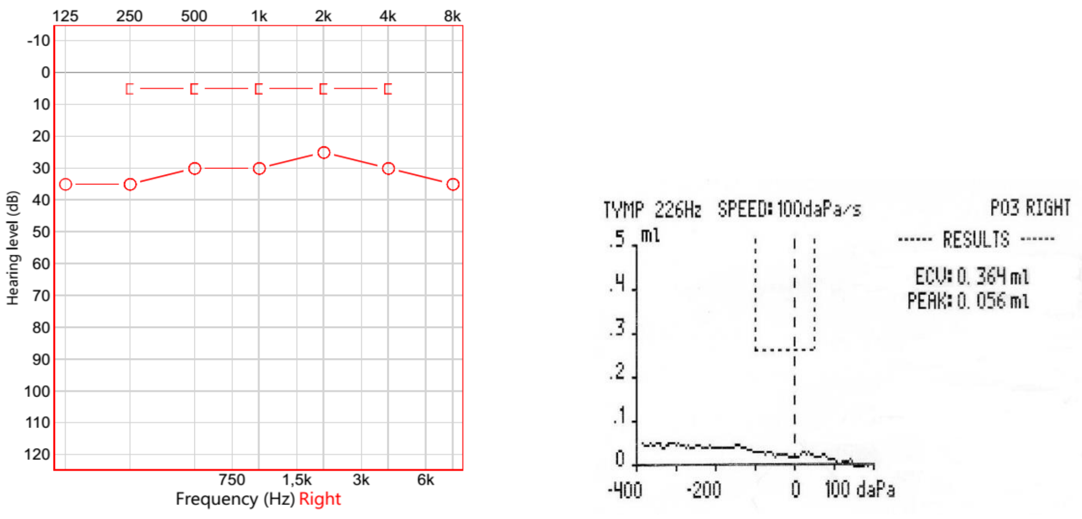

Figure 1. Tonal audiogram and tympanogram in child with adenoid hypertrophy and OME

Distribution of cases of hearing loss and normal hearing before and after surgery is displayed in Table 4. A total of 42 children (66.7%) had bilateral hearing loss and 21 (33.3%) had unilateral hearing loss. The number of hearing impaired ears before the treatment was 105.

Table 4. Distribution of cases of hearing loss and normal hearing before and after surgery

Patient's hearing	**Pre-treatment**	**Post-treatment**	**Total**
	No (%)	**No (%)**	**No (%)**
Hearing loss	105 (41.7)	11 (4.4)	116 (46)
Normal hearing	21 (8.3)	115 (45.6)	136 (54)
Total	126 (50)	126 (50)	252 (100)

A total of 6 children (9.5%) in our study had reoperation adenoidectomy. Treatment outcomes from the first surgery were analyzed. We displayed the preoperative and postoperative mean PTA and standard deviation error bars in cases of hearing loss (Figure 2). Preoperative mean PTA in children with adenoidectomy was 28 dB HL and in children with adenotonsillectomy was 27 dB HL. In both subgroups postoperative mean PTA was 16 dB HL.

