

Original articles

Audiological and behavior findings in children underwent a bilateral myringoplasty – a comparative study

Achados audiológicos e comportamentais em crianças submetidas à miringoplastia bilateral – um estudo comparativo

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Conflict of interest: non-existent

ABSTRACT

Purpose: to analyze pre-surgical hearing evaluation in children who suffering from secretory otitis media in their first five years of age. Also to verify the length of time tubes have remained in the eardrum and analyze the test results of auditory processing after myringotomy surgery.

Methods: 79 students between eight and 12 years old were divided into two groups: 1 - 40 students without otitis media history and 2 - 39 students suffering from secretory otitis media in their first five years of age and who have undergone a myringotomy surgery. The individuals underwent complete audiological evaluation and assessment of Auditory Processing.

Results: all patients showed conductive hearing loss in the pre-operative audiological tests. The mean time of ventilation tubes was 11,8 months. The left ear showed significant lower performance in the dichotic digits and pitch pattern sequence tests. The students from group 2 showed lower performance whether compared to group 1 in the dichotic digits test and gaps-in-noise.

Conclusion: children with a history of otitis media in the early years of life showed the conductive hearing loss responses in the pre-surgical evaluation and lower responses in dichotic test of digits and gaps-in-noise.

Keywords: Hearing; Otitis Media; Child

RESUMO

Objetivo: analisar os resultados pré-cirúrgico da avaliação audiológica de crianças submetidas à intervenção cirúrgica para inserção de tubos de ventilação bilateral; analisar o tempo de permanência do tubo de ventilação e avaliar o processamento auditivo, após a intervenção cirúrgica.

Métodos: 79 escolares, entre oito e 12 anos, foram divididos em dois grupos: 1 - 40 escolares sem antecedentes de otite média e 2 - 39 estudantes com histórico de otite média submetidos à cirurgia para inserção de tubos de ventilação bilateral. Todas as crianças foram submetidas à avaliação audiológica e avaliação do processamento auditivo.

Resultados: na avaliação auditiva pré-cirúrgica todos os pacientes apresentaram resultados do tipo condutivo. O tempo médio de permanência do tubo de ventilação foi de 11,8 meses. A orelha esquerda apresentou desempenho estatisticamente inferior nos testes dicótico de dígitos e padrão de frequência. Os escolares do grupo 2 apresentaram desempenho estatisticamente inferior quando comparados ao grupo 1 nos testes Dicótico de Dígitos e Detecção de Intervalos no Ruído.

Conclusão: as crianças com histórico de otite média nos primeiros anos de vida apresentaram respostas do tipo condutivo na avaliação pré-cirúrgica e respostas inferiores nos testes dicóticos de dígitos e Detecção de Intervalos no Ruído.

Descritores: Audição; Otite Média; Criança

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INTRODUCTION

The critical period of hearing development, which extends from birth to two years of life is the period of greatest neuronal plasticity of the auditory pathway. In this period, the central auditory nervous system (CANS) may be modified, depending on the quantity and quality of external stimuli. The greater the number of stimuli, greater is the number of connections between the inner ear and auditory cortex.¹

To the maturation of the auditory pathways occurs proper sound stimulation is necessary, therefore, it is essential that the peripheral auditory system be intact in the early years of life.²

Otitis media (OM) is defined as an inflammation of the middle ear often associated with an increase of infected fluid. It is an inflammation mostly seen in early childhood which decreases with age. It is known that about 2/3 of all children have at least one episode of secretory otitis media (SOM) between one and five years old.³

Once early medical intervention is not performed OM might cause a hearing loss due to accumulated fluid in the middle ear, which difficult the transmission of sound vibrations through the ossicular chain, causing loss energy of sound. As a result, it has a slight degree of hearing loss, or even moderate.

Aiming to minimize the effects of OM on language development, the surgery for ventilation tube placement, known as myringotomy, has become the most common procedure to drain fluid from the middle ear and restore hearing.⁵

The fluctuating character of hearing loss in OM could leads to an inconsistent sound stimulation of the CANS, distorting sound perception.

The auditory processing (AP) assessment is a behavioral method to evaluate the CANS in children. The American Speech Hearing Association (ASHA) defined the term AP as the efficiency and effectiveness with which the central nervous system uses auditory information.⁶

To assess AP in children suffering from OM is essential, since the effects of auditory deprivation caused by OM could lead a distortion in speech discrimination, especially in noisy environments. Phonological awareness skills will also be affected and consequently school performance could be compromised.^{7,8}

The purpose of this research was to analyze pre-surgical hearing evaluation in children who suffering from secretory otitis media and underwent a surgery for tympanostomy tubes placement in their

first five years of age. Also to verify the length of time tubes have remained in the eardrum and analyze the test results of auditory processing after myringotomy surgery, considering the right ear (RE) and left ear (LE).

