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Revision articles

Use of middle latency auditory evoked potentials in children: an integrative review

Uso do potencial evocado auditivo de média latência em populações infantis: uma revisão integrativa

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ABSTRACT

This study aimed to investigate on the literature the utility of *Auditory middle latency response* in children focusing on the study of the auditory system on its normal and deviant processes. The integrative review of the scientific literature consisted in the search for studies using databases such as PubMed, Scopus, and Scielo. The descriptors used for the search were: "auditory middle latency response" "auditory middle latency potential", and "children" "child", "childhood", "maturation", "development". Selection criteria: The studies were complete papers, which participants were children submitted to examination of the AMRL. The individually analysis of the studies verified the aspects related to the purpose of the research, the applied methodology, and the conclusion of each study. Were selected a total of 21 articles, among them eleven studies from PubMed, eight studies from Scopus, and two studies from Scielo. Of the total 21 articles, six of them were performed with healthy children, four examined the components of this potential in children with language disorders or specific language disorder, four studies assessed children with cochlear implants and seven children with other changes. This integrative review showed the importance of research auditory middle latency response in children. Based on this, a more accurate and early diagnosis of patients with alterations language, speech or learning and auditory processing disorders were allowed. Moreover, it was observed the evolution on theraupeutic monitoring.

Keywords: Child; Child Development; Evoked Potentials, Auditory; Hearing; Hearing Tests

RESUMO

Este estudo teve como objetivo investigar na literatura a utilidade do Potencial evocado auditivo de média latência na população infantil para o estudo do sistema auditivo em seus processos normais e desviantes. A revisão integrativa da literatura científica consistiu na busca de estudos utilizando as bases de dados: PubMed, Scopus e Scielo. Como descritores para a pesquisa foram utilizados os termos: "auditory middle latency response" "auditory middle latency potential" , "children", "child", "childhood", "maturation' e "development". Os estudos eram artigos completos, cujos participantes foram crianças, submetidas ao exame de Potencial evocado auditivo de média latência. A análise dos estudos individualmente verificou aspectos relacionados ao objetivo da pesquisa, a metodologia utilizada e a conclusão de cada estudo. Foram selecionados e lidos na íntegra um total de 11 estudos da base bibliográfica PubMed, oito estudos da Scopus e dois estudos da Scielo. Do total de 21 artigos, seis deles foram realizados com crianças saudáveis, quatro examinaram os componentes desse potencial em crianças com distúrbio de linguagem ou distúrbio específico de linguagem, quatro estudos avaliaram crianças usuárias de implante coclear, e sete crianças com outras alterações. Esta revisão integrativa mostrou a importância da investigação dos potenciais evocados auditivos de média latência em crianças. Tal avaliação vem permitindo um diagnóstico mais precoce e preciso de pacientes com alterações de linguagem, fala ou de aprendizado e de distúrbios do processamento auditivo além do monitoramento de evolução terapêutica.

Descritores: Criança; Desenvolvimento Infantil; Potenciais Evocados Auditivos; Audição; Testes auditivos

INTRODUCTION

Auditory evoked potentials (AEP) refer to electrical changes in the peripheral and central auditory pathways, resulting from acoustic stimulation [1]. The responses are analyzed for latency of waves corresponding to the transmission velocity of the neurobiological system in milliseconds and for amplitude in microvolts, which represents the cortical activation of auditory areas responsive to the stimulus.

Middle Latency Auditory Evoked Potentials (MLAEP) are successive waves of negative voltage represented by the letter N and of positive voltage represented by the letter P, which occurs between 10 and 80 ms after the sound stimulus, and allow the objective investigation of the integrity of the central hearing pathway. The neural generators of this potential are the primary auditory cortex, association cortex, thalamic projections and the thalamus, whose components are Na, Pa, Nb, Pb [2]. In normal conditions, the Na wave presents the first negative peak between 12 and 27 ms; Pa is the highest positive peak after Na, between 25 and 40ms; Nb is the negative peak after Pa, between 30 and 55 ms [1]. And the most commonly used measure in research has been the wave Na-Pa [3,4]. The literature describes the Na component as originated in the thalamus, and Pa as dependent on the electrode position on the scalp; if at the temporal lobe, its origin is the primary auditory cortex and if placed at the midline, its origin is subcortical [5,6].

The Na-Pa wave amplitude of MLAEP in normal subjects is symmetrical, i.e. electrodes placed on the right and left temporal lobe should have similar responses [7]. The opposite occurs in children with hearing disorders such as those identified in patients with learning disorders, who show differences between the results obtained from typical children; in this group the left contralateral auditory pathway presents a deficit and slower responses are observed at the left hemisphere level [8]. Other authors had concluded that the MLAEP latencies differed significantly between children with learning disorders one a group of typical children, thus showing the clinical significance of this potential [9].

