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Auditory processing abilities in prematurely born children☆

Alessandra Spada Durante[a,*], Stefanie Mariano[a], Paulo Roberto Pachi[b]

[a] School of Speech-Language Pathology and Audiology, Santa Casa de Sao Paulo School of Medical Sciences, São Paulo, SP, Brazil
[b] Pediatric Department, Santa Casa de Sao Paulo School of Medical Sciences, São Paulo, SP, Brazil

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ABSTRACT

Aim

To compare the performance in temporal auditory ordering and resolution tests and the latency and amplitude in the records of middle latency auditory evoked potential and P3 of prematurely born children with the performance of full-term children undergoing the same assessment protocol.

Study design: Cross-sectional observational study.

Subjects: Fifty-two children, aged 8 to 10 years, participated in the study and were divided into two groups: study group: 16 prematurely born children, and control group: 36 born full-term, at low risk for developmental alteration and without scholastic or hearing difficulties.

Outcome measures: All subjects underwent ordering tests (Frequency and duration pattern tests) and temporal auditory resolution tests (Gaps in noise test) and had their middle-latency auditory evoked potential and P3 recorded by using an Intelligent Hearing System unit.

Results: Prematurely born children had worse performance in the temporal ordering and resolution tests as compared with children born full-term. With regard to middle-latency auditory evoked potential and P3, prematurely born children had higher mean values of latencies and poorer morphology, a statistical significance was evidenced for P3 in the right ear.

Conclusions: A prematurity effect was found in the temporal auditory processing measurements and in the P3.

1. Introduction

Premature birth is an important public health problem. Improvement in Pre-Term Care (PT) in Neonatal Intensive Care Units (NICU), resulting in better knowledge of the pathophysiology of neonatal morbidities, the use of antenatal corticosteroids and pulmonary surfactant; protective ventilation techniques, or less aggressive techniques; and in the recognition of the importance of early and aggressive nutrition, besides the valorization of human milk for these patients, have all led to an increasing number of survivors [1].

However, despite these unquestionable and evident advancements, preterm birth still impacts infant development, since several complications inherent in the very cause of early birth, the therapies necessary for survival and the need for medications with side effects such as diuretics, steroids, antibiotics, among others, may induce deleterious, sensory, and cognitive consequences [2,3]. Depending on their maturity and birth weight, the type and intensity of factors acting during the fetal period may put the premature infant at a higher risk of perinatal complications. Among the sequelae found are auditory changes. Speech and language delays and permanent hearing loss are more common among PTs when compared to those born full-term. Although speech and language delays are clearly linked to hearing loss, only a small percentage of prematurely born children have permanent hearing loss [4]. However, there is a possibility that language delay and learning may be associated with changes in auditory processing [5,6].

The interest in researching hearing abilities in prematurely born children is due to the high occurrence of auditory risk indicators in this population, encompassing very low birth weight, prolonged NICU stay, and the use of ototoxic medication. Children with a history of auditory risk at birth should have the development of their auditory system monitored [7]. The presence of these indicators appears to be related to reduced functioning of the auditory efferent pathway, with reduced inhibitory function in the cochlear mechanisms, which might affect auditory processing development [8–10]. Audiological assessment with the use objective assessment methods, with an emphasis on auditory evoked potentials, and behavioral auditory processing tests can be used as an index of auditory system development, speech perception, and auditory discrimination.

Abbreviations: PT, Pre-term; NICU, Neonatal Intensive Care Unit; GIN, Gaps in noise; MLAEP, middle latency auditory evoked potential

☆ Work developed at Irmandade da Santa Casa de Misericórdia de São Paulo, Santa Casa de Sao Paulo School of Medical Sciences.

* Corresponding author at: Rua Dr. Cesário Mota Junior, 61 8. andar – CEP, 01221-020 São Paulo, SP, Brazil.
E-mail address: alessandra.durante@fcmsantacasasp.edu.br (A.S. Durante).

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Among the behavioral processing tests, those related to temporal auditory processing (temporal ordering and resolution) stand out. Temporal processing is one aspect of auditory behavior that has been related to speech perception in hearing children. More specifically, changes in temporal processing are associated with deficits in phonological processing, auditory discrimination, receptive language, and reading [11].

Aiming to increase the objectivity with which children with auditory processing disorders are assessed, it is recommended that electrophysiological parameters be used in addition to behavioral tests. Both middle- and long-latency auditory evoked potentials have been shown to be promising when related to auditory processing activities.

With this approach, the present study intends to contribute to the knowledge of the hearing abilities of premature children with indicators of risk at birth, assessing them in the age range of 8 to 10 years by means of electrophysiological and behavioral measurements.

