Clinical feature and risk factors associated with sensorineural hearing loss in children at the Children's Hospital 1: a preliminary study

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Abstract

Background: Hearing is a crucial sense and is particularly vital for children's development, especially those in the first five years of life. Congenital hearing loss leads to delayed language development, severely impacting learning ability and the development of social skills, which cause consequences on children's psychophysiology. Early detection and knowing clearly about clinical features are very important, especially for children with risk factors for hearing loss. **Objectives:** To determine the prevalence of factors associated with sensorineural hearing loss among children the Children's Hospital 1. **Material and Methods**: This study included 72 pediatric patients diagnosed with sensorineural hearing loss at Children's Hospital 1 from July 2022 to July 2023. **Results:** From July 2022 to July 2023, 72 children with a diagnosis of sensorineural hearing loss at the Children's Hospital 1 were included in this study. The degree of hearing loss most severe-to-profound hearing loss (≥ 90 dB) was 54.3% as many as 46 children (63.9%) with asymmetrical hearing loss in most of the subjects. Most of the children with bilateral congenital sensorineural hearing loss (SNHL) are in the age > 5 years old (mean age: 5.8 years). Children with a history of neonatal resuscitation accounted for the highest rate 59% within factors of risk factors for hearing loss. **Conclusion:** There was a delay in the diagnosis of prelingual sensorineural hearing loss, with a high proportion of the severe-to-profound among children presenting with a diagnosis. Enhancement of knowledge and development of hearing screening programs for at-risk children towards a universal newborn hearing screening is urgently needed.

Keywords: *hearing loss, sensorineural hearing loss, children.*

1. INTRODUCTION

Hearing is a crucial sense and is particularly vital for children's development, especially those in the first five years of life. Congenital hearing loss leads to delayed language development, severely impacting learning ability and the development of social skills, which causes consequences on children's psychophysiology. In 2019, The Centers for Disease Control and Prevention (CDC) conducted a study in the United States to collect data from states and territories, in which 98% of babies in the USA were screened for newborn hearing loss. The results showed that nearly 6000 babies born in 2019 had severe to profound hearing loss. The rate of congential hearing loss of that study was 1.7 per 1000 children screened [1].

There was a delay in the diagnosis of prelingual sensorineural hearing loss, with a high proportion of the severe-to-profound among children presenting with a diagnosis. Parents or guardians may not be aware of the child's hearing problems and may only seek medical attention when the child displays more apparent symptoms such as delayed speech or slower mental development [1].

Some studies indicate that children with early-onset hearing loss or congenital deafness if appropriately intervened before 6 months of age, will have language development levels equal to their peers at the age of 5 (in the absence of other impairments). Therefore, early identification and intervention of this condition are important factors in the restoration communication ability of the patients as well as their language development. This is especially crucial for children with delayed reception of auditory stimuli - a group that is significantly affected without early preventive planning, screening, appropriate functional hearing assessment, and intervention.

2. MATERIALS AND METHODS

2.1. Study settings

This is a case series study which was done on 72 pediatric patients admitted to Children's Hospital 1 from July 2022 to July 2023 with the diagnosis of sensorineural hearing loss.

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2.2. Study design and participants

Study design: case series study.

Participants criteria included: aged under 16; confirmed diagnosis of sensorineural hearing loss at the Audiology Unit of Children's Hospital 1 by pure tone audiometry, conditioned play audiometry (CPA), auditory brainstem response (ABR) or auditory steady-state response (ASSR); having the results of other audiometric tests including tympanography and acoustic reflex testing; and having the results of temporal bone CT Scan and brain MRI.

The exclusion criteria were unknown family history of the patients, unknown obstetric history of the patient's mothers, medical history of the child and mother (before and during pregnancy), and Relatives of patients who disagreed to participate in the study.

2.3. Conducting method

Firstly, all subjects who met the admission criteria were explored the clinical characteristics including the reasons for detecting hearing loss, the age of that detection, their medical history and obstetric history of their mothers related to sensorineural hearing loss; and hearing loss history of their parents and siblings. Next, the audiometric parameters comprising hearing threshold, severity of the hearing loss, the results of tympanography and acoustic reflex were recorded. Finally, the patients were conducted temporal bone CT Scan and brain MRI according to the standards and evaluated the results of captured images.

2.5. Statistical method

The data were processed and analysed using Stata 14.0 software.

