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Original Article
Artigo Original

Unilateral and asymmetric hearing loss in childhood

Perda auditiva unilateral e assimétrica na infância

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Keywords

Hearing Loss
Child
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ABSTRACT

Purpose: To describe unilateral and bilateral asymmetric sensorineural hearing loss in children and its etiological, audiological and demographic characteristics. **Methods:** Retrospective cross-sectional study developed in the *Seção de Implante Coclear* of *Hospital de Reabilitação de Anomalias Craniofaciais*, through the analysis of medical records. **Results:** Data from 1152 patients were analyzed: 424 (37%) adolescents, adults or elderly, and 728 (63%) children, of whom 691 (95%) had bilateral symmetrical hearing loss, and 37 (5%) had unilateral hearing loss (n=10) or bilateral asymmetric (n=27) sensorineural hearing loss. The mean age at diagnosis of unilateral sensorineural hearing loss was 33.58±21.69 months, and for asymmetric bilateral it was 33.12±21.69 months, with a prevalence of 1.4% and 3.7%, respectively. The highest risk indicator for hearing loss for both groups was the family history of permanent deafness, which began in childhood. The majority of the relatives of children with unilateral sensorineural hearing loss presented the highest low socioeconomic classification (50%), while children with bilateral asymmetric sensorineural hearing loss were also be subdivided into upper (37%) and lower (37%). **Conclusion:** We observed a greater occurrence of asymmetric bilateral sensorineural hearing loss compared to unilateral hearing loss, as well as the hereditary risk indicator, with a predominance of the deep ear and female preponderance in both groups. Although neonatal hearing screening provides early identification of unilateral sensorineural hearing loss, the age at the audiological diagnosis is still above the recommended level. In addition, the majority of the children's family members presented a low level of income.

Descritores

Perda Auditiva
Criança
Perda Auditiva Neurossensorial
Perda Auditiva Unilateral
Características da População

RESUMO

Objetivo: Descrever a perda auditiva sensorioneural unilateral e bilateral assimétrica em crianças quanto às características etiológicas, audiológicas e demográficas. **Método:** Estudo retrospectivo transversal, desenvolvido na Seção de Implante Coclear do Hospital de Reabilitação de Anomalias Craniofaciais, por meio da análise de prontuários. **Resultados:** Foram analisados os dados de 1152 pacientes, sendo 424 (37%) adolescentes, adultos ou idosos e 728 (63%) crianças, dentre as quais, 691 (95%) apresentavam perda auditiva bilateral simétrica e 37 (5%) perda auditiva sensorioneural unilateral (n=10) ou bilateral assimétrica (n=27). A idade média ao diagnóstico na perda auditiva sensorioneural unilateral foi de 33,58±21,69 meses e na bilateral assimétrica de 33,12±21,69 meses, com prevalência de 1,4% e 3,7%, respectivamente. O indicador de risco para a deficiência auditiva de maior ocorrência para ambos os grupos foi o de antecedente familiar. A maioria dos familiares das crianças com perda auditiva sensorioneural unilateral apresentaram a classificação socioeconômica baixa superior (50%), enquanto que as crianças com perda auditiva sensorioneural bilateral assimétrica se subdividiram igualmente em baixa superior (37%) e média inferior (37%). **Conclusão:** Houve uma maior prevalência da perda auditiva sensorioneural bilateral assimétrica em relação à unilateral, bem como do indicador de risco de hereditariedade, com predomínio do grau profundo na pior orelha e preponderância do sexo feminino, em ambos os grupos. Apesar de a triagem auditiva neonatal propiciar a identificação precoce da perda auditiva sensorioneural unilateral, a idade no diagnóstico audiológico ainda se encontra acima do recomendado. Adicionalmente, a maioria dos familiares das crianças apresentou nível de rendimento baixo.

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INTRODUCTION

The World Health Organization (WHO) estimated in 2018 that hearing impairment affects about 466 million people worldwide (6.1% of the world population), and of this total, 34 million (7%) are children[1]. In Brazil, more than 6 million people are affected, which makes it a public health problem[2].

