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Hearing in Children with Otitis Media with Effusion – Clinical Retrospective Study

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A B S T R A C T

Hearing loss accompanied with middle ear effusion was analyzed according to audiometric frequencies for different age group. Results for left and right ears were compared in/ and between study and control group. Pure tone audiometry for bone and air conduction and tympanometry was performed in study group of ninety-eight children with conductive hearing loss and otitis media with effusion Control group included fifty-seven children with hearing loss, enlarged adenoids, dysfunction of Eustachian tube and no present middle ear effusion served. Means of hearing loss thresholds for 250 Hz – 4 kHz were established and compared between groups of right vs. left ears of tested vs. control ears according to age subgroups: 1–3 yr, 4–6 yr, 7–9 yr, 10–12 yr, 13–15 yr. At age 1–3 yr otitis media with effusion children showed no ear side difference in hearing loss. Age groups of 4–6 and 7–9 yr otitis media with effusion children showed left ears with higher threshold of hearing loss across all of the tested frequencies than right ears in study and control ears. Right ears showed smaller hearing loss in study and control group and no age group predicted for hearing impairment. Higher hearing loss threshold for 4 kHz in adolescence in otitis media with effusion ears is early sign of sequels after repetitive episodes of middle ear effusion. Control groups showed no ear side or age group dependent difference of hearing loss threshold. Age group of 4–6 and 7–9 y have faster craniofacial structural change in soft tissue than bone base so ear side differences suggest being developmentally determined.

Key words: *hearing loss, otitis media with effusion, aging*

Introduction

Otitis media with effusion (OME) is a common childhood illness during the first 3 years of life which etiology described to be multifactorial and symptomatology age--related. It is also characterized by functional and mechanical obstruction of Eustachian tube which is most common in early childhood until 7 yr., reduction of the nasopharyngeal outlet and disturbance in the middle ear gas composition with present long-term negative gas--pressure[1]. Conductive hearing loss which often accompanies OME may adversely affect binaural processing, sound localization, speech perception in noise and impact normal speech and language development[2,3]. Children suffer from OME also have behavioral problems and are not able to focus on problem at school what result with learning disturbance[4]. Average pure tone hearing loss at speech frequencies (500 Hz to 4 kHz) ranges from normal hearing to moderate hearing loss (0–55 dB) with 50th percentile at 25 dB hearing level (HL) while 20% of ears exceed 35 dB with the lower frequencies more adversely affected[5,6].

Previous clinical studies usually used only pure-tone threshold averaged across several frequencies to describe the hearing loss in OME[7]. There are no recent studies analyzing correlation of hearing loss threshold means separate frequencies, conductive hearing loss threshold, aging and side of the ear.

The aim of this work was to found out to find out characteristics of conductive hearing loss in correlation with age, ear side and audiometric frequencies groups in order of therapy planning and to help how adjust speech and language follow-up programs.

Methods

Study group included 98 children (196 ears) (40 female and 58 male) with positive history of recurrent

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hearing loss or present otitis media with effusion which was established by tonal audiometry (air and bone conduction) and tympanometry after 6 weeks of repetitive testing. All of the tested ears showed conductive hearing loss (none of the ears showed sensorineural hearing loss) and tympanogram of type B. Control group (V) included 57 children (114) (27 female and 30 male) with enlarged adenoids confirmed by nasal fiberendoscopy. Repetitive audiometric and tympanometric testing after 6 weeks confirmed conductive hearing loss and type C on tympanometry. Children with sensorineural hearing loss were excluded from study. Mean age for both examined groups was 8 years (range from 1 to 15 years for both groups). Study group and control group were selected from the general outdoor population and were examine weekly during domiciliary visits. The children were subdivided according to the following observation age groups: group 1 (1–3 year), group 2 (4–6 years), group 3 (7–9 years) group 4 (10–12 years), group 5 (13–15 years).

An impedance audiometer model AZ7- was used to obtain tympanograms which were categorized according to the Jerger classification as type A, C or B.

Tonal audiometry (digital clinical audiometer model AC3-Interacustics) established means hearing loss thresholds (MHL) for 250 Hz, 500 Hz, 1 kHz, 2 kHz, and 4 kHz. Statistical analysis was performed using SPSS 10.0 software for Windows. Differences between mean hearing loss thresholds between OME and V groups were established for separate frequencies according to age groups and left and right ears respectively by Kruskal-Wallis test. All of the OME ears have undergone insertion of ventilatory tubes on both ears and adenoidectomy, while V group have undergone adenoidectomy.

