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ORIGINAL ARTICLE

Comparison between click and ce-chirp® stimuli in neonatal hearing screening

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Open acess

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Abstract

Objective: To compare the application time of the Automated Auditory Brainstem Response (A-ABR) between the click and CE-Chirp® stimuli.

Methods: Forty-six newborns were evaluated without risk indicators for hearing loss and presenting transient evoked otoacoustic emissions (TEOAE). The A-ABR was performed with Interacoustics® Titan equipment in a hospital, with the click and CE-Chirp® stimuli at the same time. Descriptive statistical analyses and inferential statistics analyses (Student's t-test calculation for mean comparisons among independent samples) were used for the variables age, gender, examination time, laterality and test stimulus used.

Results: Of the 46 neonates in the sample, 23 were male and 23 female. The mean age of the sample was 23.1 days. The mean procedure time using the Click stimulus was 85.9 seconds for the right ear and 86.1 seconds for the left ear, whereas for the use of the CE-Chirp® stimulus the results obtained for the right and left ear were28.4 seconds and 27.9 seconds, respectively. There was a statistically significant difference between the mean times obtained through the CE-Chirp® and Click stimuli for both ears (p=0.000). There was no statistically significant difference in the comparison between the right and left ears or between females and males.

Conclusion: It was found that the mean duration of the A-ABR procedure using the CE- Chirp® stimulus is three times lower than with the Click stimulus.

Keywords: neonatal screening, hearing loss, auditory evoked potentials, electrophysiology.

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Authors summary

Why was this study done?
This study was carried out with the objective of comparing two acoustic stimuli in the performance of the Neonatal Hearing Screening (NHS). NHS is mandatory in all maternity hospitals to identify newborns with suspected hearing loss. As it is a screening procedure, it is expected that the exam will be carried out quickly, since many neonates must be attended at the maternity hospital. Thus, this study tested the exam time for the standard stimulus (click) and a new stimulus (CE-chirp®).

What did the researchers do and find?
The researchers tested and compared the exam time of standard stimulus (click) with a new stimulus (CE-chirp®). The examinations were carried out in 46 neonates, of both sexes, in both ears. Prior to the comparison of the stimuli, an analysis was performed to check if there were differences between ears and sex, and the results were not statistically significant. When the stimuli were compared, there was a statistically significant difference in the examination time, being less for the stimulus (CE-chirp®), that is, CE-chirp® made the procedure faster.

What do these findings mean?
These results indicate that the Neonatal Hearing Screening procedure with the stimulus (CE-chirp®). Other research has already been carried out showing the sensitivity and specificity of this stimulus. Thus, (CE-chirp®) can be used safely, making the procedure faster, which directly impacts the quality of the Neonatal Hearing Screening programs.

INTRODUCTION

Neonatal Hearing Screening (NHS) is performed by means of electroacoustic and/or electrophysiological tests and is the main way to identify hearing loss early in newborns. This screening procedure should be fast, simple and select the individuals with a higher probability of change in the tested function[1], since the number of babies born with bilateral hearing loss is one to three in every 1,000 live births and this number increases to 2 to 4% in the ones treated in neonatal intensive care units[2].

Considering that half of the cases of hearing impairment could be minimized with early intervention, in 2012 the Ministry of Health[3] prepared the Care Guidelines for Neonatal Hearing Screening, which provides for the network of childhood hearing health care. The recommendations of these Guidelines, as well as that of the Multiprofessional Committee on Hearing Health (COMUSA)[4], are the use of the Automated Auditory Brainstem Response (A-ABR) for newborns with risk indicators for hearing loss, as the initial screening method, since this test predominantly evaluates the central auditory pathway[5], enabling the identification of neural hearing disorders. Some authors have shown that the population with risk indicators and who remain in a neonatal Intensive Care Unit (ICU), have a higher occurrence of retrocochlear hearing loss, thus suggesting the use of A-ABR[6,7].

A-ABR is an objective evaluation of hearing in newborns with risk indicators for hearing loss[4]. Placing electrodes at specific points of the skull allows the capture of hearing responses when acoustic stimulation is performed. The synchronous spike of the brainstem auditory fibers allows the recording of the responses in the equipment, which interprets the result as pass (present, satisfactory result) or fail (absent, unsatisfactory result). Different acoustic stimuli may be used to evoke responses, such as click and, more recently, CE-Chirp®[8].