2.6. Ethical considerations

This study was approved by the Ethics Committee of Children's Hospital 1 with numbers 149/GCN-BVNĐ1.

3. RESULTS

3.1. Characteristics of the study sample

On average, children are diagnosed with hearing loss at 5.8 years of age (#71 months). The oldest age at diagnosis is 14.2 years (#171 months) and the youngest is 0.8 years (#10 months). Over 80% of children diagnosed with hearing loss are female, and the majority of them reside in rural areas.

There were 5 cases where the child had a family member (parents, siblings) diagnosed, accounting for 12.8%. The rate of patients whose mothers had preeclampsia, fever caused by viruses, and Covid-19 infection during pregnancy was 2.8%, 4.2%, and 2.8%, respectively.

There were 23 out of 72 cases having past medical history of premature birth, accounting for 31.9%, of which 2 cases were extremely premature (less than 28 weeks) and 17 cases were very premature (from 28 to less than 32 weeks). Of the 72 patients, the rate of children with normal birth weight was 64.2%.

3.2. Clinical Feature and Risk factors for hearing loss

Around 22% of hearing loss cases were detected before age 2, while over 40% were detected after age 6. No cases were identified at an earlier stage. Detection was mainly due to decreased hearing (62%) and speech delay (28.3%), with only 2.2% of children undergoing hearing loss screening.

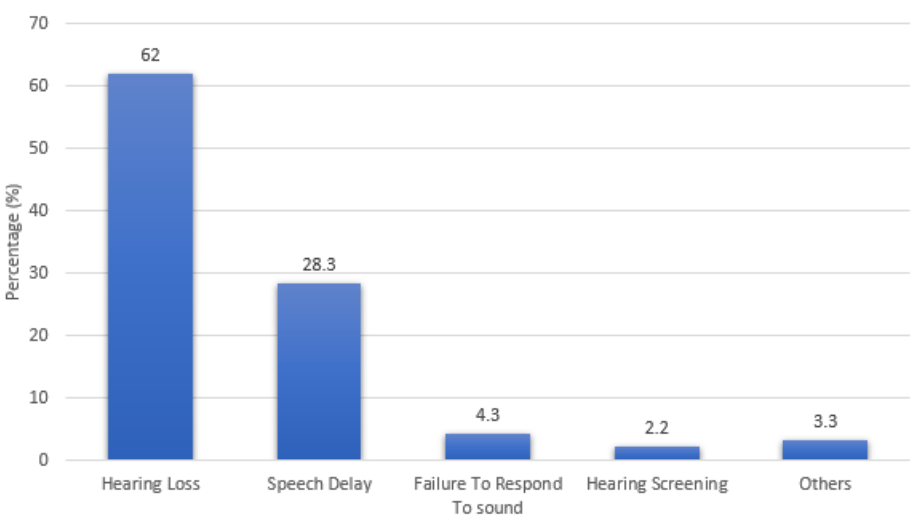

Figure 1. Distribution of reason for examination

The risk factors for hearing loss

Among the risk factors for hearing loss, infants who had past medical history of being treated in neonatal resuscitation unit for more than 5 days accounted for the majority with 23 cases, representing 59% of the total. 4 cases, accounting for 10.3% had a history of treatment requiring respiratory support during the neonatal period, 1 case had undergone extracorporeal membrane oxygenation (ECMO), and 1 case had jaundice and required blood transfusion. There were also 3 cases (7.7%) with craniofacial abnormalities. There were 5 cases where the child had a family member (parents, siblings) diagnosed, accounting for 12.8%. The rate of patients whose mothers had preeclampsia, fever caused by viruses, and Covid-19 infection during pregnancy was 2.8%, 4.2%, and 2.8%, respectively.

3.3. Audiometric parameters

There were 42 cases performed pure tone audiometry (53.16%), and 30 cases (46.8%) assigned to measure ABR and or ASSR. The results demonstrate that 13.9% of cases have hearing loss in only one ear and 86.1% in both ears. In the latter group, the percentage of children who have asymmetrical hearing loss in two ears was 63.9%.

