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Differential diagnosis: hearing loss or autism spectrum disorder

Diagnóstico diferencial: perda auditiva ou transtorno do espectro do autismo

Diagnóstico diferencial: pérdida auditiva o transtorno del espectro autista

Gabriele Selli[*]
Ana Carolina Steiner Stupp[*]
Débora Frizzo Pagnossim[*]
Cristina Maria Pozzi[*]
Vanessa Maria de Assis Pessin[*]

Abstract

Introduction: Hearing loss (HL) is characterized by a change in the auditory system, with decreased hearing ability, while the Autism Spectrum Disorder (ASD) is defined as a developmental and behavioral change. However, there are many symptoms of HL and ASD that overlap, requiring a differential diagnosis to be performed by a multidisciplinary team. **Objective:** To characterize the process of differential diagnosis between HL and ASD and its association in children from zero to twelve years of age, at a Hearing Health Outpatient Clinic (Serviço Ambulatorial de Saúde Auditiva - SASA). **Method:** This is a cross-sectional and qualitative document-based study in a database of 94 records of children attended by the clinic from 2012 to 2017, with at least one diagnostic hypothesis of ASD. The statistical analysis was descriptive with a comparison test between the two population proportions with a 5% significance level. **Results:** Of the 94 suspected cases of ASD, 36 were confirmed. There was a prevalence of males and the age group of three to four years at the time of the suspicion or confirmed diagnosis of ASD. Most of the children presented borderline hearing loss within the normal limits, and normal results in the Brainstem Auditory Evoked Potential (BAEP) responses. Although there was a prevalence of language delays in the language assessment, when this was associated with other communicative changes (symbolic function, communicative intention and/or echolalia) there was an increase in the changes in the BAEP. **Conclusions:**

* Universidade do Vale do Itajaí, Santa Catarina, Brazil.

Authors' contributions:
GS, ACSS: Elaborated the project, submitted it to the research ethics committee (CEP), collected data and wrote the article.
DFP: Conducted the orientation of the academics.
CMP, VMDAP: Conducted evaluation and review of the final article.

Correspondence e-mail: Gabriele Selli - gabi_selli@hotmail.com
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Multidisciplinary care is important for the differential diagnosis of HL, ASD, or the association between them, in order to ensure the most adequate intervention for each case.

Keywords: Diagnosis Differential; Hearing Loss; Autism Spectrum Disorder.

Resumo

Introdução: a perda auditiva (PA) caracteriza-se por uma alteração no sistema auditivo, com diminuição da audição e o Transtorno do Espectro do Autismo (TEA) é definido como uma alteração de desenvolvimento e do comportamento. Muitos sintomas da PA e do TEA se sobrepõem, requerendo um diagnóstico diferencial. Objetivo: determinar as características do atendimento em um Serviço Ambulatorial de Saúde Auditiva (SASA) para diagnóstico diferencial de deficiência auditiva em crianças de zero a 12 anos de idade, com suspeita ou confirmação de TEA. Metodologia: pesquisa quantitativa documental transversal em banco de dados com 94 registros de crianças de zero a 12 anos, com suspeita ou confirmação de TEA. A análise estatística foi descritiva com teste de comparação entre duas proporções ($\alpha < 5\%$). Resultados: dos 94 registros, 36 tinham a confirmação de TEA e 58, a suspeita deste. Houve prevalência do sexo masculino e da faixa etária de três a quatro anos. Observou-se forte tendência de crianças com TEA suspeito apresentarem audição dentro dos padrões da normalidade, enquanto que as com TEA confirmado tiveram forte tendência para ocorrência de PA condutiva. Na avaliação eletrofisiológica foram observadas alterações não compatíveis com PA coclear em alguns casos de TEA confirmado, sendo que nos atrasos de linguagem associados a outras alterações na função comunicativa houve forte tendência para alterações no PEATE não compatíveis com PA coclear. Conclusões: deve-se ter atenção, durante os atendimentos audiológicos infantis, para os resultados da avaliação eletrofisiológica, que associada à história clínica pode despertar a suspeita de TEA.