The click stimulus on ABR reaches the basilar membrane with a considerable difference between the base and the apex of the cochlea, not stimulating the cells at the same time. This stimulation results in an asynchronous depolarization of the neurons. For this reason, researchers have been developing studies to build the new CE-Chirp® stimulus model. In this stimulus, the time of presentation for the low, medium and high frequencies are different, causing a simultaneous stimulation in all regions of the cochlea[8]. Because of this difference, the CE-Chirp® stimulus is suggested for the Neonatal Hearing Screening, since it facilitates the detection of the responses by presenting greater amplitudes and reducing the duration of the test[9,10].

In view of the need to develop faster and more effective tests for this population and aiming to contribute to the advancement of research in the area, this study aimed to compare the time of application of the test with the click and the CE-Chirp® stimuli in A-ABR.

METHODS

This is a cross-sectional and analytical study. The research's sample is consisted of 46 newborns who were born in a public hospital. Included in the study were newborns with no risk factors for hearing loss, who presented transient-evoked otoacoustic emissions. As exclusion criterion, all newborns with syndromes associated with hearing loss, with presence of craniofacial malformations, family history of sensorineural hearing loss, neurological disorders, congenital anomalies or infections, bacterial meningitis, hyperbilirubinemia at the exsanguinotransfusion level and those with apgar lower than 06 (six) at the 1st and 5th minute were removed from the sample. Thus, we investigated the presence of Risk Indicators for Hearing Loss-RIHL, as suggested by the Joint Committee on Infant Hearing[11], and clinical history in order to verify the eligibility criteria.

The data collection was performed during the period of August to November 2015, with the Titan equipment of the brand Interacoustics®. The subjects underwent A-ABR and were in natural sleep on their mother's lap or on the bed. At that time, the tests were performed with the click and CE-Chirp® stimuli at the intensity of 35 dBHL and a repetition rate of 93 clicks/second. For the tests, the newborns had their skin cleaned with Nuprep® abrasive paste to fix the electrodes. The reference electrodes were placed on the right and left mastoids (A1 and A2) and the active (Fz) and ground (Fzp) electrodes on the forehead. To measure the time of examination of the different stimuli, the Casio HS-3 chronometer was used.

For the analysis of the variables age, gender, examination time, laterality and test stimulus used, the data collected were stored in an Excel spreadsheet and the statistical analysis was performed with the aid of the IBM StatisticalPackage for Social Sciences software version 18.0 (SPSS Inc., Chigago, IL). Descriptive statistical analyses (calculation of measures of central tendency and of variability and graphical analysis for the quantitative variables of the study) and inferential statistical analyses (Student's t-test calculation for mean comparisons among independent samples) were performed. For all the tests performed, the significance level of 5% was established, i.e., significant statistical mean differences among groups will be denoted by $p< 0.05$.

This research was approved by the Ethics Committee of the Federal University of Rio Grande do Sul. It should be noted that Resolution 466/12, which deals with human research, was fully respected. Thus, the newborns who participated in this study were the ones whose parents and/or guardians signed the Informed Consent Term (ICT), in which topics such as the objective, methodology of the proposed study, as well as risks, discomforts and secrecy regarding their identification were clarified.

RESULTS

The sample of this study consisted of 46 newborns (23 males and 23 females). The minimum age observed for the newborns was 18 days and the maximum age was 27 days. In this sample, the evaluated newborns had a mean of 23.1 days of age with a variation of 2.7 days. Table 1 shows the description of the newborns by gender and age (days).

The description of examination times with Click and CE-Chirp® stimuli by ears are reported in Table 2. There was a statistically significant difference between the mean times obtained through the CE-Chirp® and Click stimuli for both ears and gender.

In the A-ABR evaluation, the CE-Chirp® stimulus presented statistically lower mean times when compared to the Click stimulus. The descriptive values are shown in Table 3.

Figure 1 shows the time of the CE-Chirp® stimulus on the right and left ears. In Figure 2, the Click stimulus time is described for both ears.

In the analysis of the time of the stimuli between the right and left ears there was not a statistically significant difference, both for the CE-Chirp® stimulus ($p= 0.572$) and for the Click stimulus ($p= 0.959$).