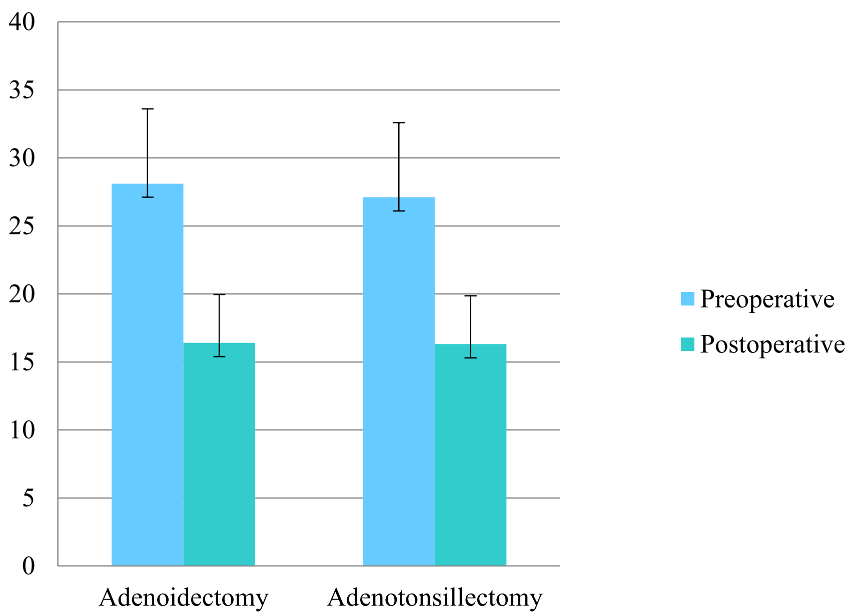

Figure 2. Preoperative and postoperative mean PTA and standard deviation error bars

Pre-treatment and post-treatment pure tone average (PTA) of hearing-impaired ears was compared in children with adenoidectomy and adenotonsillectomy (Table 5). A statistical analysis with Paired t test shows significantly lower pure tone thresholds after adenoidectomy (t = 12.3773, df = 33, SE of difference = 0.948, p < 0.0001) and adenotonsillectomy (t = 17.5799, df = 70, SE of difference = 0.614, p < 0.0001).

Table 5. Pre-treatment and post-treatment PTA in cases of hearing loss

Surgical intervention	**Pre-treatment PTA** Median (min-max)	**Post-treatment PTA** Median (min-max)	**t**	**p**
Adenoidectomy	28 (21-40) n = 34	17 (10-30) n = 34	12.3773	< 0.0001
Adenotonsillectomy	27 (21-38) n = 71	16 (10-27) n = 71	17.5799	< 0.0001

Distribution of different types of tympanograms before and after surgery are displayed in Figure 3 and

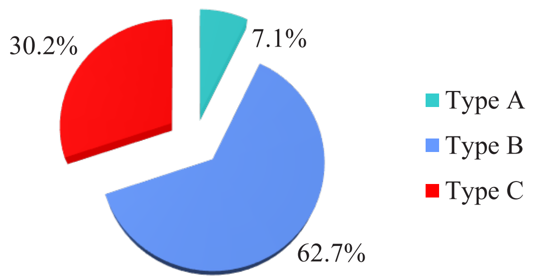

Figure 3. Types of tympanograms before surgery

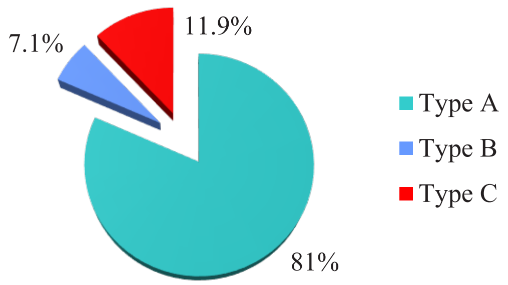

Figure 4. Types of tympanograms after surgery

Figure 4.

Type B tympanogram was predominant before treatment (62.7%), and type A tympanogram after treatment (81%).

DISCUSSION

We analyzed preoperative and postoperative audiological profile of 63 children with adenoid hypertrophy and hearing loss due to Eustachian tube dysfunction and OME. Based on strong research evidence, the most common cause of conductive hearing loss in children is OME (Gifford et al., 2009).