Palavras chave: Diagnóstico diferencial; Perda auditiva; Transtorno do Espectro Autista

Resumen

Introducción: la perdida de audición (PA) se caracteriza por un cambio en el sistema auditivo, con disminución de la audición, y el transtorno del espectro autista (TEA) se define como un cambio en el desarrollo y el comportamento. Muchos sintomas de PA y TEA se superponen, lo que requiere que un equipo multidisciplinario haga un diagnóstico diferencial. Objetivo: caracterizar el proceso de diagnóstico diferencial entre BP, ASD y su asociación en niños de cero a doce años en un Servicio de Salud Auditiva Ambulatoria (SASA). Metodología: investigación documental cuantitativa transversal em una base de datos con 94 registros de niños de 0-12 años tratados de 2012 a 2017, con al menos una hipótesis diagnóstica de TEA. El análisis estadístico fue una prueba descriptiva y comparativa entre dos proporciones a un nível de significación del 5%. Resultados: entre los 94 casos sospechos de TEA, 36 tuvieron confirmación. Hubo una prevalencia de varones y el grupo de edad de tres a cuatro años en el momento de la sospecha o confirmación de TEA. La mayoría de los niños tienen umbrales auditivos normales y resultados normales en los potenciales evocados auditivos del tronco encefálico (BAEP). En la evaluación del lenguaje, hubo una prevalencia de retraso del lenguaje, pero cuando se asoció con otras alteraciones comunicativas (función simbólica, intención comunicativa y / o ecolalia), hubo un aumento em las alteraciones BAEP. Conclusiones: la atención multidisciplinaria es relevante para el diagnóstico diferencial de PA, TEA o su asociación, con el objetivo de la interación más adecuada para cada caso.

Palabras clave: Diagnóstico Diferencial; Pérdida auditiva; Transtorno del Espectro Autista.

Introduction

Hearing loss (HL) is one of the main disorders that causes limitations in the communication and social interaction of children[1].

The World Health Organization[2] suggests 15 dB in the tritonal average of 500, 1,000 and 2,000 Hz frequencies as a normal hearing limit for children: hearing thresholds above this value already indicate a HL[3].

Similar to hearing loss, language changes are also seen in Autism Spectrum Disorder (ASD), which often lead to undefined or inaccurate diagnoses, compromising the definition of appropriate approaches for speech-language pathology.

The number of children diagnosed with ASD has been increasing significantly, and cross-sectional studies report an increasing growth in the number of cases. In 2008, the prevalence of ASD was one child with ASD for every 88 without; in 2014, it was one for every 68[4] and one for every 54 children[5] in 2018.

The ASD is classified as a neurodevelopmental disorder, characterized by persistent deficits in communication and social interaction, including deficits in social reciprocity, nonverbal communication behaviors and skills to develop, maintain and understand relationships[6]. In addition to these deficits, the presence of restricted and repetitive patterns of behavior, interests or activities is required to the diagnosis of ASD. As a change in behavior and development, its symptoms should appear before the age of three[7].

HL behaves similarly to ASD, since partial or total deprivation of auditory experiences allows delay in language development, and consequently can lead to isolation or social distance.

In both HL and ASD, comprehension difficulties make it possible for behavioral, cognitive and emotional changes to appear, as well as sensory deprivation, failures in perceptual organization skills, reception and structuring of information, difficulties in the development of written language and, consequently, limitation in school development[8,9].

With a prevalence of HL in children with ASD of one for every 54[10], HL and ASD may also be associated, which indicates the need for a differential diagnosis, since the characteristics of HL and ASD require analysis and clinical differentiation[9]. The differential diagnosis of ASD must be careful and consider the three fields affected: development of social interaction, communication and behavior[11].

The differential diagnosis should assess the hearing and language skills of the child with suspected HL or ASD. Hearing assessment should consist of behavioral and electrophysiological assessments, with emphasis on the analysis of the Brainstem Auditory Evoked Potentials (BAEP). Although the objective of a hearing assessment is to determine the hearing thresholds in a conventional audiometry, when this is not possible, an accurate estimate of the child's hearing should be obtained[12], which makes the association of behavioral and objective methods relevant[13].