No statistically significant differences were found for the means obtained in the A-ABR between female and male newborns both for the right ear and the left ear.

Table 1: Sample description (n=46)

Variable	Gender	n	Minimum	Maximum	Median	Mean	SD
Age (in days)	Female	23	18	27	23	22.5	2.6
	Male	23	19	27	24	23.6	2.7
	Total	46		27	23	23.1	2.7

SD = standard deviation

Table 2: Description of examination time with Click and CE-Chirp® stimuli by ear

Ear	Time (seconds)	n	Minimum	Maximum	Median	Mean	SD
Right	CE-Chirp®	46	14	74	24.0	28.4	13.2
	Click	46	30	159	83.8	85.9	29.0
Left	CE-Chirp®	46	15	81	23.6	27.9	12.9
	Click	46	29	165	87.3	86.1	26.5

Table 3: Comparison among the mean times obtained in the A-ABR, comparative by gender, ear and type of stimulus.

Gender	Ear	Stimulus	n	Mean	SD	P
Female	Right	CE-CE-Chirp®	46	26.6	13.0	0.000 *
		Click	46	89.8	29.7	
	Left	CE-CE-Chirp®	46	25.9	13.2	0.000 *
		Click	46	88.6	28.9	
Male	Right	CE-CE-Chirp®	46	27.9	12.9	0.000 *
		Click	46	87.9	28.8	
	Left	CE-CE-Chirp®	46	28.1	14.8	0.000 *
		Click	46	87.6	27.1	

SD = standard deviation; p-value = Student's t-test result for comparison of independent means. ns = difference of non-significant means at 5%; * = difference of significant means at 5%.

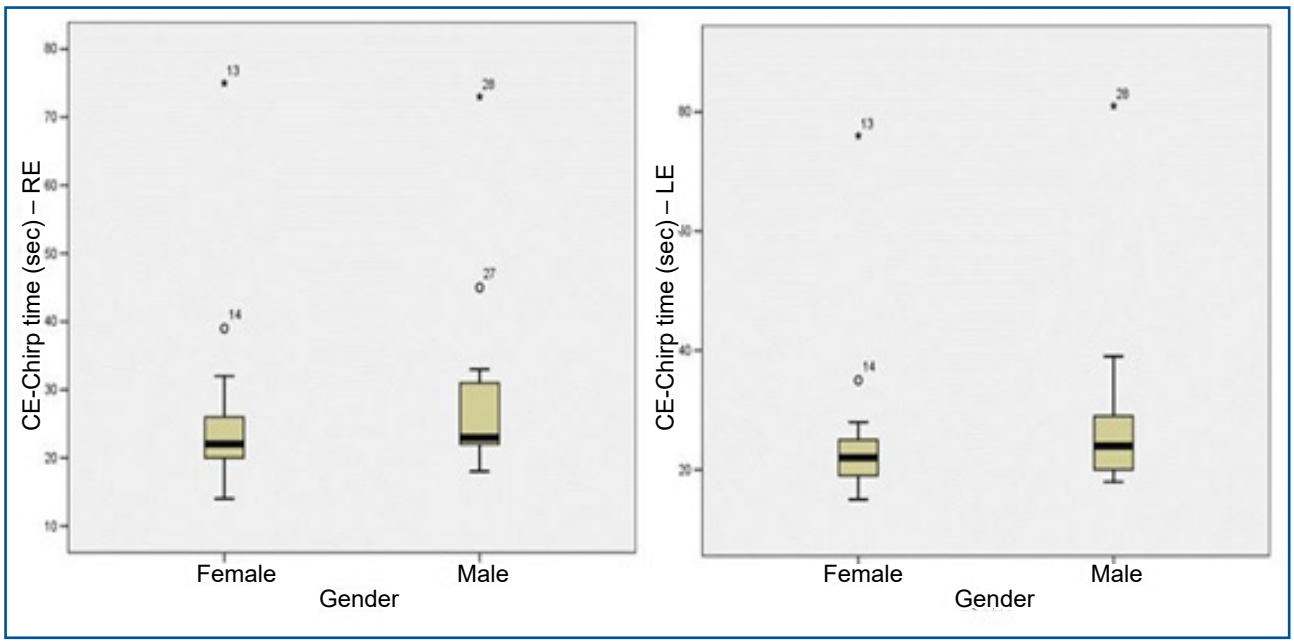

Figure 1: Box plot for the variable CE-Chirp® time (seconds) on the right ear and left ear.