METHODS

This study carries approval from the Research Ethics Committee of the Faculty of Medical Sciences, State University of Campinas, under number 682/2010.

All selected participants were invited through telephone contact with those responsible who signed the Consent and informed, allowing the inclusion of subjects in the study.

The study included 79 elementary school students from public school, consisting of 38 females and 41 males with ages between 8 and 12.

- Group 1 (G1): 40 students without OM history and typical development.
- Group 2 (G2): 39 students with history of OM who underwent a surgery for bilateral ventilation tubes placement in their first five years of age.

Inclusion criteria for both group were defined as: age between 8 to 12, normal otoscopy, hearing and immitance results within normal standard and no history of learning complaints.

Besides that, in the G2 were added the following inclusion criteria: history of otitis media in the first five years of life and absence of middle ear infection for a period of 12 months before the date of evaluation.

Children who had mental disorders, neurological disorders and/or genetic syndromes; were using psychoactive medications; attended speech therapy; or did not fulfil the inclusion criteria were excluded from the sample.

Procedures

The G1 subjects were selected by the school's pedagogical coordinator, who analyzed the academic performance of children, and later by the researcher, who considered their otologic complaints.

The G2 subjects who underwent surgery for placement of bilateral ventilation tubes, between 2000 and 2006, at the State Hospital of Sumare were selected by the researcher through analyzing the medical records, considering the inclusion and exclusion criteria.

The data analyzed in the medical records of patients were: patient identification, pre-surgical hearing

evaluation and data of surgery as: age of children, types of ventilation tubes and length of time tubes have remained in the eardrum.

All individuals were submitted to anamnesis in order to investigate the history of ear infections; language development and auditory behavior through different environments.

The hearing evaluation consisted of pure tone audiometry; speech audiometry - Speech Recognition Threshold (SRT) and phonemically balanced monosyllabic words and immittance (tympanometry and acoustic reflexes).

The normal criteria adopted for hearing evaluation were: hearing thresholds up to 20 dB according to Davis and Silverman⁹ and percentage of correct answers between 88 and 100% of phonemically balanced monosyllabic words¹⁰. Tympanometry was considered at its maximum peak compliance at an atmospheric pressure of 0 daPa, an equivalent volume between 0.3 and 1.3 ml and an acoustic reflex between 70 and 100 dB above the hearing threshold for pure tone, according to Jerger and Carvalho.^{11,12}

The behavioral assessment of AP was composed by tests with verbal and non-verbal stimuli. It was selected a dichotic test and a low redundancy monaural speech test proposed by Central Auditory Processing - Evaluation Manual^{13,14} and two tests that evaluate the temporal processing proposed by Musiek.^{15,16}

Specific Procedures

The hearing evaluation and behavioral assessment of AP were performed in all subjects in a 60-minute session in a soundproof booth with a 15 minute break. An AC40 audiometer and earphones (model: TDH 39P) were used. Impedance was performed using 235h immittance audiometry (Interacoustic). For the behavioral tests, a CD player (model: Sony) was linked to the audiometer.

The DD test aims to evaluate the binaural integration ability and consists of two pairs of syllable digits in the Portuguese Language presented simultaneously to each ear (total 80 - four, five, seven, eight and nine). The child was asked to repeat the four digits he/she heard at the free attention stage. The evaluation was applied at an intensity level of 50dBSL intensity in both ears based on the averages of hearing thresholds as references in the frequencies of 500, 1000 and 2000Hz.

The syntetic sentence identification test (SSI) assess the figura-ground ability and consists of ten synthetic

sentences presentation with the presence of competing message (history), at the same ear, for signal/noise ratio of 0, -10 and -15. The patient was asked to point out the sentence he/she heard which was written in a frame. The intensity used was 40dBSL based on the averages of hearing thresholds as references in the frequencies of 500, 1000 and 2000Hz for signal/noise ratio of 0 and then an increase of 10 and 5dB was made for the signal/noise ratio of -10 and -15.

The temporal processing tests selected were the Gaps-in-noise (GIN) and the Pitch pattern sequence (PPS). The GIN aims to evaluate the ability of temporal resolution and consist in the perception of the shortest gap in milliseconds (ms) which can be detected in a continuous broadband noise. The gaps were randomly distributed into lists, and in each list, different gap duration between 2 to 20ms, occur six times. The subject was instructed to indicate each time he/she realized a gap. The test was applied to the monaural condition of 50dBSL intensity based on the averages of hearing thresholds as references in the frequencies of 500, 1000 and 2000Hz.