BAEP is an objective and short-latency electrophysiological method that allows the assessment of the entire auditory pathway, from the auditory nerve to the brainstem. The parameters analyzed include: morphology; absolute latency and amplitude of waves I, III and V; interpeak latencies of intervals I-III, I-V and III-V; ratio of amplitude and I-V latency and interaural difference of I-V interval or absolute latency of wave V[14].

In turn, language assessment must consider that the language characteristics of children with ASD and HL often overlap. Although changes in symbolic function and social interaction are expected both in children with ASD and in children with HL, language delay in ASD occurs through an atypical model of language development, while language delay in HL occurs through late language development. These differences can be observed in pre-verbal communication skills, which are delayed in children with ASD, but not in children with HL[15].

Thus, language assessment is crucial to raise, confirm or deny diagnostic hypotheses by analyzing the set of difficulties and facilities and obtaining data for decision making on how to proceed with the treatment. Included in the multidisciplinary context, the speech-language pathologist is responsible for determining the treatment[16].

Early diagnosis of both HL and ASD allows an adequate intervention, thus resulting in a better prognosis. Therefore, further research is needed to help in the differential diagnosis, showing the importance of the early evaluation of the child who has changes in the communication process. Even if the diagnosis is not confirmed, it is important to be aware of the development issues of the child, so that significant delays and implications can be identified[9].

Therefore, this study aims to determine the characteristics of care in a Hearing Health Outpatient Clinic (SASA) for the differential diagnosis of hearing impairment in children aged 0-12 years, with suspected or confirmed ASD.

Methods

This is a cross-sectional and qualitative document-based study, which was carried out in a Hearing Health Outpatient Clinic (SASA) that serves 52 municipalities in the Upper, Middle and Lower Valley of Itajaí. This study was approved by the Research Ethics Committee (CEP) of Univali under consubstantiated opinion No. 2.538.514 of March 12, 2018.

The SASA in which the study was conducted provides medium and high complexity care, and the child care team consists of 2 otorhinolaryngologists, 1 neuropediatrician, 3 speech-language pathologists, who perform hearing assessments and the selection, indication and adaptation of sound amplification devices, 1 speech-language pathologist, who performs electrophysiological hearing assessments, 3 speech-language pathologists, who perform language assessment in auditory rehabilitation, 1 psychologist and 1 social worker.

The process of differential diagnosis of hearing impairment includes otorhinolaryngological, neurological and psychological analysis, in addition to an interview with a social worker. In the field of speech-language pathology, hearing assessments always combine behavioral methods that are appropriate for the child's age and electrophysiological assessment (analysis of Evoked Otoacoustic Emissions and BAEP). Behavioral evaluations consist of observation of auditory behavior for uncalibrated sounds and visual reinforcement audiometry with ER-3A insert earphones or playful audiometry, logoaudiometry (tests chosen based on age and language development of the child) and analysis of acoustic immittance measures.

In turn, language assessment follows the institution's own protocols, consisting of interviews with parents and application of appropriate tests for the age of the child being assessed. At the end, an evaluation report is prepared and describes the child's form of communication, establishing whether there is language delay and whether it is pure (when only language is affected) or associated with other changes in communicative functions, such as changes in symbolic function, communicative intention or presence of echolalia.

The neurological evaluation performed at the study center also uses instruments suitable for the age of the child evaluated and duly validated for clinical use. Thus, the diagnosis of ASD followed the criteria provided for in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders until 2013, and, from 2013, those foreseen in the fifth edition of the same instrument. The neurological assessment is recorded in the medical record and the diagnostic hypothesis is provided in a Multidisciplinary Report for Differential Diagnosis of Hearing Impairment, which is prepared and provided to those responsible for the child evaluated. Thus, cases of ASD confirmed were considered only when the diagnosis was included in this report.

In order to close the cases and prepare the reports mentioned above, the team holds a weekly multidisciplinary meeting, in which, in addition to the report, they feed a database of the Institution with the results of all evaluations carried out with each child.