This study aims to compare the performance in temporal auditory ordering and resolution tests and the latency and amplitude in the records of middle latency auditory evoked potential and P3 of prematurely born children with the performance of full-term children.

2. Patients and method

Approval for this study was granted by the local ethics committee (*277/09*). Informed written consent was obtained from the parent or legal guardian of each child evaluated in this study.

2.1. Sampling

The calculation of the sample size considering a 95% confidence interval and a 3% error was performed at the Statistical Office of the Faculty of Medical Sciences of Santa Casa de São Paulo (FCMSCSP), and a sample of 36 subjects for each group was suggested.

To compose the control group of this research, 120 questionnaires regarding school complaints were sent to the elementary school teachers of a public school in the city of São Paulo. The teachers indicated the students, in the age group of 8 to 10 years of age, without any learning complaint. Next, 36 children were randomly selected, born at term, with low risk for developmental alteration and without school and hearing difficulties.

The selection of the children to participate in the study group of the present research was performed through the analysis of medical records at the High Risk Outpatient Clinic of Pediatrics of the Irmandade of Santa Casa of Misericórdia of Sao Paulo - University Hospital. Sixty-two charts of children aged 8 to 10 years were selected (those having no syndrome stigmata, neurological or psychiatric disorders), of which 43 children presented hearing risk factor at birth; hearing; were attending a public school in Sao Paulo city, presenting normal tonal and verbal audiometry. Of the 43 invited, only 16 agreed to participate in the research.

Thus, data were obtained from 52 children, paired by sex, between 8 and 10 years of age, whose tone auditory thresholds were within the normal range (with thresholds up to 25 dBHL in the sound frequencies from 250 to 8 kHz); had a tympanometric curve type A and contralateral stapedial acoustic reflexes (in the sound frequencies from 500 to 4000 Hz). Those participating in the study were divided into two groups:

2.2. Control group

Thirty-six children born full-term with no risk indicators for auditory changes, no auditory, scholastic or language complaints, enrolled in public schools in São Paulo's central region.

Table 1
Distribution of auditory risk indicators ($N = 16$).

Auditory risk indicator	N	(%)
Birth weight < 1500 g	8	50
Ototoxic medication > 7 days	8	50
Low Apgar	4	25
Mechanical ventilation > 5 days	2	12.5

2.3. Study group

Sixteen children receiving care at the hospital preterm follow-up clinic, with a history of prematurity, and having at least 1 risk indicator for hearing loss in the perinatal period. In this group, the mean birth weight was 1497 ± 379 g, and the mean gestational age was 32.2 ± 2.8 weeks. The risk factors for hearing loss considered in our evaluation were: low birth weight, use of ototoxic drugs (aminoglycosides and/or diuretics), Apgar score in first and/or fifth minutes < 6, and prolonged mechanical ventilation. Table 1 shows the distribution of these risk factors in the cohort evaluated.

In the anamnesis conducted with the parents/legal guardians of prematurely born children, scholastic difficulties were reported in 56% of cases. All children with altered tests had access to the auditory training program at the institution.

2.4. Procedures

All participants had their temporal auditory processing assessed and middle latency auditory evoked potential and P3 measured as described below.

2.4.1. Temporal auditory processing

The tests were performed by means of a Compact Disc recording, played on headphones by means of an Itera Madsen audiometer coupled to a Compact Disc player, in an acoustic booth, with an intensity of 50 dB SL.

1. Temporal ordering: Frequency and Duration Pattern Tests (AUDITEC), version for children, 3 binaurally presented tones, response naming (20 sequences each). The percentage of correct responses for each test was recorded.
2. Temporal Resolution: Gaps in Noise (GIN) test [12]: done monoaurally, training, test 1 in the first ear tested (32 sequences), test 2 in the second ear tested (32 sequences). In the GIN test, the stimuli are distributed among four test tracks and one training track. White-noise segments, six second each, are interspersed with random gaps (silence intervals). Gaps are randomized and have varying durations (2, 3, 4, 5, 6, 8, 10, 12, 15 and 20 ms). The training track was played before the beginning of the test, thus ensuring that the child understood the instructions.

Participants were instructed to push a response button upon hearing the gaps inserted in the noise. The gap detection threshold was recorded (identification of at least 4 gaps in six attempts). The ear being tested first was alternated, with approximately half of the children starting off with the right ear and half of them, with the left ear.

2.4.2. Middle latency auditory evoked potential and P3

Auditory evoked potentials were assessed by using the two-channel Intelligent Hearing System Smart EP (USB Jr. Platform). The subjects were seated in a slightly reclined chair and instructed to remain relaxed, albeit on the alert. After the skin was cleaned with an abrasive paste, the electrodes were placed with the help of an electrolyte paste in accordance with the protocol for each potential test to be performed, as described below. The stimuli were delivered by means of insertion