With the advent of Neonatal Hearing Screening (NHS) and, consequently, the referral for early diagnosis, speech therapists are more frequently confronted in the clinical routine with unilateral and bilateral asymmetric hearing loss. They were formerly diagnosed later, in contrast to symmetrical bilateral hearing losses, in particular, of profound degree[3]. This fact is also related to etiological factors, since according to the literature, 45% of the unilateral sensorioneural hearing loss cases are congenital[4].

Historically, the importance of unilateral hearing loss has been underestimated. The fact that the child invariably has normal oral language development, leads to assume the absence of implications for child development, related to hearing and linguistic abilities, among others. However, even light unilateral hearing loss, regardless of type, can cause adverse effects on the child's development, for example, in the educational and behavioral fields[5].

Thus, there is a growing increase on discussions about the possibilities and indications of intervention measures in unilateral and asymmetric hearing loss in childhood, such as implantable hearing aids and, in the international scientific community, the cochlear implant, in addition to the Hearing Aid (HA)and the adaptation Contralateral Routing of Signal (CROS) [6-9].

Considering strictly the prevalence of unilateral hearing loss in the United States, from 3% to 6% of school-age children have some degree of unilateral sensorineural hearing loss[10]. In addition, specialized literature demonstrated that more than one in ten children initially diagnosed with unilateral sensorineural hearing loss progressed to a bilateral hearing loss[11]. No data were found on the prevalence of unilateral sensorineural hearing loss in childhood in national researches, as well as on asymmetric bilateral sensorineural hearing loss.

Previous studies pointed out abnormalities in 39% of the children with unilateral sensorineural hearing loss[12], besides the alteration in the cochlear nerve in 50% of them[13]. Moreover, the malformation characterized by the Enlarged Vestibular Aqueduct (EVA) was described as a potential cause of unilateral sensorineural hearing loss. From a sample of 128 children, 30 (23.4%) had unilateral sensorineural hearing loss, 27 (90%) had ipsilateral type, and three (10%) bilateral type[14]. In this context, imaging examinations are valued in both unilateral and bilateral hearing loss cases, by means of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI).

Additionally, acquired asymmetric unilateral and bilateral sensorineural hearing loss were described as a complication consequence of infection by bacteria. *Streptococcus pneumoniae* was associated with a higher risk of deep bilateral sensorineural hearing loss and *Neisseria meningitidis* infection was associated with unilateral sensorineural hearing loss, usually[15].

The literature in the area is still scarce in relation to unilateral and asymmetric sensorioneural hearing loss in childhood, which leads to questions regarding the impact of hearing loss on child development, the possible etiologies, risk factors and the possibility of developing preventive measures.

Thus, this study aimed to describe unilateral and bilateral asymmetric sensorineural hearing loss in children regarding etiologic, audiological and demographic characteristics.

METHODS

This is a retrospective cross-sectional study carried out with the approval of the Ethics in Research Committee, CAAE 57705516.4.0000.5441. The data were obtained in the *Seção de Implante Coclear* of *Hospital de Reabilitação de Anomalias Craniofaciais* of *Universidade de São Paulo* (SIC/HRAC/USP), which has standardized medical records and clinical protocol, which serve as research material and hearing evaluation. Guardians or parents of the participating children signed an Informed Consent Form (ICF) of SIC/HRAC/USP on the date of hospital enrollment. The ICF remains in the patient's medical records and contains information regarding the authorization of the use and disclosure of the recorded data for scientific studies.

Casuistic selection

We analyzed 1152 medical records of patients regularly enrolled in SIC/HRAC/USP, from October 1, 2012 to October 30, 2016. As inclusion criteria, we considered the age range from zero to 11 years, 11 months and 29 days old, and the previous audiological diagnosis of unilateral or bilateral asymmetric sensorineural hearing loss, regardless of its degree[16-18]. We determined as asymmetric bilateral hearing loss those with different audiometric degree and/or configuration between the ears, according to guidance in the basic audiological evaluation of the speech therapy counselling system[18].