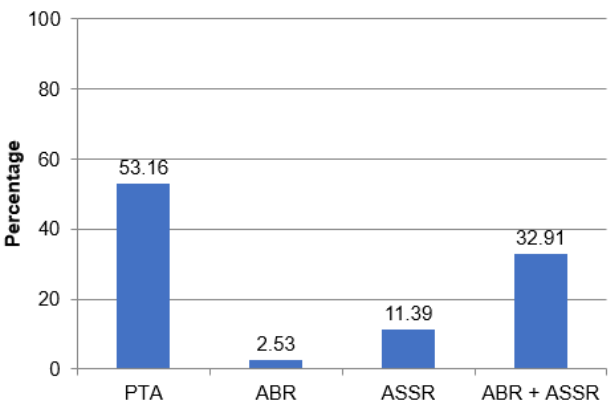

Figure 2. *Audiometry testing*

Table 1. Results of Otoacoustic Emissions Test

OAE	Left Ear		Right Ear	
	Case	Rate (%)	Case	Rate (%)
Pass	8	11.1%	9	12.5%
Refer	64	88.9%	63	87.5%
N	72	100%	72	100%

In 72 cases, Refer results accounted for the majority of 88.9% (Left ear) and 87.5% (Right ear), the cases with Pass results were normal ears in those cases. Children with hearing loss in only one ear account for 12.5% (Right ear) and 11.1% (Left ear).

Table 2. Results of tympanometry

	Left Ear		Right Ear	
	Case	Rate (%)	Case	Rate (%)
Type A	35	48.6%	38	52.8%
Type As	36	50%	33	45.8%
Type B	1	1.4%	1	1.4%
Type C	0	0	0	0

The results of tympanometry show that 71 out of 72 cases, accounting for 98.6%, had type A and As tympanograms, and 1 case had type B tympanogram. The data also demonstrated that 100% of patients did not have acoustic reflex in both ears.

Results of measuring stapedial reflexes: we recorded that 100% (72 cases) of pediatric patients had no stapedial reflexes in both ears.

Table 3. Hearing loss degree

Degree	Case (n)	Rate (%)
Normal	0	0
Mild (21 - 40 dB)	2	2.8%
Moderate (41 - 70 dB)	14	19.4%
Severe (71 - 90 dB)	17	23.6%
Profound (> 90 dB)	39	54.3%
	N = 72	100%

All relevant risk factors have been analyzed using simple linear regression to determine the association between any of these factors and the severity of profound hearing loss. We used a group of children with no risk factors as a reference group to compare with the remaining groups of children. However, the results obtained were not statistically significant. In general, the rate of severe to profound hearing loss in both ears was similar.

Table 4. Frequency of risk factors and the condition severe profound hearing loss.

Risk factors	Number (cases)	Rate (%)	OR	p
		LEFT EAR		
0	18/29	62.1%	-	< 0.05
1	14/19	73.7%	2.44 (0.43 - 13.67)	2.444 (> 0.05)
2	9/14	64.3%	1.42 (0.22 - 9.13)	1.429 (> 0.05)
≥ 3	8/10	80.0%	2.22 (0.33 - 14.80)	2.222 (> 0.05)
		RIGHT EAR		
0	22/29	75.9%	-	< 0.05
1	13/19	68.4%	1.27 (0.21 - 7.45)	0.789 (> 0.05)
2	10/14	71.4%	1.84 (0.29 - 11.47)	0.511 (> 0.05)
≥ 3	8/10	80.0%	1.6 (0.23 - 11.08)	1.634 (> 0.05)

4. DISCUSSION

In terms of clinical characteristics, a study of 72 children diagnosed with hearing loss revealed an average diagnostic age of 5.8 years (#71 months), with the oldest being 14.2 years (171 months) and the youngest being 0.8 years (#10 months). These findings are consistent with the study conducted by Pham Dinh Nguyen in 2018 at Children's Hospital 1, in which the youngest age being 1 month old and the oldest being 12 years old [2]. Similarly, in this study only less than 3% of children were detected to have hearing loss before 1 year of age.

The findings revealed that the majority of cases exhibited profound hearing loss with 51.4% (> 90dB), and most instances of hearing loss were asymmetrical, accounting for 63.9%. Among the 72 cases, 10 had unilateral deafness, and 3 cases involved sudden deafness. These results are consistent with Wiranadha et al 2020 study, which reported with 71.01% rate of profound hearing loss[3]. The reason for these results is not due to higher prevalence of severe and profound hearing loss in the community, but rather because severe and profound hearing loss is easier to detect than children with mild hearing loss.