All children had mild conductive hearing loss. Pure tone average (PTA) was lower after adenoidectomy and adenotonsillectomy (p<0.0001). Preoperative mean PTA in children with adenoidectomy was 28 dB HL and in children with adenotonsillectomy was 27 dB HL. In both subgroups postoperative mean PTA was 16 dB HL. In our previous study averaged hearing loss associated with OME in children was 26 dB HL (Ristovska et al., 2017). Children with OME may be at risk for poor school performance because of hearing loss, problems with behavior or attention, and difficulties understanding speech in noisy classroom settings. The impact of OME on hearing ranges from no hearing loss up to moderate hearing loss (0-55 dB HL). The average hearing loss associated with OME in children is 28 dB HL, but about 20% of children with OME have hearing thresholds > 35 dB HL (Rosenfeld et al., 2022). Cai et al. (2018) reported mean PTA (500, 1000, 2000) of 26.8 dB HL in school age children with OME. In terms of the effusion viscosity, Al-Salim et al. (2021) reported mean 4PTA 35.41±12.64 in children with mucoid fluid in the middle ear. James et al. (2018) concluded that adenoidectomy can improve the middle ear function and the hearing profile of child and can be considered as a practical management option in children with chronic adenotonsillar hypertrophy with OME. We did not analyze the PTA in terms of the adenoid tissue size. According to Durgut & Dikici (2019) adenoid tissue size and location have no effect on hearing thresholds and the duration of effusion in OME. Another study confirmed the high correlation between adenoid size and incidence of OME. There was a highly significant relation between grade IV adenoid hypertrophy (adenoid has relation with torus tubarius, vomer, and soft palate) and tympanometry type B and highly significant relation between adenoid hypertrophy grade IV and mucoid type of middle ear effusion. With more increase in the adenoid size, more viscosity of middle ear effusion was detected (Abdel Tawab & Tabook, 2021). In the present study, type B tympanogram was predominant before treatment (62.7%), and type A tympanogram after treatment (81%). In some children the ventilation tubes were still present at control examination. Tympanometry may provide useful information on positive or negative middle ear pressures that pneumatic otoscopy does not. Tympanogram type B with normal ear canal volume is fairly sensitive in diagnosing OME (Anwar et al., 2016). The most common cause of flattened, type B tracing with a low static admittance and normal ear canal volume is decreased mobility of the tympanic membrane secondary to otitis media with effusion (Onusko, 2004). In children with OME treated with adenoidectomy Rajan et al. (2022) reported type B tympanogram in 86% and type C tympanogram in 14% before adenoidectomy. Post-treatment distribution of tympanograms was as follows: type A tympanogram in 27%, type B tympanogram in 57%, and type C tympanogram in 16% of all cases. In children with adenoid hypertrophy, Augustian et al. (2022) found bilateral effusion in 20%, unilateral effusion in 12%, and prevalence of asymptomatic OME 32%. They also found significant association between OME and adenoid size. After adenoidectomy and myringotomy in cases with bilateral OME, in about 93% of children with bilateral type B tympanogram and all children with unilateral type B and bilateral type C, tympanograms returned to normal on three months follow-up. A total of 21 children (33.3%) had tympanostomy tube placement in addition to adenoidectomy or adenotonsillectomy. Tympanostomy tubes help to ventilate the cavities of the middle ear and balance the pressures on each side of the tympanic membrane. Different types of tympanostomy tubes can be used in treatment of OME. Shepard tubes are primarily used in Europe. Adenoidectomy can be combined with ventilation tubes placement in children over the age of 4 if hypertrophy is detected with nasal endoscopy or under the age of 4 years in the event of nasal obstruction or recurrent rhinopharyngeal infections (Vanneste & Page, 2019). A Meta-Analysis showed that tympanostomy tubes improve hearing at 1 to 3 months compared with watchful waiting, with no evidence of benefit by 12 to 24 months. The benefits of tympanostomy tubes must be weighed against a variety of associated adverse events (Steele et al., 2017). Complications from tympanostomy tube insertion include tympanic membrane perforation, chronic otorrhea, and tympanosclerosis (Minovi & Dazert, 2014). According to the Cochrane review, the effect of ventilation tubes on hearing in children with OME, as measured by standard tests, appears small and diminishes after six to nine months by which time natural resolution also leads to improved hearing in the non-surgically treated children (Browning et al., 2010). Primary adenoidectomy with tympanostomy tube placement may be superior to tympanostomy tube placement only in decreasing the risk of repeated tympanostomy tube placement and the risk of recurrent acute otitis media, OME, or otorrhea (Mikals & Brigger, 2014). A total of 6 children (9.5%) in our study had reoperation adenoidectomy. Schneuer et al. (2022) concluded that one in five children having adenoidectomy under 5 years required reoperation.

CONCLUSION

Mild conductive hearing loss is the most common degree and type of hearing loss in children with adenoid hypertrophy and hearing loss. Bilateral hearing loss is more common than unilateral hearing loss. In children with adenoid hypertrophy and conductive hearing loss, hearing thresholds after adenoidectomy or adenotonsillectomy are significantly lower than preoperative hearing thresholds. The most common type of tympanogram before the treatment is Type B tympanogram and type A tympanogram is the most common after treatment.

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