Thus, data collection was performed in this database, which contained a record of 441 users. The study sample consisted of 94 children on this list between 0-12 years of age, attended from 2012-2017, with at least one diagnostic hypothesis of ASD performed by the neuropediatrician at the institution.

Exclusion criteria included records in which there was no suspicion or confirmation of ASD, and records that had other associated comorbidities, such as genetic syndromes, chronic non-progressive encephalopathies or malformations.

The database is entered into an Excel spreadsheet with the following variables: age; gender; reason for referral; date of the first consultation; date of completion of the multidisciplinary diagnosis, date and opinion of the otorhinolaryngological, neurological, psychological and social service evaluation; result of the hearing behavioral assessment; result of electrophysiological hearing assessment; result of language assessment; conclusion and approach for the case.

In this sense, this study included the following variables from this database: age; gender; reason for referral for the differential diagnosis of hearing loss; result of the otorhinolaryngological evaluation; result of the audiological evaluation; result

of language assessment; neurological assessment opinion, composition of the multidisciplinary team and conduct.

The child's age at the time of suspicion or diagnosis of ASD performed at the study center was used for the "age group" variable, while language development milestones were adopted, which show greater evidence of changes in the first years of life, were adopted for grouping the age group.

The variable "reason for referral for the differential diagnosis of hearing loss" was searched in the column of the SASA database for this purpose. As there was a great variety in completing this field, the reasons were grouped by similarities: language delay ("does not speak, speaks little, is late to speak, cannot communicate"); suspected HL ("I think he/she doesn't listen, the school complains that he/she doesn't listen, doesn't wake up even with loud noises, has already undergone hearing assessment and has PA"); Risk Indicators for Hearing Loss - Risk Indicators for Hearing Loss- with no complaints from the family regarding the child's hearing; delay in neuropsychomotor development - NPMD - or other neurological/psychological conditions other than ASD; suspected/confirmed ASD. It is noteworthy that in many cases a single child had more than one reason for referral to a SASA.

The variable "composition of the multidisciplinary team" was established based on the evaluations that were completed in the database - when the column in the database was blank, it was considered that the child did not perform an evaluation in that professional field.

The otorhinolaryngological evaluation was divided into: no changes, changes in the external and/or middle ear associated or not with changes in the upper airways and changes only in the upper airways.

The results of audiological evaluations were classified according to the provisions of the "Guide for audiological evaluation" of the System of the Brazilian Federal and Regional Councils of Speech-Language Pathology and Audiology[17], which recommends the criteria set forth by Silman and Silverman (1997) for the type of HL and by Northern and Downs (2002) for the classification of the HL degree in children. The results of the acoustic immittance measures were also analyzed based on the provisions of this guide.

In turn, the analysis of BAEP and Otoacoustic Emissions followed the protocol adopted in the SASA, which uses the standard of normality established in the international literature[18,19]. Thus, the possible results in the BAEP were: BAEP with no changes; Expected BAEP for cochlear HL, in which there is a delay in the absolute latencies of waves I, III and V, with no change in interpeak intervals I-III, III-V and IV, BAEP absent and/or absence of cochlear microphones and unexpected BAEP in Cochlear HL, which included changes related to wave V, increased absolute latencies and increased interpeak intervals, BAEP absent with the presence of cochlear microphonic or BAEP absent with inconclusive cochlear microphonic.

The results of the language assessment were classified as pure (difficulties in understanding or producing language) or associated (presence of organic or neurodevelopment problems) language delay[20], which highlight the changes in the symbolic function (reconstruction of objects and events by the imagination associating with previous experiences, which can be evidenced in pretend plays, role-playing and games)[21] or in the communicative intention (absence or reduction of it) and echolalia (repetition of words).

Data analysis was performed using descriptive statistics with calculation of absolute and relative frequencies and measures of central tendency and dispersion, when necessary. The comparison between the percentages, according to the gender; age at diagnosis; reasons for referrals to SASA and relationship between the results of BAEP or hearing assessment or language assessment with suspected our confirmed ASD was performed by means of comparison tests between two proportions with a 5% significance level.