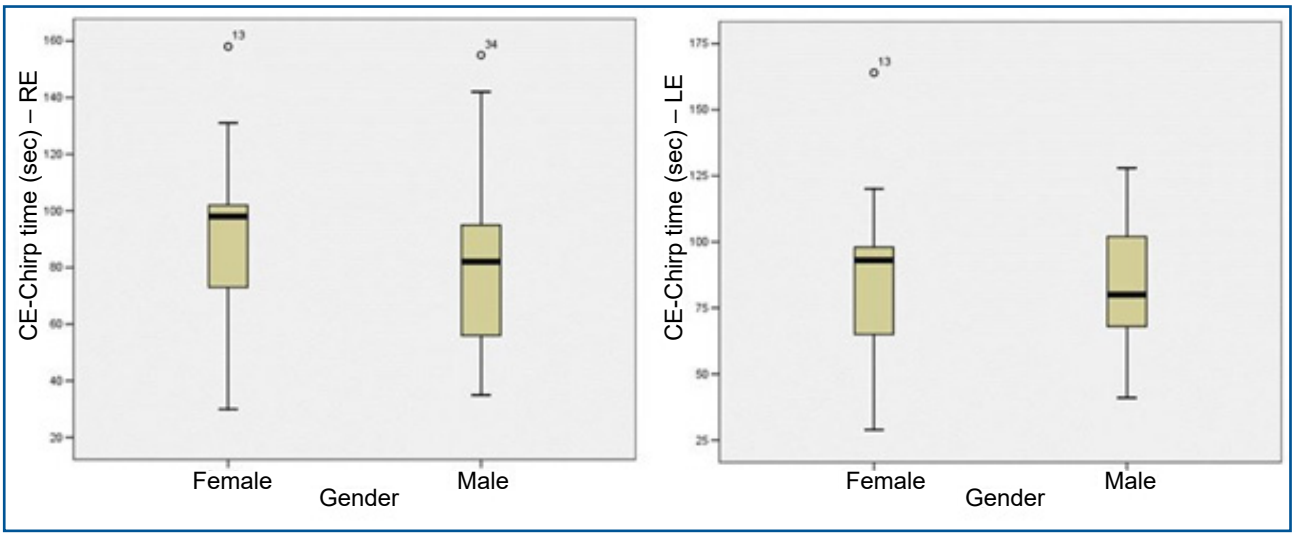

Figure 2: Box plot for the variable Click time (seconds) on the right ear and left ear.

DISCUSSION

The results of this research compared the time of performance of the A-ABR with two distinct stimuli. The sample of the present study presented an intentional homogeneous distribution in relation to gender. Regarding age, the newborns in this sample had a mean of 23.1 days of life, as well as a study carried out in the city of São Paulo, in which the time of A-ABR with new technologies was compared in newborns, a population similar to the one of the present study[9].

The mean time to perform the A-ABR with the use of the Click stimulus found in the present study was 85.9 seconds for the right ear and 86.1 seconds for the left ear. However, in a Brazilian study[9], performed in a similar population, the results found for the click stimulus in the A-ABR, with a repetition rate of 90 Hz, presented a mean time of 27.9 seconds, whereas in another study[12] the mean time was 32.9 seconds. These results did not corroborate those found in this study for the Click stimulus time. These data could be explained because the equipment used in the referred studies and in the present research are not from the same manufacturing brand, which could have influenced the responses obtained in the tests.

However, in the findings of this research, for the CE-Chirp® stimulus, the mean times found for the right and left ears were 28.4 seconds and 27.9 seconds, respectively. These findings were similar to those of a recent study[13], in which the CE-Chirp® stimulus was used, and that mean times of 28 seconds were found.

The findings of the present study showed that the CE-Chirp® stimulus time, used in the A-ABR, is lower and statistically significant when compared to the Click. Research that evidenced the short time to detect responses with the CE-Chirp® stimulus has already been presented by other authors[10,14-16], which corroborates the findings of this research. It is known that the CE-Chirp® stimulus by performing a simultaneous stimulation in all regions of the basilar membrane, increases the neural synchrony causing a greater amplitude and detection of responses[16], which would then justify the reduction of the examination time.