We excluded data from children with conductive or mixed hearing loss and/or associated neurological alterations and/or insufficient data available in the medical records.

From 1152 medical records, 424 (37%) were from adolescents, adults or elderly, 728 (63%) were from children. From the children, 691 (95%) of them had bilateral symmetrical hearing loss and 37 (5%) unilateral or bilateral asymmetric sensorineural hearing loss.

Casuistic

The casuistic consisted of data from 37 children from zero to 11 years, 11 months and 29 days old, with unilateral sensorineural (n=10) and asymmetric bilateral (n=27) hearing loss. Of these, 20 (54%) were females and 17 (46%) males, with an average age of 36 ± 21.28 months old.

Procedure

Data registered in the medical records were analyzed considering the stage of the audiological diagnosis regarding the clinical history, audiological evaluation and socioeconomic evaluation, described below:

- Clinical History

In the clinical history, the following information was considered: chronological age of the child at the time of evaluation, sex, NHS data and etiology of hearing loss.

- Audiological Evaluation

We considered the audiological diagnosis defined after the evaluation protocol used in the service, which comprises behavioral (auditory behavior assessment and audiometry with visual reinforcement from six months old and conditioned ludic audiometry from 30 months old), electroacoustic (otoacoustic emissions and acoustic impedance measurements) and electrophysiological procedures (auditory brainstem evoked potentials and auditory evoked potential of stable state).

- Socio-economic evaluation

This evaluation was performed by the institution's social worker, based on the Instrumental Protocol of Socioeconomic Classification of the Social Service of SIC/HRAC/USP, which covers the following domains: family socio-economic situation and social opinion[19].

Results analysis

The collected data were qualitatively described and showed in tables using relative frequencies (percentage).

RESULTS

In the analysis of 37 children, we found that ten (27%) had unilateral sensorineural hearing loss, six (60%) females and four (40%) males, and the age at diagnosis ranged from eight to 40 months old, with an average of 33.58 ± 21.69 months old and a median of 30 months old. On the other hand, 27 (73%) children had asymmetric bilateral sensorineural hearing loss, 14 (52%) females and 13 (48%) males. The age at diagnosis ranged from three to 48 months old, with an average of 33.12 ± 21.69 months old and a median of 30 months old, excluding two children with acquired hearing loss due to meningitis and who had the diagnosis defined with 38 and 76 months old. Therefore, the prevalence of unilateral and bilateral asymmetric sensorineural hearing loss was 1.4% and 3.7%, respectively.

With regard to risk indicators for hearing impairments[17], we found that all children had at least one complication in their history, in both groups: group with Unilateral Hearing Loss (UHL) and group with Asymmetric Bilateral Hearing Loss (ABHL) (Table 1).

Table 2 shows the information regarding NHS in both groups.

The classification of the degree of unilateral and bilateral asymmetric sensorineural hearing loss and the occurrence, by ear, are in Table 3.

The distribution of children regarding the asymmetry of the degree of hearing loss in the NHS group was of profound-severe in 51% of the cases, followed by deep-moderate in 30%, severe-moderate in 11% and deep/light and moderate/light in 4% each.

Table 4 shows data from the casuistic socioeconomic classification.