Results

Table 1 shows the data related to the gender and age of the children whose records were analyzed.

Table 1. Distribution of the participants regarding gender and age group at the time of diagnosis or suspicion of ASD developed by the study center (n=94).

Age at diagnosis (years)	Gender						p-value
	Female		Male		Total		
	N	%	N	%	N	%	
0 |-- 2	1	1.06	4	4.26	5	5.32	0.48
2 |-- 3	4	4.26	18	19.15	22	23.40	0.10
3 |-- 4	6	6.38	27	28.72	33	35.11	0.03*
4 |-- 5	3	3.19	11	11.70	14	14.89	0.25
5 |-- 10	4	4.26	8	8.51	12	12.77	0.52
10 |-- 12	1	1.06	2	2.13	3	3.19	0.75
Not reported	2	2.13	3	3.19	5	5.32	0.80
Total	21	22.34	73	77.66	94	100.00	<0.0001*

*significant values

Table 1 shows a prevalence of males (77.66%) and the age group of three to four years (35.11%) at the time of suspected or confirmed ASD performed at the study center.

The mean age at the time of suspected or confirmed ASD was 3.79 years, with a standard deviation of 1.90. The minimum age was 11 months and the maximum age was 11.1 years. It should be noted that three children were diagnosed with ASD after 10 years of age, which impacts the mean and increases the standard deviation. Thus, we chose to use the median central tendency measure, which shows that more than half of the sample had the diagnosis of ASD when they were up to 3.3 years of age.

Regarding gender, the statistical analysis shows a greater number of boys who had a differential diagnosis of hearing loss and who had suspected ASD, regardless of the age group ($p<0.0001$), but especially on the age group between 3-4 years ($p=0.03$).

With respect to the reasons for referral to the SASA, it was found that the main reason was language delay (63.83%), followed by suspected HL (22.81%); presence of RIHL (12.28%); delay in NPMD or other neurological/psychological conditions other than ASD (5.32%) or suspected/confirmed ASD (5.32%).

Chart 1 shows the composition of the multidisciplinary team to assist the 94 children who participated in the study.

Chart 1. Composition of the multidisciplinary team that participated in the assessment for differential diagnosis of hearing impairment (n=94).

Field of assessment	Assessed	Not assessed
Neuropediatrics	94	0
Speech-language pathology - basic audiological evaluation	93	1
Otorhinolaryngology	92	2
Psychology	89	5
Speech-language pathology - language evaluation	80	14
Social work	73	21

Chart 1 also highlights that 25 children did not perform the electrophysiological assessment and 14 did not perform the language assessment. Of the 94 children, 69 (73.40%) were assessed by the entire multidisciplinary team of that SASA where the study was conducted.

The otorhinolaryngological evaluation showed 54 (57.45%) cases with no changes; 34 (36.17%) with changes in the external and/or middle ear associated or not with changes in the upper airways, and 6 (8.51%) with changes only in the upper airways.

The results of audiological diagnosis showed 60 (63.83%) children with hearing within the normal range of bilateral normality, 33 (35.11%) with HL and 1 (1.06%) with incomplete evaluation, making the audiological opinion impossible.

Table 2 shows the classification regarding the degree and type of HL of these children. Table 3, in turn, shows the relationship between suspected or confirmed ASD and audiological diagnosis.

Table 2. Distribution of subjects regarding the type and degree of hearing loss per ear. (n=33)

	Type of HL									
	Conductive		Sensorineural		Mixed		Retrocochlear factor		Total	
Degree of HL	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
Mild	9	8	4	4	1	1	0	0	14	13
Moderate	1	1	2	3	5	4	0	0	8	8
Severe	0	0	4	4	1	1	0	0	5	5
Profound	0	0	5	5	0	1	0	0	5	6
Retrocochlear factor	0	0	0	0	0	0	1	1	1	1
Total	10	9	15	16	7	7	1	1	33	33