Results

Otitis media with effusion and adenoid ears of left and right side showed no difference in hearing loss threshold at 1–3 yr. At age of 4–7 yr left OME ears have significantly higher MHL than left V ears across tested frequencies (250 Hz $p<0.004$), (500 Hz, $p<0.011$), (l kHz, $p<0.021$), (4 kHz, $p<0.003$) (Table 1.). At age 7–9 yr left OME ears have significantly higher MHL than left (V) ears across tested frequencies (250 Hz $p<0.014$), (500 Hz, $p<0.01$R5), (l kHz, $p<0.006$), (4 kHz, $p<0.041$) (Table 2.). Older ages showed no MHL differences between left OME *vs*. V ears. Right ears of OME and V have no significant differences in MHL across age groups except for 4 kHz at 4–6 yr and 1 kHz at 7–9 yr. Comparison of hearing levels between OME and V in each age group was also made for total ears together at each frequency (Table 3.), showing significant differences (OME *vs*. V, $p<0.05$) in age group 4–6 yr (250 Hz, 500 Hz, 1 kHz, 4 kHz), 7–9 yr (250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz) and 13–15 yr (4 kHz).

TABLE 1
LEFT EAR: COMPARISONS OF MEANS OF HEARING LOSS BETWEEN OME (OTITIS MEDIA WITH EFFUSION) AND V (CONTROL) ACROSS FREQUENCIES AND AGE GROUPS. P<0.05 WAS SIGNIFICANT

Frequency (Hz)	OME (dB)		V (dB)		p
	$\bar{X}$	SD	$\bar{X}$	SD	
Age group 1					
250	31.25	8.76	26.67	6.06	0.258
500	35.00	10.69	29.17	9.17	0.293
1000	33.13	11.32	25.83	9.70	0.207
2000	33.13	16.89	23.33	8.76	0.233
4000	30.63	14.50	29.17	11.58	0.844
	N=8		N=6		
Age group 2					
250	31.13	11.01	24.00	7.50	0.004
500	32.00	9.86	26.00	8.54	0.011
1000	30.13	10.09	23.80	9.16	0.021
2000	28.13	9.65	24.20	8.98	0.097
4000	31.13	10.83	22.40	10.12	0.003
	N=40		N=25		
Age group 3					
250	32.12	7.51	25.00	10.98	0.014
500	32.69	11.07	23.89	11.32	0.015
1000	34.23	12.78	23.33	11.50	0.006
2000	30.58	14.17	22.22	10.74	0.041
4000	32.50	14.65	26.11	16.05	0.097
	N=26		N=18		
Age group 4					
250	30.42	13.22	27.50	8.66	0.540
500	31.25	13.16	22.50	15.55	0.296
1000	29.58	12.70	22.50	13.23	0.353
2000	30.83	15.20	26.25	16.01	0.348
4000	36.67	16.14	23.75	4.79	0.125
	N=12		N=4		
Age group 5					
250	30.83	12.76	25.00	4.08	0.326
500	31.25	14.16	27.50	8.66	0.536
1000	34.17	16.90	26.25	11.09	0.394
2000	30.00	18.34	20.00	8.16	0.386
4000	37.50	15.15	18.75	6.29	0.035
	N=12		N=4		

Discussion

Up to 90% of children are expected to suffer from otitis media with effusion by the time they enter primary school[4]. Previous experimental studies found that primary mechanism in hearing loss at low frequencies is a reduction of the admittance of the middle-ear air space due to displacement of air with fluid. In addition, primary mechanism of hearing loss at high frequencies is an increase in tympanic membrane mass by entrained fluid[7]. Tos et al. found significant differences between glue and mu-

TABLE 2
RIGHT EAR: COMPARISONS OF MEANS OF HEARING LOSS BETWEEN OME (OTITIS MEDIA WITH EFFUSION) *VS*. V (CONTROL) ACROSS FREQUENCIES AND AGE GROUPS. P<0.05 WAS SIGNIFICANT

Frequency (Hz)	OME (dB)		V (dB)		p
	$\overline{X}$	SD	$\overline{X}$	SD	
Age group 1					
250	33.75	7.91	26.67	8.76	0.127
500	34.38	5.63	25.83	11.14	0.144
1000	30.63	4.96	27.50	13.32	0.345
2000	31.25	14.58	27.50	6.12	0.321
4000	35.63	10.84	25.00	8.94	0.075
	N=8		N=6		
Age group 2					
250	28.38	10.21	24.60	8.28	0.125
500	28.25	10.23	24.20	7.99	0.074
1000	27.63	11.43	22.00	8.16	0.054
2000	25.25	11.32	23.00	9.01	0.482
4000	28.38	10.94	21.40	10.05	0.015
	N=40		N=25		
Age group 3					
250	31.35	9.23	28.61	16.07	0.113
500	33.65	9.55	30.28	15.86	0.103
1000	35.96	12.73	29.17	18.01	0.023
2000	31.92	13.50	28.61	20.49	0.091
4000	37.50	15.44	34.17	19.35	0.169
	N=26		N=18		
Age group 4					
250	24.58	11.57	23.75	7.50	1.000
500	22.08	11.96	25.00	10.80	0.455
1000	24.58	12.87	27.50	6.45	0.806
2000	20.83	10.41	21.25	14.36	0.853
4000	24.58	16.16	22.50	18.93	0.948
	N=12		N=4		
Age group 5					
250	32.92	13.05	26.25	7.50	0.266
500	35.00	15.23	23.75	7.50	0.245
1000	38.75	17.34	26.25	11.09	0.200
2000	31.25	16.67	23.75	10.31	0.428
4000	38.33	19.23	22.50	10.41	0.112
	N=12		N=4		