Table 1. Occurrence of risk indicators for hearing impairment in the sample studied

Occurrence of risk indicators for hearing impairment (%)	UHL %	ABHL %
Family history of permanent deafness, beginning in childhood	60	52
Neonatal jaundice	-	33
Intensive care unit stay for more than five days	50	18
Birth weight less than 1,500 grams	30	11
Bacterial or viral infections (meningitis)	-	11
Craniofacial anomalies involving the ear and temporal bone (EVA)	10	-
Exposure to ototoxic drugs	20	-

Caption: UHL: unilateral hearing loss; ABHL: asymmetric bilateral hearing loss

Table 2. Outcome of neonatal hearing screening in children with audiological diagnosis of unilateral and asymmetric bilateral sensorineural hearing loss

NHS (%)	UHL %	ABHL %
Not Realized	10	15
Realized	90	82
Passed	10	15
Failed	80	67
No data	-	14

Caption: NHS = Neonatal Hearing Screening; UHL: unilateral hearing loss; ABHL: asymmetric bilateral hearing loss

Table 3. Results of unilateral and asymmetric bilateral sensorineural hearing loss, by ear, and its degree, according to WHO classification[17]

CLASSIFICATION	UNILATERAL				BILATERAL			
	RE		LE		RE		LE	
	n	%	n	%	n	%	n	%
Light	-	-	1	10	1	4	1	3.7
Moderated	2	20	-	-	7	26	5	22.2
Severe	1	10	1	10	8	30	9	31.5
Profound	3	30	2	20	11	40	12	42.6

Caption: n: number of children; RE: right ear; LE: left ear

Table 4. Data from the socio-economic classification of children's guardians according to Graciano[19]

SOCIO-ECONOMIC CLASSIFICATION (%)	UHL %	ABHL %
Upper low	50	37
Lower middle	30	37
Middle	10	0
Lower	10	26

Caption: UHL: unilateral hearing loss; ABHL: asymmetric bilateral hearing loss

DISCUSSION

Specialized literature has extensively discussed the impact of sensory deprivation on the development of auditory skills and oral with there is no profound bilateral hearing impairment, but rather a hearing loss that may not be classified as incapacitating, for example, unilateral or asymmetrical bilateral sensorineural hearing loss, in a light degree. Thus, scientific evidence is scarce regarding the prevalence of unilateral and asymmetrical bilateral sensorineural hearing loss in children, which reinforces the need and importance of research in the area.

In this study, we found that the prevalence of unilateral sensorineural hearing loss was 1.4% inferior to that described in the international literature, which ranged from 3% to 6%. This difference, however, can be justified by the age group, since the comparative research is a population study in children at school age, that is, chronological age higher than this study[10]. We did not find studies that discuss the prevalence of asymmetric bilateral sensorineural hearing loss in children, which was of 3.7% in this study.

Regarding sex, most of the children with unilateral or asymmetric bilateral sensorineural hearing loss were female, which diverges from a previous study[20].

There was a higher occurrence of profound hearing loss degree (50%), followed by severe and moderate (20%) in unilateral sensorineural hearing loss. The ear most commonly damaged was the right (60%). Similarly, there was a higher prevalence of profound degree in children with asymmetric bilateral sensorineural hearing loss. The findings in Table 3 demonstrated the need for the use of HA in the therapeutic process, since most of the children analyzed showed at least one ear with a degree of auditory loss considered incapacitating. The benefits and satisfaction of HA users with unilateral auditory loss, regardless of the type, were previously reported[21,22].

Of the complete casuistic, 32 children (86.4%) performed NHS, which demonstrates the impact of public policy actions aimed at the diagnosis and intervention of hearing impairment in the first years of life, including Federal Law No. 12,303, of August 2, 2010, which determined the obligation of NHS. Additionally, we observed that eight (80%) children with unilateral sensorineural hearing loss and 18 (67%) with asymmetric bilateral sensorineural hearing loss were identified with "failure" result in the NHS procedure. Despite this, the age of the diagnosis remains late, much above six months old, which is recommended by the scientific institutions[23].

Thus, after almost two decades of the implementation of Brazilian public policy focused on hearing impairment, it is necessary to perform a critical analysis in order to determine the weaknesses of the network involving the stages of identification, diagnosis and treatment of hearing impairment.