Data collection was conducted at the Audiology Laboratory at the State University of Campinas.

Statistical analysis was performed using nonparametric methods and tables were presented descriptively as the average values, standard deviations and p-values. The significance level was 5% ($p < 0.05$), and significant data are highlighted in bold.

To analyze student performance on AP tests with respect to the RE and LE, the Wilcoxon test was used.

Regarding student performance on the AP test, the Kruskal-Wallis test was used.

RESULTS

Pre-operative hearing evaluation was analyzed in all of the children's selected medical records for myringotomy surgery (Figure 1). In some subjects, due to age, was held just as tympanometry. It was found at Figure 1 conductive hearing loss and tympanogram type B in most of the children.

The mean age found for who underwent surgery myringotomy and the mean time of the ventilation tubes were 36 and 11.8 months, respectively.

In the analysis of the AP tests, broken down by individual ears there was a significant difference between the RE and the LE. The RE performed better than the LE in DD and PPS. (Table 1).

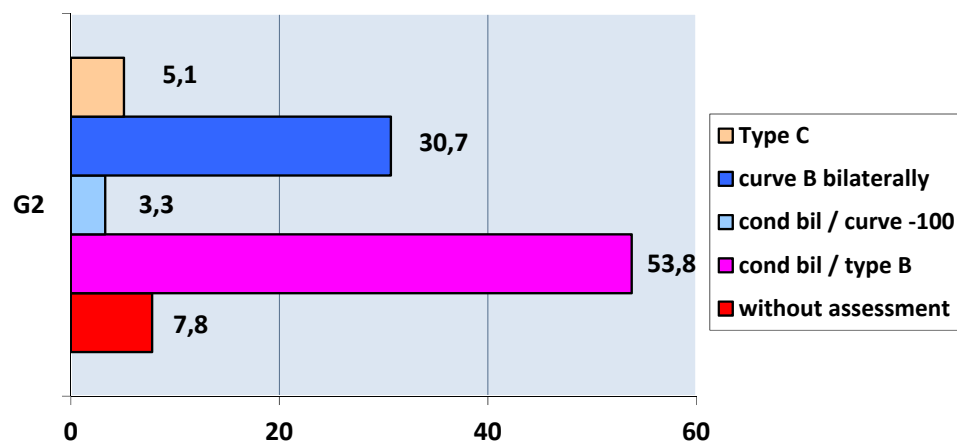


Figure 1. Characterization of pre-surgical hearing evaluation.

Table 1. Student performance on the AP tests for the RE and LE

Tests	Right ear (n=79)			Left ear (n=79)			P-value
	Mean	SD	Median	Mean	SD	Median	
DD	95,0	7,1	97,5	92,3	10,6	95,0	0,0001
PPS	61,6	24,6	63,3	58,7	25,6	57,0	0,0251
GIN	5,5	2,5	5,0	5,4	2,0	5,0	0,5453
GINP	70,8	14,2	73,3	70,6	12,8	72,0	0,7371
SSI	74,7	23,1	80,0	73,9	22,9	70,0	0,5473

n - number of subjects; SD - standard deviation; DD - dichotic digits; PPS - pitch pattern sequence test; GIN - gaps-in-noise; GINP - gaps-in-noise/percent; SSI - synthetic sentence identification with ipsilateral competing message. The p -value was calculated using the Wilcoxon test.

In table 2 are exposed the analysis in relation to auditory processing tests, showing that G1 presented lower performance when compared to G2 for the DD test.

The mean and median for GIN test were similar to G1 and G2, although the Kruskal-Wallis analysis suggests significant differences between groups. G2 showed higher values compared to G1. (Figure 2)

Table 2. Student performance on AP tests based on groups

Tests	G1				G2				P-value
	n	Mean	SD	Median	n	Mean	SD	Median	
DD									
RE	40	97,9	3,3	100,0	39	91,3	9,5	95,0	0,0007
LE	40	96,7	5,5	100,0	39	86,6	14,4	90,0	<0,0001
PPS									
RE	40	66,7	22,4	70,0	39	56,8	26,1	56,7	0,1742
LE	40	64,4	24,5	80,0	39	53,9	27,3	47,0	0,1732
GIN	80*	5,1	2,6	5,0	78*	6,1	2,0	6,0	<0,0001
GINP	80*	74,7	11,4	75,5	78*	63,3	13,4	65,0	<0,0001
SSI	80*	78,4	19,9	80,0	78*	73,6	23,5	70,0	0,1425

n - number of subjects/* number of ears; SD - standard deviation; DD - dichotic digits; RE - right ear; LE - left ear; PPS - pitch pattern sequence test; GIN - gaps-in-noise; GINP - gaps-in-noise/percent; SSI - synthetic sentence identification with ipsilateral competing message. The p -value was calculated by the Mann-Whitney test.