HL=Hearing Loss; RE=Right Ear; LE=Left Ear

Table 3. Results of hearing assessment in cases of suspected or confirmed ASD. (n=94)

Hearing assessment	Confirmed ASD		Suspected ASD		p-value
	N	%	N	%	
Hearing thresholds within the normal range	19	52.78	42	72.41	0.052
Conductive hearing loss	6	16.67	3	5.17	0.065
Sensorineural hearing loss	6	16.67	9	15.52	0.088
Mixed hearing loss	2	5.56	4	6.90	0.915
Auditory dyssynchrony	1	2.78	0	0.00	0.202
Retrocochlear factor	1	2.78	0	0.00	0.202
Not completed	1	2.78	0	0.00	0.202
TOTAL	36	100.00	58	100.00	--

ASD=Autism Spectrum Disorder.

Table 2 shows that the audiological findings were similar bilaterally in the 33 children with HL, with a prevalence of mild sensorineural HL.

Table 3 also shows that most of the children with suspected (72.41%) or confirmed (52.78%) ASD had hearing thresholds within the normal range, with a strong tendency for children with suspected ASD to show hearing thresholds within the normal range ($p=0.052<0.1$), while children with confirmed ASD showed a tendency to have conductive HL ($p=0.065<0.1$).

On the one hand, TOAEs in children with suspected or confirmed ASD who underwent the procedure were normal bilaterally in 46 (48.94%) cases and partially or completely changed in 19 (20.21%) right ears and 20 (21.28%) left ears. On the other hand, DPOAEs were performed only in

children with changes in TOAEs, with an absence of all frequency ranges analyzed on the right in 7 (7.54%) cases and on the left in 5 (5.32%) cases. Two (2.13%) children had DPOAEs partially present on the left.

Chart 2 shows the results of the study participants regarding the neurodiagnostic assessment of the BAEP. Table 4 shows the relationship between the suspected or confirmed ASD and the results on the BAEP test.

Chart 2. Distribution of the subjects regarding the neurodiagnostic assessment of the BAEP. (n=94)

BAEP		RE	LE
Delay in absolute wave latency	I	2	0
	III	0	3
	V	6	7
	III and V	4	2
	I, III and V	9	7
Increased interpeak intervals	I-III	0	3
	III-V	0	0
	I-V	6	5
	I-III and I-V	5	4
	III-V and I-V	5	4
	I-III, III-V and I-V	1	2
Change in the wave morphology	V	1	1
BAEP absent and microphonic	Present	1	1
	Absent	6	6
	Inconclusive	3	2
No changes		33	37
Not performed		25	26

Table 4. Relationship between confirmed ASD and BAEP results. (n=63)

BAEP		Confirmed ASD		Suspected ASD		p-value
		N	%	N	%	
Expected results in cases of cochlear HL	Delayed absolute latencies, no changes in interpeak intervals	1	1.45	5	7.25	0.463
	BAEP absent and no cochlear microphonic	2	2.90	5	7.25	0.657
	Total	3	17.6	10	21.7	0.721
UNEXPECTED results in cases of cochlear HL	Changes related to the wave V	3	4.35	3	4.35	0.751
	Delayed absolute latencies and increased interpeak intervals	9	13.04	7	10.14	0.137
	BAEP absent and presence of cochlear microphonic	1	1.45	0	0.00	0.181
	BAEP absent and inconclusive cochlear microphonic	1	1.45	1	1.45	0.680
	No changes	8	11.59	23	33.33	0.108
	Total	14	82.4	36	78.3	0.721

BAEP=Brainstem Auditory Evoked Potential; ASD=Autism Spectrum Disorder. Changes related to the wave V: latency delay; interaural difference and increased I-V interval.

In turn, Table 2 shows that 33 children had no changes on the right and 37 had no changes on left on the BAEP, with the delay in the absolute latency of waves I, III and V and the increase in the interpeak interval IV being the most frequent changes.

The ASD and BAEP ratio found a prevalence of no change in children with suspected ASD and delayed absolute latencies and increased interpeak intervals in those with confirmed ASD (13.04%). There was no statistically significant relationship

between confirmed ASD and the results in the BAEP (p=0.721>0.05) (as shown in Table 4).