The analyses obtained in this research did not show statistically significant difference among the means obtained for the duration of A-ABR in the comparison between the right and left ears for both stimuli. However in another study[16], the researchers found a higher response detection time for the left ear, regardless of the stimulus used. Nevertheless, in the aforementioned research, the authors justify this finding, due to possible outer/middle ear alterations, which were not controlled in the research and which may have influenced the increase in the time for sound conduction, which was not observed in the findings of this study.

There are no reports in the literature of findings of time differences between genders, in similar populations and tests. Thus, no statistically significant differences were found in this sample.

It should also be emphasized that the sensory deprivation caused by hearing loss has great consequences for the development of newborns, as well as for their families and society[12]. In order to minimize the effects for these individuals and to establish an early diagnosis[17], alternatives to ensure the effectiveness of the procedures used in the NHS have been developed. The time presented in this study was three times lower for the CE-Chirp® stimulus in the A-ABR, evidencing the relevance of this technology for this procedure. Some authors[10,13-15] emphasize the importance of the CE-Chirp® stimulus for use in Neonatal Hearing Screening, since this stimulus facilitates the automatic detection of responses, reducing test time[9]. Since Neonatal Hearing Screening with the use of A-ABR is recommended for newborns with risk factors for hearing loss, and many of the newborns remain in the ICU, the procedures for the Neonatal Hearing Screening should aim at reducing handling time of the newborn in this environment, since procedures with elevated time may generate stress in this population[18].

This study contributes to the speech-language pathology literature, reinforcing the importance and improvement of the techniques used in the Neonatal Hearing Screening. The CE-Chirp® stimulus allows a faster evaluation of the newborns, which contributes to a greater number of subjects being screened, and those who are suspected of presenting hearing loss may be diagnosed early.

New research should be performed on newborns with risk indicators for hearing loss, since this study evaluated newborns with no risk indicators for hearing loss.

Thus, we highlight the importance of the results of the present study, aiming at greater agility and comprehensiveness of the A-ABR with the CE-Chirp® stimulus in the Neonatal Hearing Screening of populations considered to be at risk for retrocochlear alterations, contributing to an early and reliable diagnosis.

CONCLUSION

It is possible to conclude that the CE-Chirp® stimulus presented reduced time in A-ABR testing, with a mean time of 28.4 seconds for the right ear and of 27.9 seconds for the left ear, presenting three times lower time in the A-ABR when compared to the click.

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Resumo

Objetivo: Comparar o tempo de aplicação do Potencial Evocado Auditivo de Tronco Encefálico Automático (PEATE-A) entre os estímulos clique e CE-Chirp®.

Método: Foram avaliados 46 recém-nascidos sem indicadores de risco para perda auditiva e que apresentavam emissões otoacústicas evocadas por estímulo transiente (EOAT) presentes. O PEATE-A foi realizado com o equipamento Titan da Interacoustics® em ambiente hospitalar, com os estímulos clique e CE-Chirp®na mesma ocasião. As análises estatísticas descritivas e análises estatísticas inferenciais (cálculo do teste t de Studentpara comparações de médias entre amostras independentes) foram utilizadas para as variáveis idade, gênero, tempo de exame, lateralidade e estímulo de teste utilizado.

Resultados: Dos 46 recém-nascidos da amostra, 23 são do sexo masculino e 23 do sexo feminino. A idade média da amostra foi de 23,1 dias. O tempo médio do procedimento usando o estímulo clique foi de 85,9 segundos para a orelha direita e 86,1 segundos para a orelha esquerda, enquanto que para o uso do estímulo CE-Chirp®foram obtidos resultados para a orelha direita e esquerda de 28,4 segundos e 27,9 segundos respectivamente. Houve diferença estatisticamente significante entre os tempos médios obtidos por meio dos estímulos CE-Chirp® e Clique para ambas as orelhas (p=0,000). Não houve diferença estatisticamente significante na comparação entre as orelhas direita e esquerda ou entre o sexo feminino e masculino.

Conclusão: Verificou-se que o tempo médio de realização do procedimento PEATE-A com uso do estímulo CE-Chirp® é três vezes menor do que com estímulo Clique.

Palavras-chave: triagem neonatal, perda auditiva, potenciais evocados auditivos, eletrofisiologia.