TABLE 3
TOTAL NUMBER OF OME (OTITIS MEDIA WITH EFFUSION) AND V (CONTROL) EARS: COMPARISONS OF MEANS OF HEARING LOSS BETWEEN OME *VS*. V ACROSS FREQUENCIES AND AGE GROUPS. P<0.05 WAS SIGNIFICANT

Frequency (Hz)	OME (dB)		V (dB)		p
	$\overline{X}$	SD	$\overline{X}$	SD	
Age group 1					
250	32.50	8.16	26.67	7.18	0.056
500	34.69	8.26	27.50	9.89	0.055
1000	31.88	8.54	26.67	11.15	0.145
2000	32.19	15.27	25.42	7.53	0.223
4000	33.13	12.63	27.08	10.10	0.179
	N=16		N=12		
Age group 2					
250	29.75	10.64	24.30	7.83	0.001
500	30.13	10.16	25.10	8.24	0.001
1000	28.87	10.79	22.90	8.64	0.002
2000	26.69	10.55	23.60	8.92	0.104
4000	29.75	10.91	21.90	9.99	0.000
	N=80		N=50		
Age group 3					
250	31.73	8.34	26.81	13.69	0.004
500	33.17	10.24	27.08	13.96	0.004
1000	35.10	12.66	26.25	15.18	0.000
2000	31.25	13.72	25.42	16.45	0.008
4000	35.00	15.11	30.14	17.99	0.071
	N=52		N=36		
Age group 4					
250	27.50	12.51	25.63	7.76	0.759
500	26.67	13.16	23.75	12.46	0.612
1000	27.08	12.76	25.00	10.00	0.675
2000	25.83	13.73	23.75	14.33	0.565
4000	30.63	16.96	23.13	12.80	0.309
	N=24		N=8		
Age group 5					
250	31.87	12.67	25.63	5.63	0.134
500	33.13	14.51	25.63	7.76	0.188
1000	36.46	16.91	26.25	10.26	0.126
2000	30.63	17.15	21.87	8.84	0.262
4000	37.92	16.93	20.63	8.21	0.008
	N=24		N=8		

cous and serous effusion at 2 and 4 kHz and between glue ear and no effusion et 8 kHz. He concluded that glue OME may cause a reduction in the emission at 2, 4 and 8 kHz more than the other kind of effusion[8].

Otitis media with effusion (OME) is defined as the presence of fluid in the middle ear without signs or symptoms of acute ear infection. Persistent middle ear-fluid from OME results in decreased mobility of the tympanic membrane and serves as a barrier to sound conduction[9,10]. It was pointed that protective ET function of one ear does not predict the ET function of the opposite ear. Previous experimental studies found that primary mechanism in hearing loss at low frequencies is a reduction of the admittance of the middle-ear air space due to dis-

placement of air with fluid. In addition, primary mechanism of hearing loss at high frequencies is an increase in tympanic membrane mass by entrained fluid[3]. Until now, it remains unknown whether OME develops independently in each ear or as one disease with manifestation in both ears at the same time[4]. That leads to impairment of binaural processing with impact on level of speech discrimination particularly in noisy background of school. Children with bony parameter of craniofacial characteristics of must be recognized as those of high risk for development of OME more frequent on left side. Children of attention at school as well as individually adjust speech and language rehabilitation

