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# Comparative Study of Automated (Algo 1 Plus) and Standard ABR in Evaluation of Hearing in Neonates and Infants

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**Keywords:** Automated ABR; Standard ABR in Newborns

**Abstract:** The study covered 55 newborns and infants in whom, basing on the assessment of the hearing organ, a comparative analysis of sensivity of the methods of screening and standard recording of auditory brain stem responses were performed.

The studied children were divided into two groups. Group I consisted of 30 healthy full-term babies from normal pregnancies and group II of 25 babies born from high risk pregnancies presenting also a high risk of hearing loss. The screening tests were made while the babies stayed in the Department and we use Algo-1 Plus (Natus Medical Inc.) equipment which allows automatic computer analysis of brain stem responses. The standard ABR recording was performed at the Audiology Lab. of Dept. of Otolaryngology at the dates which are different time intervals from the screening test, no longer however than 6 months. In the group of a full-term newborns 98% agreement between positive screening test and standard ABR recording results was obtained and the mean threshold values in the tested group ranged from 18.0 to 22.0 dBnHL. In group II consisting of newborns and infants presenting a risk of hearing loss the agreement in lack of response on both tests applied was observed at 86% level. The simplicity of the ABR automatic analysis method, the possibility to carry on population based studies at the Neonatal Department prove enormous benefits resulting from use of screening test complemented with standard ABR if necessary.

**Zusammenfassung:** *Vergleichende Untersuchung der automatisierten (Algo 1 Plus) und der Standarduntersuchung der Hirnstammpotentiale (ABR) zur Einschätzung der Hörfähigkeit bei Neugeborenen und Kindern.* Diese Untersuchung umfaßte 55 Neugeborene und Kinder, bei denen eine vergleichende Analyse der Hörfähigkeit mit Screening Methoden mit der Standardableitung von Hirnstrompotentialen durchgeführt wurde.

Die untersuchten Kinder wurden in zwei Gruppen geteilt, die Gruppe I umfaßte 30 gesunde und reife Babys aus normalen Schwangerschaften und die Gruppe II umfaßte 25 Babys aus Risikoschwangerschaften mit der großen Möglichkeit eines Hörverlustes. Die Screening-Tests wurden während des Aufenthaltes der Babys in der Klinik gemacht

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und wir verwandten das ALGO-1 Plus (Natus Medical Inc.) Gerät, das eine automatische Computeranalyse der Hirnstammpotentiale ermöglicht. Die Standardprüfung der akustischen Hirnstammpotentiale (ABR) wurden im audiologischen Laboratorium der HNO-Klinik durchgeführt, und zwar nach der Entlassung aus der Klinik, jedoch nicht später als sechs Monate. In der Gruppe der gesunden und reifen Neugeborenen wurde eine Übereinstimmung von 98% zwischen dem Screening-Test und der Standarduntersuchung (ABR) festgestellt, wobei die Schwellenwerte in der untersuchten Gruppe zwischen 18.0 und 22.0 dBnHL lagen. In der Grupp II, die Neugeborene und Kinder mit dem Risiko eines Hörverlustes umfaßte, betrug die Übereinstimmung in der Feststellung eines Hörfehlers in beiden Untersuchungen 86%. Die einfache Anwendung der automatisierten Analyse und Möglichkeit der Untersuchung noch in der Klinik belegen den enormen Gewinn eines solchen Screening-Testes, der bei Bedarf durch eine Standardableitung ergänzt werden kann.

## Introduction

For the last 10 years, electrophysiological audiometry, consisting in recording Auditory Brain Stem Response (ABR) has been considered to be a "golden standard" for screening neonates who demonstrated at least one of the 10 risk factors determined by American Joint Committee of Infant Hearing[3,9]. However, as results from the recent studies of Elssman et al.[1], and first of all of Mauk et al.[7] at least half of the children with severe or deep bilateral hearing loss have never demonstrated any risk factor. Therefore, ABR examinations carried only in children having risk, of hearing losseven if perfectly performed, can leave out at least a half of the total number of children with bilateral hearing loss requiring correction with a hearing aid. Because of that, among others, it has become an obvious necessity to evaluate hearing in neonates and infants in population based studies, so that following the challenge of Ewerett Koop of 1989, by the year 2000 all children with significant hearing impairment would be identified before 12 month of age[5].

So widely spread population based hearing tests are possible only with the use of fast, simple and non-invasive screening examination. One of the promising techniques for screening neonates is the measurement of otoacoustic emission first described by David Kemp from London in 1978[4]. The second screening test is the recently introduced "automated" recording of brain stem potential released with the acoustic stimulus – which can be done with the use of Algo-1 Plus Infant Hearing Screener (Natus Medical Corp., USA),[2,8]. The ALGO-1 Plus provides a "pass-refer" outcome, comparing an individual neonates ABR signal with a normative template algorithm.