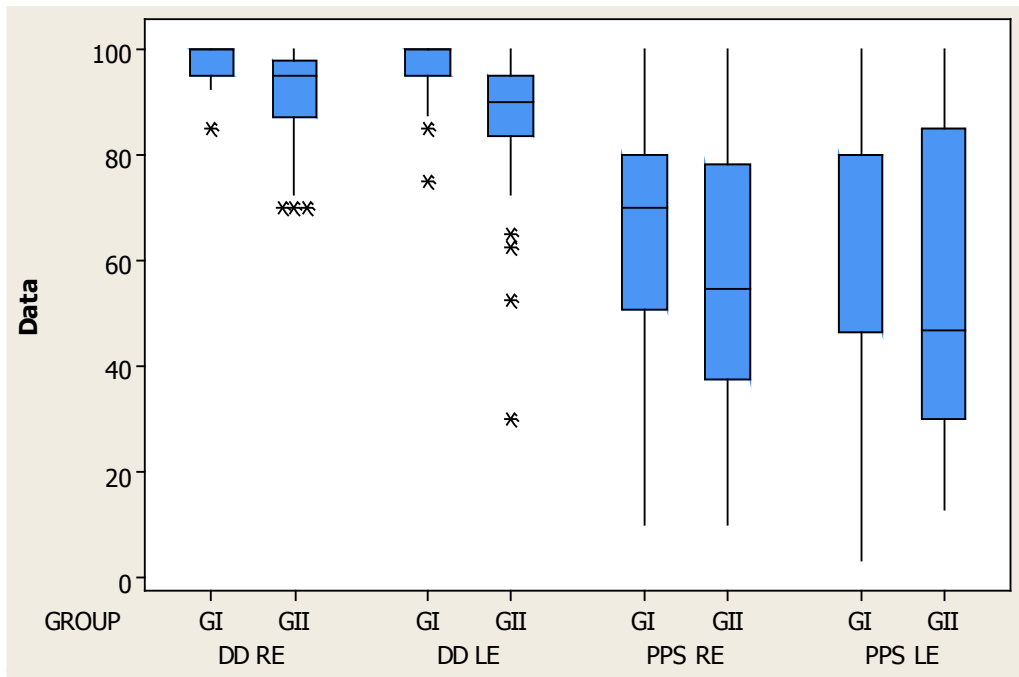


Figure 2. Boxplot shows the results from G1 and G2 for the DD and PPS test between the right and left ear.

The difference between the groups regarding the GIN test can be seen in Figure 3, where both mean and standard deviation are higher in the study group.

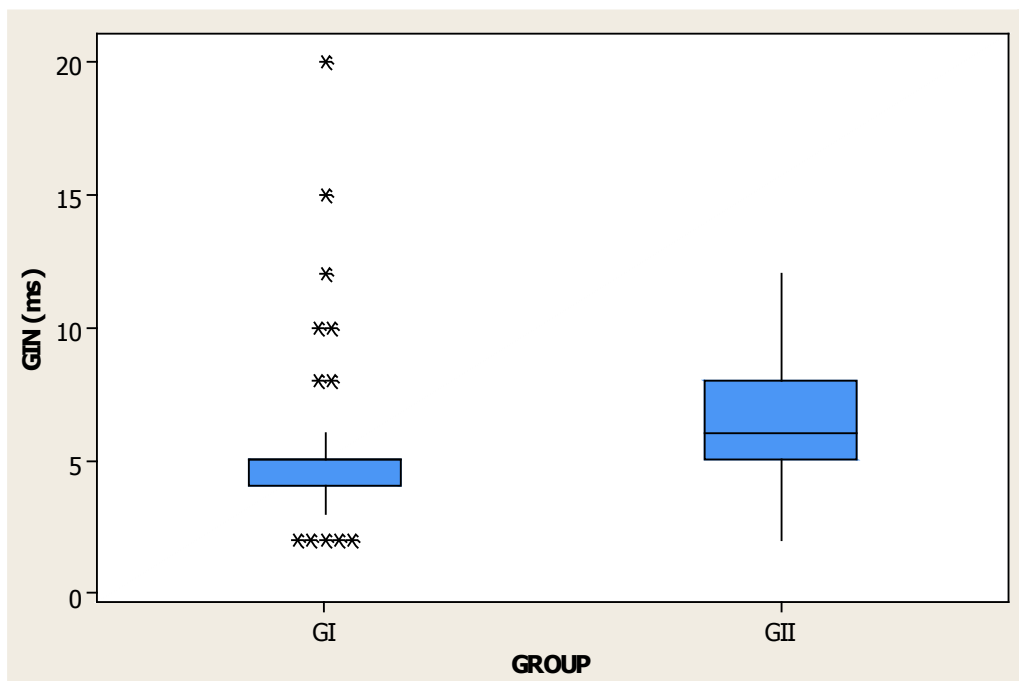


Figure 3. Boxplots shows the results of children for GIN test comparing group 1 and 2.