MLAEP has been used to compare patients before and after surgery to place the cochlear implant [10] to assess the central auditory pathways in children of alcoholic parents [11], and with auditory processing disorder [12]. Progress in the use of electrophysiological measurements of MLAEP for diagnosis and treatment of central auditory processing disorder is now consensus in the literature considering the international recommendation of ASHA (1996) [13], which suggests that the use of these measures in assessing patients with central auditory processing disorders. Several studies have used the investigation of MLR in children. Comparisons of records obtained in typical children and other children with speech and language disorders users of cochlear implants or even to assess the auditory pathway in children receiving pharmacological sedation has been published [14-18]. Therefore, this study aimed to investigate, in the literature, the use of MLAEP in children to study the auditory system in its normal and deviant processes.

METHODS

The first step consisted of elaborating the research question in order to establish the bibliographic search: “What is the use of MLAEP to study children in their normal and deviant processes” A systematic review of the scientific literature consisted in finding studies in English, published in any year. The databases used were PubMed, Scopus and Scielo. The descriptors used were: auditory middle latency response (auditory middle latency potential) and children (child, childhood, maturation, development).

Selection Criteria

The inclusion criteria of the study were: complete articles whose participants were children who underwent MLAEP examination. Articles comparing children and adults responses were also included. Exclusion criteria were articles of expert opinion, literature review, abstracts in conference proceedings, letters and comments.

Data Analysis

At first, the selection was based on titles and abstracts. The papers were read in full and analyzed according to the methodology used in examining MLR. An analysis of the study, individually, was carried out checking the aspects related to the aim of the research, the methodology used (when specified), and the conclusion of each study.

LITERATURE REVIEW

As a result of the search, 545 studies were found in literature in PubMed database, 1778 studies in Scopus and nine studies in Scielo database. The studies that were not available for electronic access at the website or national academic databases, and those that did not fit into one or more specific criteria, and did not respond to the research question were excluded. Thus, 11 articles were selected and read in full from PubMed, eight studies from Scopus and two studies from SciELO.

Table 1. Articles included from electronic database PubMed

FOUND ARTICLES	REVIEW AND PUBLICATION YEAR
Al-Saif SS, Abdeltawwab MM, Khamis M. **Auditory middle latency responses in children with specific language impairment**.[19]	Eur Arch Otorhhinolaryngology. 2012;269(6):1697-702.
Kurnaz M, Satar B, Yetiser S. **Evaluation of cochlear implant users performance using middle and late latency responses**. [10]	Eur Arch Otorhinolaryngo l. 2009;266(3):343-50.
Rodríguez Holguín S, Corral M, Cadaveira F. **Middle-latency auditory evoked potentials in children at high risk for alcoholism**.[11]	J Epilepsy Clin Neurophysiol. 2001;31(1):40-7.
Arehole S, Augustine LE, Simhadri R. **Middle latency response in children with learning disabilities: preliminary findings**. [9]	J Commun Disord. 1995;28(1):21-38.
Davids T, Valero J, Papsin BC, Harrison RV, Gordon KA. **Effect of increasing duration of stimulation on the electrically evoked auditorybrainstem and middle latency responses in pediatric cochlear implant users**.[15]	J Speech Lang Hear Res. 2008;244:7-14.
Schochat E, Musiek FE, Alonso R, Ogata J. **Effect of auditory training on the middle latency response in children with (central) auditory processing disorder**. [18]	Braz J Med Biol Res. 2010;43(8):777-85.
Gordon KA, Papsin BC, Harrison RV. **Effects of cochlear implant use on the electrically evoked middle latency response in children**.[16]	J Speech Lang Hear Res. 2005;204(1-2):78-89.
Luoa JJ, Khuranac DS, Kotharec SV. **Brainstem auditory evoked potentials and middle latency auditory evoked potentials in young children**. [14]	J.Clin Neurosci. 2013;20:383-8.
Frizzo ACF, Funayama CAR, Isaac ML, Colafêmina JF. **Potenciais Evocados Auditivos de Média Latência: estudo em crianças saudáveis**. [20]	Rev Bras Otorrinolaringol. 2007;73(3):398-403.
Lamas A, López-Herce J, Sancho L, Mencía S, Carrillo A, Santiago MJ, Martínez V. **Bispectral index and middle latency auditory evoked potentials in children younger than two-years-old**.[17]	J Clin Neurosci. 2009;26(3):150-4.
Nelson MD, Hall JW, Jacobson GP**. Factors affecting the recordability of auditory evoked response component Pb (P1)**.[21]	Am J Audiol. 1997;8(2):89-99.