Our results shows that left ears of OME children have higher level of hearing loss than right ears of the same group and left ears of control group. Right ears of both groups showed no hearing loss difference across tested frequencies in different age groups. Johnson et al.[4] found that each ear undergoes pathological changes independently and results. Herbeek[9] found difference in ET function between left and right side on group level or on individual level. Those results confirmed our findings of higher level of hearing loss for left ears which can be explained by variation in developmental process of epipharyngeal space, palatal airway and inclination of the scull base. According to our findings OME ears of left side between ages 4 to 6 and 7 to 9 are more prone for higher level of hearing loss than controls equally for all tested frequencies what can be developmentally explained. Maw[11] found slowest bony nasopharyngeal growth between ages of 4.4 to 6.5 years as unfavorable developmental period characterized by lower clirens and mucociliar dysfunction of ET. Children with OME have significant reduction in certain skeletal and soft tissue dimension in the nasopharynx, soft palate is shorter and positioned higher, what contribute to the lower clirens and derange of middle ears through ET. After age of 9 years there is no difference in hearing level between OME *vs*. left ears. At that time start faster growth rate of nasopharyngeal area what means bigger nasopharyngeal outlet and better drainage of the middle ear. Left ears and total of ears of children with enlarged adenoids have lower level of hearing loss. Although they have anthropological characteristics different from normal population they still have enhanced favorable anatomical characteristic of nasopharynx and ET clirens than OME ears[12]. That is the reason of the prevalent presence of type C and no middle effusion.

It was found[1] that active OME produced a hearing loss up to 30 dB often with low frequencies more adversely affected. Our experience from routine clinical work confirm 250 Hz as the most vulnerable frequency which is first to show higher hearing level when OME starts to develop even when speech frequencies have normal hearing level. Flat type of curve is frequently recording in such cases as sign of effusion in the middle ear.

Typical finding for OME ears is horizontal curve of conductive hearing loss with no significant difference between hearing levels. Our results shows that hearing level on 4 kHz is significantly higher on left and sum of OME ears *vs*. V control ears and higher than on other tested frequencies. Right ears of control group are not characterized with sensor neural hearing loss as left ears. With aging higher frequencies have more importance in speech discrimination. Such finding suggest that left middle ear and probably all anatomical structures which take part in hearing have more severe pathoanatomical changes than those on right side so therapy planning have to be separate for each side of ear.

Conclusion

Otitis media with effusion ears at 1–3 yr showed no ear side difference in hearing loss threshold and higher level of hearing loss than other age groups. Dynamic developmental period of craniofacial structures at age of 4 up to 9 years is accompanied with higher level of hearing loss for left ears than it was found in other ages an left side and right ears. Ears of children with enlarged adenoids showed no ears side difference in hearing loss threshold. Children with otitis media with effusion require additional attention at school as well as individually adjust speech and language rehabilitation program.

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OŠTEĆENJE SLUHA KOD DJECE SA SEKRETORNIM OTITISOM

S A Ž E T A K

Svrha studije je ustanoviti karakteristike oštećenja sluha kod sekretornog otitisa na pojedinoj audiometrijskoj frekvenciji, različitim dobnim grupama te desnoj i lijevoj strani uha zasebno. Tonalna audiometrija za zračnu i koštanu vodljivost te timpanometrija su učinjene kod ispitivane grupe od 98 bolesnika dječje dobi sa provodnim oštećenjem sluha uzrokovanim fluidom u srednjem uhu. Kontrolna grupa je obuhvaćala 57 bolesnika dječje dobi sa povećanim adenoidnim vegetacijama, popratnim oštećenjem sluha provodnog tipa i poremećenom funkcijom eustahijeve tube. Prosječna životna dob ispitivanih grupe je bila 8 godina. Prosječne vrijednosti pragova sluha su određene za pojedinu frekvenciju te odvojeno za grupu desnih i lijevih ušiju prema životnim podgrupama; 1–3 godina, 4–7 godina, 8–12 godina te iznad 12 godina. U dobnoj grupi 1–3 godina nije bilo razlike u pragu sluha između desnih i lijevih ušiju ispitivane grupe i kontrole, a ujedno se prikazala ravna krivulja tonalnog audiograma za govorni registar. Dobna grupa 4–6 godina te 7–9 godina je pokazala viši prag sluha provodne redukcije praga sluha za ispitivane frekvencije kod lijevih ušiju kod ispitivane grupe u odnosu na kontrolnu. Desna uha ispitivane grupe i kontrola nisu pokazivala razlike u razini praga sluha među testiranim frekvencijama. Od 10 godina i više nije bilo značajnih razlika u pragovima sluha među testiranim grupama ušiju ispitivane i kontrolne grupe bolesnika. Frekvencija od 4 kHz je pokazala značajno lošiji prag sluha za lijevo uho u preadolescentnoj i adolescentnoj dobi kao rani znak posljedica oštećenja unutarnjeg uha zbog opetovanih epizoda sekretornog otitisa. Grupa lijevih ušiju kod sekretornog otitisa u dobi od 4–9 god pokazuje veća oštećenja sluha provodnog tipa duž cijelog ispitivanog frekvencijskog registra u odnosu na lijeva uha kontrolne grupe lijevih ušiju. Na desnoj strani grupa ispitivanih ušiju nije bilo razlika. Ova životna dob je karakterizirana većim kraniofacijalnim strukturalnim promjenama genetski determiniranim što određuje karakteristike slušanja.