The objective of the present preliminary report is to make a comparative analysis of the sensitivity and specificity of the methods of automated and standard recording of auditory brain stem response in neonates and infants.

## Materials and Methods

The studies covered 55 neonates born both at term and preterm. Thirty of them were healthy full-term children from physiological gestation and labour, while

the remaining 25 neonates and preterm children were born from high risk pregnancies and risk of hearing loss. Among the risk factors, the most common were perinatal injuries and the associated anoxia of the central nervous system, in 7 cases additionally connected with intracranial haemorrhage. In 6 cases rubella was diagnosed in mothers during the 1st trimester of pregnancy. Developmental anomalies, Down's syndrome or other diseases in mothers (Table 1) were found in single cases. The screening tests were made while the children stayed in Neonatology Department, basing on the automated ABR record, using Algo-1 Plus equipment.

The Standard ABR tests were made at the Audiology Laboratory of the Department of Otolaryngology, Faculty of Medicine, Jagiellonian University, using MEDELEC type Sensor connected with Apple II computer. Standard record tests were made, at different time intervals from the screening test, which did not however exceede the period of 6 months.

Both types of audiological tests were made immediately after feeding during the physiological sleep. Biopotentials were collected by silver electrodes placed in the standard way: active electrode on the forehead; reference and grounds electrodes on mastoid processes. The acoustic stimulus was an unfiltered click delivered to each ear separately through earphones.

**Table 1.** Hearing loss risk factors in the group of 25 children with incorrect ABR responses.

| | |
|---|---|
| perinatal injury | 4 |
| intracranial haemorrhages | 7 |
| rubella | 6 |
| other diseases in mother | 3 |
| Down's syndrom | 3 |
| developmental defects | 2 |
| total | 25 |

## Results

In the group of 60 ears in healthy and full-term neonates, agreement in both audiological tests used was found in 59 ears which makes 98.33% of cases. The standard recording in these children allowed to make the evaluation of the threshold values within the 18.0 to 22.0 dBnHL range, whereas in the group of neonates born with the risk of the hearing loss, the agreement of results in both, automated and standard brain stem potential recording was found for 42 ears, which makes 84% of cases.

In 38 ears both tests did not reveal any brain stem responses and in the remaining 4, the tests confirmed normal threshold values. In 5 ears (10% of cases) the lack of accordance was caused by the Algo-1 Plus equipment including in the group of deaf children all those in whom standard ABR tests revealed correct response with the threshold value at the 10–15 dBnHL level. In the remaining 3 ears (6%), despite the positive result in the automated recording, in the standard

**Table 2.** Responses in automated and standard brain stem responses.

| | Algo 1 Pass ABR posit. responses | Algo 1 Refer ABR no responses | Algo 1 Pass ABR no responses | Algo 1 Refer ABR posit. responses |
|---|---|---|---|---|
| No. of ears | 4 | 38 | 3 | 5 |
| % | 84 | | 6 | 10 |

ABR test of both ears, threshold values increased to the 60 dBnHL level were obtained, while in 1 case there was no positive response.

## Conclusions

The results obtained confirm high agreement in both audiological tests, particularly in the group of neonates from normal gestation and labour, while in the group of neonates with risk of hearing loss, the said accord is slightly lower, as it was observed in 84% of cases. The difference was caused by the fact that the Algo-1 Plus included in the group of deaf children all those in whom check-up tests showed correct response when other audiological tests were used. It is however not possible to account for lack of response in standard ABR recording tests with positive result of the automated test. It is possible that in the period between the first screening test and the standard test there occurred some damage to the hearing organ structure of unknown etiology. The agreement of the applied audiological tests in both groups of studied children, which is 91.81%, confirms the applicability of automated recording of brain stem potential as a screening test in both groups of children. Low weight, of the battery powered equipment makes it possible to install it at any place. The simplicity and speed of the test, ca. 15–20 min, as well as no need for the presence of a highly qualified audiologist to interpret the results are additional advantages of this test and make it possible to increase the number of the tests made. The fact that when using this test we are unable to determine the degree of the hearing loss nor find the nature of the damage cannot outweigh the benefits it offers. More sensitive and more specific test which allows to determine the threshold values, the topodiagnostics of the damage site by the standard ABR recording method, and requires much more time and the presence of a highly qualified pedoaudiologist for the interpretation of the results obtained, should be reserved for those children who do not undergo the screening test and therefore form a group with high probability of hearing loss which should be subject to more extensive audiological diagnostic procedures.

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