We have observed that children are only brought in for examination when they have clear symptoms or signs, such as 62% with hearing impairment, 28.3% with speech delay, or lack of response to sound or speech. We are particularly concerned that very few children are being brought in for hearing screening or through the guidance of healthcare staff. In our study, the rate was only 2.2%, which is similar to the findings of Pham Dinh Nguyen [2].

Our research results mainly observed Type A and Type As tympanograms, accounting for over 90% in both ears. This rate is consistent with the findings of authors Nguyen Xuan Nam [4], Le Duy Chung 2021 [5], and Alonso-Luján [6] who reported 95.5% Type A and As, and 4.4% Type C tympanogram. The results indicate that most cases have normal middle ear status, clear tympanic membranes, and no signs of fluid or infection.

In 72 cases where Otoacoustic Emissions Tests were performed, the majority of children (88.9% for the left ear and 87.5% for the right ear) showed Refer results. However, in cases where Pass results were obtained, it was found that the children had normal ears or mild hearing loss in only one ear, which is different from those of author Phan Truong Vuong Phu 2021 [7], who found that 98% of children with congenital hearing loss had Refer results when tested using Otoacoustic Emissions Test.

In the study sample, the majority of pediatric patients with severe-profound hearing loss had no stapedial reflexes. However, it is not conclusive to diagnose hearing loss solely based on negative assessment results, additional audiometrics should be combined to achieve a more accurate diagnosis.

Regarding risk factors related to pregnancy history, we recorded that 4.2% of children whose mothers had viral fever during pregnancy and especially approximately 2.8% of babies are born to mothers infected with Covid-19 during their pregnancy.Among the known risk factors, viral infections are mentioned a lot and in recent years, SAR-CoV-2 infection, many reports have posited an association between SAR-CoV-2 infection and SNHL, many systematic reviews studies, and meta-analyses in many countries show that there are cases of SNHL related to COVID-19 and hearing loss with the findings of authors Yaseen NK 2021, Chern A 2021, Kilic O 2019 [8-14].

In our study, we found that over 50% of pediatric patients did not have any risk factors for hearing loss. Additionally, the majority of pediatric patients did not have any accompanying diseases, accounting for 73.6% of cases. Only one case was related to Waardenburg syndrome, which was characterized by unusual blue eyes. This finding is in line with the opinion of experts around the world, such as De Claude [15], who suggest that screening only children with risk factors for hearing loss according to JCIH guidelines may result in missing many cases.

Although, according to JCIH as well as presented in the above sections, there is a correlation between risk factors and hearing loss, when conducting univariate analysis of risk factors related to hearing loss, severe - profound, we observe that the results are not statistically significant. This is different from some domestic authors such as Lai Thi Thu Ha 2022, or Pham Doan Tan Tai 2017, who also noted several statistically significant factors. To explain this, through evaluation, we found that the authors of previous research used a much larger sample size and a longer research period than ours, and the research time was also longer.

When evaluating the relationship between risk factors and severe SNHL, we chose the group of pediatric patients without any risk factors as a reference to evaluate the remaining pediatric patient groups. However, the results recorded were not statistically significant. In general, the rate of severe - profound hearing loss in both ears is similar. We found that severe-profound hearing loss occurred at similar rates in both ears. Surprisingly, 75.9% of cases with hearing loss in the right ear and 62.1% of cases with hearing loss in the left ear had no identifiable risk factors according to JCIH. This result is different from that of author Pham Doan Tan Tai [1] when Researching 382 children with hearing loss diagnosed at Children's Hospital 1 in 3 years is 15%, and is higher than author De Claude [15] when conducting research with 170 pediatric patient records over 8 years with a rate is 55%.

In this study, we found that children with additional risk factors, such as being born prematurely, having a low birth weight, or other factors for hearing loss according to the Joint Committee on Infant Hearing (JCIH), experienced a higher degree of hearing loss compared to the group without any risk factors.

5. CONCLUSION

Currently, the issue of hearing loss screening for infants and young children is not widely applied. We would like to point out the current situation and the need to promote health education for families with hearing-impaired children in the community. At the same time, emphasized the most important thing is to plan and coordinate hearing screening programs for children among relevant specialties. Information about hearing loss should be provided by medical staff from the time a child is born, or ideally by a screening program before the child leaves the hospital.

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