With regard to language assessment, 80 of the 94 study participants underwent language assessment. Of these 80, 29 (36.25%) had pure language delay and 49 (61.25%) had associated language delay. The association of language delay occurred with changes only in the symbolic function (26.25%); only in the communicative intention (16.25%), or both in the symbolic function and in the communicative intention (16.25%). In addition, 5 (6.25%) children had echolalia in addition to changes in symbolic function and communicative intent. Finally, two children had only phonological disorders (2,5%).

The comparison between the result of the BAEP and the result of the language assessment was possible in 61 children who underwent both assessments (as shown in Table 5). In order to carry out this comparison, it was necessary to group the children as to the type of results in the BAEP (expected and unexpected cases of cochlear HL) and in the language assessment (pure or associated language delay, with other changes in communicative functions).

Table 5. Relationship between the BAEP result and language assessment. (n=61)

BAEP		Pure language delay		Associated language delay		p-value
		N	%	N	%	
Expected results in cases of cochlear HL	Delayed absolute latencies, no changes in interpeak intervals	3	14.29	2	5.00	0.209
	BAEP absent and no cochlear microphonic	4	19.05	2	5.00	0.080
	Total	7	33.3	4	10	0.024
UNEXPECTED results in cases of cochlear HL	Changes related to the wave V	2	9.52	5	12.50	0.756
	Delayed absolute latencies and increased interpeak intervals	4	19.05	11	27.50	0.466
	BAEP absent and presence of cochlear microphonic	1	4.76	0	0.00	0,967
	BAEP absent and inconclusive cochlear microphonic	0	0.00	2	5.00	0.297
	No changes	7	33.33	18	45.00	0.378
	Total	14	66.7	36	90.0	0.024

BAEP=Brainstem Auditory Evoked Potential Change in the wave V: latency delay; interaural difference and increased I-V interval.

As shown in Table 5, 14 children with pure language delay and 36 with delay associated with other changes in communicative function had unexpected results in the BAEP for cochlear HL. Statistical tests showed that there is a significant probability that a child with language delay associated with other changes in communicative function will have unexpected BAEP results for cochlear HL (p=0.024<0.05).

At the end of the evaluation process, the approach defined by the SASA team in 82 (87.23%) cases was the referral for multidisciplinary monitoring in other institutions of the care network for people with disabilities. In addition, 58 (61.70%) children continue to have audiological and language monitoring at the SASA; while 13 (13.83%) needed adaptation of PSAP/CI and 9 (9.57%) received family guidance.

Discussion

The prevalence of males (77.66%) found in this study is in line with the prevalence reported in the literature, especially in studies conducted with children with ASD associated or not with HL[22,23,24,25,26], with one girl to every three boys[23] in cases of ASD. However, this prevalence is not described in relation to HL.

Regarding age, the results (mean age of 3.79 and median age of 3.3 years) were similar to the numbers found in a study in Spain on the age at diagnosis of ASD, which reported that it occurs in

the first three years of life in 69% of the children studied[24], in addition to another European study[25] that reported an average age of 3.6 years.

Although isolated characteristics can be noticed at around 15.17 months of age, the average age at which parents notice the first symptoms is 16.43 months[27].

Language delay (63.83%) and suspected or confirmed HL (22.81%) were the main reasons for referral found in the study, which are also described in the literature as the most common when there is a suspected ASD[23, 27].

These studies also report socialization difficulties, stereotyped and repetitive behaviors, changes in the look, inappropriate behaviors, lack of attention, excessive tranquility and lack of "playing"[23,27].

With respect to the referrals for differential diagnosis, 70.43% of the children were evaluated by all the professionals of the multidisciplinary team of the study center; however, as already reported, 14 children did not perform the language assessment, which is essential in the differential diagnosis of HL and ASD, since there are similarities and differences in the language of children with HL and children with ASD[14].