Table 2. Articles included from eletronic database Scopus

FOUND ARTICLES	REVIEW AND PUBLICATION YEAR
Mason SM, Mellor DH. **Brainstem, middle latency and late cortical evoked potentials in children with speech and language disorders.**[22]	Electroencephalogr Clin Neurophysiol. 1984;59(4):297-309.
Psillas G, Daniilidis J. **Low-frequency hearing assessment by middlelatency responses in children with pervasive developmental disorder**.[23]	Int J Pediatr Otorhinolaryngol. 2003;67:613-9.
Davids T., Valero J., Papsin BC., Harrison RV.,Gordon KA. **Effects of stimulus manipulation on electrophysiological responses in pediatric cochlear implant users. Part I: Duration effects.**[24]	J Speech Lang Hear Res. 2008;244:7-14.
Wioland NG., Rudolfb MN., Metz-Lutz. **Electrophysiological evidence of persisting unilateral auditory cortex dysfunction in the late outcome of Landau and Kleffner syndrome.** [25]	Electroencephalogr Clin Neurophysiol. 2001;112:319-23.
Leite RA., Wertzner HF., Gonçalves IC., Magliaro FCL., Matas CG. **Auditory evoked potentials: predicting speech therapyoutcomes in children with phonological disorders.** [26]	Rev Clinics. 2014;69(3):212-8.
Lamas A., Herce JL., Sancho L., Mencía S., Carrillo A., Santiago MJ., Martínez V. **Analysis of Bispectral Index and Middle Latency Auditory-Evoked Potentials Parameters in Critically Ill Children.** [27]	J Clin Neurosci. 2009;26(3):150-4.
Frizzo ACF., Issac ML., Fernandes ACP., Menezes PL., Funayama CAR. **Auditory middle latency response in children with learning difficulties**.[8]	Rev Bras Otorrinolaringol. 2007;73(3):398-403.
Kraus N., Ian Smith D., Reed NL., Stein LK., Cartee C. **Auditory middle latency responses in children: Effects of age and diagnostic category.** [5]	Electroencephalogr Clin Neurophysiol. 1985;62(5):343-51.

Table 3. Articles included from eletronic databases Scielo

FOUND ARTICLES	REVIEW AND PUBLICATION YEAR
Romero ACL., Sorci BB., Frizzo ACF. **Relação entre potenciais evocados auditivos de média latência e distúrbio de processamento auditivo: estudo de casos.** [12]	Rev CEFAC. 2013;15(2):478-84.
Magliaro FCL., Scheuer CI., Assumpção Júnior FB., Matas CG. **Estudo dos potenciais evocados auditivos em autismo.** [28]	Pró-Fono Rev Atual Cient. 2010;22(1):31-6.

We observed that few studies discuss MLR in children in the literature. It was also observed that the methodological approach contemplated from five longitudinal studies up to 16 cross-sectional studies with the inclusion of more than 500 children. The studies were carried out with babies, from six days after birth until in adults with 48 years of age. Some studies compared children with adults.

Out of the total 21 articles, six were carried out with healthy children [5,14,17,20,21,27], four examined the components of this potential in children with language disorders or specific language disorder [5,19,21,28], four studies assessed children of cochlear implant users [10,15,16,24] and seven investigated children with other changes [11,12,18,23,25,26,28].

A detailed analysis of the data indicate similarities in some studies that made use of MLR for monitoring intervention of children users of cochlear implant [10,15,16,24] ; an improvement in the response after a period of use of the implant was observed, and in patients

with auditory processing disorder submitted to speech therapy, who also showed reduced latency after intervention [12,18]. One of the studies [16] highlights that at the moment of placing the implant, MLEAP response was captured in only 35% of the children and after one year of use, MLEAP was verified in 100% of children, which indicates that the pattern of activity and development of the auditory thalamic pathways depends on the time of hearing deprivation that occurs in early childhood from the analysis of MLR components.

Another recent study [18] showed the effect of auditory training in children with auditory processing disorder (APD). Before the auditory training, these children, when compared with control group of children, showed lower amplitude and after auditory training, this amplitude increased significantly, concluding that MLAEP measurements are useful in diagnosing and monitoring improvement of auditory function in patients with APD.

The literature [14] showed that the measurement of Brainstem Auditory Evoked Potential and MLEAP is feasible in children in the first months of life, in spite of behavioral difficulties to carry out the examination in this age group; in this study with 93 children under three years old, it was observed that peak latency, interpeak latency and amplitude of the waves of Brainstem Auditory Evoked Potential and MLAEP were shown clearly, even in children who are still in brain maturation process.

Authors [5] point out that in children, MLEAP responses can be useful in the investigation of auditory sensitivity and estimating the minimum auditory threshold. However, the analysis of absent or abnormal MLEAP responses in order to investigate central auditory pathways should be interpreted with caution. In some cases little differences are observed in patients with a wide range of neurological, cognitive, speech and language disorders compared with patients with typical development. Functional deficits of central auditory pathways and cerebral hemispheres are described in children with learning disorders, language or speech disorders through MLEAP when compared with children with typical development [8,19,25].

A study examining the measures of MLEAP in children with language disorders for the investigation of neurotransmission quality along the auditory pathways [25] indicated dysfunction of primary auditory cortex. Finally, MLEAP has been increasingly used to assess central auditory pathways of children, to assess whether the auditory pathway is healthy and whether there is cerebral functional deficits. This literature review reinforces the importance and use of MLEAP and child population. However, considering the limited number of studies identified in the literature described in this research, it is extremely relevant to carry out further studies using this measure.

CONCLUSION

Out of the total of 21 articles found in this review, six of them were conducted with healthy children, four examined the components of this potential in children with language disorders or specific language disorder, four studies assessed children with cochlear implants and seven investigated children with other changes. This integrative review showed that MLEAP has been increasingly used to assess central auditory pathways of children, however further studies should be conducted using this measure.

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