In unilateral hearing loss, the age at diagnosis ranged from eight to 40 months old, with an average of 33.58 ± 21.69 months old and a median of 30 months old, and the age of the later diagnosis (40 months old) was one (10%) child who was not submitted to NHS. As for children with asymmetric bilateral sensorineural hearing loss, the age at diagnosis ranged from three to 48 months old, with an average of 33.12 ± 21.69 months old and a median of 30 months old. As previously reported, this picture needs to be improved; however, unilateral hearing loss due to NHS need to be diagnosed earlier. Until recently this type of hearing alteration was diagnosed in school age, when the consequences of binaurality absence become more perceptible[24].

Although NHS is not the focus of the study, it is worth commenting on the "pass" result in these children. Thus, it was not possible to define whether this finding represents the false negative in the procedure, since the information described in the medical records was provided by their relatives, which can make them inaccurate and reinforces the need for professionals following the recommendations of scientific societies and the Ministry of Health, on giving the written result to the family.

Still with regard to age at diagnosis, the results reinforce the urgency of effective protocols for the diagnosis of unilateral and asymmetric bilateral sensorineural hearing loss in children, including electroacoustic and electrophysiological methods, since, in the first months of life, this type of hearing loss may go unnoticed. The auditory behavior of the child in these cases may delay the audiological diagnosis, since the child sometimes detects environmental and speech sounds. Thus, the auditory difficulty will be evidenced only when the most complex auditory skills are required for the development of oral language.

The protocol for child audiological evaluation in the service recommends the use of masking in order to evaluate the ears separately, which allows the precise diagnosis of hearing loss.

Regarding the probable etiological diagnosis, there was a higher occurrence of family history in children with unilateral hearing loss (60%) compared to asymmetric bilateral loss (52%) (Table 1). Similar data related to the higher prevalence of heredity factor, among all other indicators, have been described in the literature[25]. In the history, among different intercurrences, more than five days in the Intensive Care Unit (ICU) was the most significant (85.7%), probably due to the existence of other associated factors, such as ototoxic medication, hyperbilirubinemia, low weight and the use of ventilation, as already described in the literature[26].

Specifically in unilateral hearing loss, a child (10%) had malformation characterized by EVA, as previously described[7]. Thus, it is pertinent to discuss the relevance of imaging diagnosis in the diagnosis process of children with unilateral hearing loss, since hearing loss resulting from the EVA can be progressive and become bilateral. Moreover, studies have shown that imaging exams such as CT and MRI are important tools in determining the etiology of children with hearing loss, since they found

anatomical abnormalities in 39% of the evaluated children[12]. Thus, it is necessary to consider the need for imaging exams to determine more precise behaviors in the treatment of child hearing impairment.

In the analysis of socioeconomic classification, we observed that more than 60% of those responsible for children have a level of personal or family income considered low, which can hamper integral care to pregnant women and children. This is an expected finding since the service is public and inserted in the Unified Health System (SUS), but it reinforces the need to expand strategies that provide health promotion to the pregnant woman, a period in which prenatal care is one of the most relevant factors of protection against low birth weight and prematurity, which may lead to ICU stay, and, consequently, the chances of acquiring a hearing loss[27].

CONCLUSION

In the casuistic studied, the prevalence of asymmetric bilateral sensorineural hearing loss was 3.7%, higher compared to unilateral hearing loss, 1.4%, with preponderance in females. Profound hearing loss was the most frequent in both groups, as well as the risk indicator of family history. Although NHS provides earlier identification of unilateral hearing loss, the age of audiological diagnosis is still above the recommended. Additionally, most of the children's relatives showed low income level, consistent with the current reality of a public service inserted in the Unified Health System.

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Author contributions

Conception and design of the study FNG, BCSS, ESA, KFA; data collection FNG, KFA; analysis and interpretation of the data FNG, BCSS, ESA, KFA; elaboration of the article or critical review for relevant intellectual content FNG, LCBJC, BCSS, ESA, RCBA, EBO, KFA; Final approval of the version to be presented for publication FNG, LCBJC, BCSS, ESA, RCBA, EBO, KFA.