The minimum team for the differential diagnosis of hearing loss in children in a SASA must include an otorhinolaryngologist, speech-language pathologist, neuropediatrician, psychologist and a social worker. The literature also includes nurses and pedagogues in the teams that serve children with ASD, which provides an improvement in the quality of life and dynamics of families[28,23].

When analyzing the results obtained in the assessments for differential diagnosis of hearing impairment, it was possible to notice a significant number of children with confirmed or suspected ASD and otitis (19.15%) still in the otorhinolaryngological assessment prior to the hearing assessment. This is in line with the literature that reports that children with ASD are twice as likely to develop mastoiditis that can be hidden by communicative deficits, which is present in children with ASD and/or HL. Therefore, it is important to carry out routine middle ear tests[26].

The basic audiological evaluation showed changes in 43.62% of the children, which is similar to the proportion reported by Demopoulos and Lewine[3], in children with ASD (55%) when compared with children with typical development (14.9%).

In contrast, Romero et al.[29] found 100% of hearing thresholds within the normal range when studying the hearing of nine children with ASD.

Even with the presence of otitis in the otorhinolaryngological evaluations, the results of the auditory evaluation with changes showed a prevalence of sensorineural HL (15 right ears and 16 left ears), which is in line with data found in the literature, indicating that there is a higher occurrence of sensorineural HL in children diagnosed with concomitant ASD and HL[30], with a predominant mild degree, both in this study and in the literature[30].

Another study indicates that children with ASD tend to have increased hearing thresholds, on average 5 dB, when compared to those with typical development[31].

In order to complement the basic audiological assessment and close the differential diagnosis of hearing loss, 69 children underwent BAEP assessment, in which it was possible to observe an increase in the absolute latencies of waves I, III and/or V and changes in interpeak intervals I-III, III-V and/or IV in 9 children with confirmed ASD and in 7 children with suspected ASD, which is described in the literature in children with confirmed ASD[32].

Although the literature reports that subjects with ASD have significant changes in BAEP, indicating impairment of the auditory pathway in the brainstem[32], there was no statistically significant difference when comparing the confirmed ASD and suspected ASD groups in this study ($p=0.721>0.05$).

In addition to hearing assessment, language assessment has a relevant role in a differential diagnosis of HL and ASD, since it is possible to find differences in the language of children with HL and children with ASD. Thus, there was a prevalence of language delay (82.98%) in the language assessment, which is considered the main symptom perceived by parents of children with suspected or confirmed ASD[27,30,33], associated with changes in symbolic function in 37.23% of children, represented by less variability in play, with no progressive increase in complexity as age increases[34].

Another aspect also found in language assessments was the reduced or absent communicative intention (24.47%), which is expected in children with ASD who rarely have a communicative intention and, when they do, it has no functionality[33].

The results of this study showed that children with language delay associated with other changes

in communicative function are more likely to have unexpected BAEP results for cochlear HL ($p=0.024<0.05$), which is line with the study by Demopoulos and Lewine[3], who reported a statistically significant relationship between the language of children with ASD and some aspects of hearing assessment.

Multidisciplinary intervention was the most appropriate approach for children, both those with confirmed ASD and those with suspected ASD, which is in line with the literature[30] that recommends this approach for children with global deficits.

The approach for children with confirmed HL (13.83%) associated or not with ASD, included the indication, selection and adaptation of PSAP or CI, which are reported as beneficial for children with HL and ASD[30].

Conclusion

At the end of this study it was possible to verify a strong tendency for children with suspected ASD to have hearing thresholds within the normal range, while those with confirmed ASD have a strong tendency for conductive HL.

The results of the electrophysiological evaluation showed changes not compatible with cochlear HL for 13.04% of confirmed ASD cases, as well as children with language delay associated with other changes in communicative function have a strong tendency to have changes in the BAEP that are not compatible with cochlear HL.

Therefore, it is necessary to be aware of the results of the electrophysiological evaluation during child audiological care, which associated with the clinical history can arouse the suspicion of ASD. In these cases, the professional should refer to multidisciplinary care in order to allow early intervention, or to the appropriate intervention in cases of late diagnosis.

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