DISCUSSION

The temporary alteration in the peripheral auditory system due to OM changes the quality of sound perception once the acoustic signal can be observed in incomplete form, which induces an alteration in decoding sounds.

The pre-surgical hearing evaluation findings in this study demonstrated alterations in all subjects, similar to the literature^{17, 18} which showed that SOM causes significant auditory deprivation characterized by mild conductive hearing loss bilaterally and revealing absence of the indicative peak pressure in the presence of middle ear effusion acoustic impedance on the acoustic impedance.

Regarding the age when myringotomy's was performed the present study presented mean of 36 months. The data corroborates the findings of Pereira et al.¹⁹ who underwent myringotomy surgery with short term ventilation tubes in 75 children in a private clinic, totaling 150 ears, with a mean age of 34.7 months. In the other hand, Beker's et al.²⁰ finding differs somehow from the present work. The authors performed myringotomy surgery in a Public Hospital, in 30 children with a mean age of 47.8 months.

Due to fluid accumulation in the middle ear caused by SOM is important to consider early treatment. The sooner medical intervention is performed, and myringotomy surgery procedure as indicated in these cases, the risk of chronic infection and its consequences, such as the ossicular chain damage and cholesteatomas should be minimized.²¹ In addition to refund more quickly of hearing and thus avoid impairment on language and auditory skills.

The common types of ventilation tubes used in myringotomy surgery are of short term (six to 12 months). In 90% of cases the tubes are expelled spontaneously. These results corroborate the findings in this study which observed that the mean time of ventilation tube was 11.8 months. Testa et al in their study with 109 subjects found that the mean time was 9.97 months.³

Haggard and Hughes²² claim that episodes of OM in childhood are associated with difficulties in learning, language and attention. Keith²³ associated frequent episodes of OM with possible factors for the APD.

In the analysis of the AP tests, broken down by individual ears (table 1) there was a significant difference between the RE and the LE. The RE performed better for DD and PPS tests considering both groups.

According to Colella-Santos²⁴ on the DD test, the better performance on the mean responses in the RE for G2 students is no longer expected because the asymmetry between the ears for this test occurs up to 6 years of age. However, it is also observed lower mean responses in the LE of G2 on the DD, when compared to the mean responses in the LE of G1, besides a variation in the results, which can be seen in Figure 2. Thus, these differences between the mean responses of G2 compared to G1 can be justified as a result of a maturational delay was likely caused by stimulation of inconsistency caused by conductive hearing loss due to otitis media.

In the analyses of AP tests performance between the groups there were statistically significant results for DD and GIN tests in the gap detection threshold and percentage of correct answers. In the remaining SSI and PPS tests no statistically significant difference was revealed, therefore the mean responses of G2 was lower compared to the mean responses of G1 (Table 2).

Several other studies have applied the GIN test in children and found values between 4.2ms and 5ms for the gap detection threshold and approximately between 73.6% and 78.27% for the percentage of correct answers. These results are similar to the findings in this present study for GIN of G1.^{25,26}

The low GIN scores in the group of children who underwent bilateral ventilation tube insertion (G2), suggests that episodes of SOM during the early years of life can preclude the proper input of auditory information responsible for sensory encoding of temporal information. These factors are essential for enhancing temporal resolution because this skill develops at approximately 6 to 7 years and depends on the segregation of different auditory stimuli.

Therefore, the data found in this study suggest the importance of early medical intervention in order to minimize the effects caused by OM in the development of hearing abilities and considering the assessment of PA in children with OM history early in life, in order to understand better the changes in the development of auditory function in this population.

CONCLUSION

Based on the analysis of the results it can be concluded that the pre-surgical hearing evaluation of children who have undergone a myringotomy showed conductive hearing loss and tympanometry type B and the mean time of ventilation tubes was 11.8 months.

Children with a history of otitis media in the early years of life had lower responses in behavioral tests as dichotic digits and GIN when compared to children with no history of otitis media.

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