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Otoacoustic emissions screening in newborn babies

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ABSTRACT

Background: The article presents the results of retrospective study which is focused on otoacoustic emission screening of newborns.

Aim: To analyse and compare physiological and risk newborns examinated of otoacoustic emission.

Method: There was used the method of retrospective study through the record sheet and information portal in a chosen medical institution within quantitative research. File selection contained all newborns hospitalized in the medical institution in the year of 2014 and babies who took an examination of hearing impairments.

Results: In the year of 2014 in the medical institution was born 1 516 newborns. The examination of otoacoustic emission was done of 1 510 newborns. From the number of 1 258 physiological newborns there were 5 (0.4 %) of them with hearing impairment. From the number of 252 risk newborns there were diagnosed 7 (2.78 %) newborns with hearing impairment.The conclusion is that the hearing impairment is more often in risk newborns. Diabetes mellitus was the risk factor in the hearing impairment.

Conclusion: The incidence of hearing impairments occurs in risk newborns as well as physiological. It is necessary to discover hearing impairment in early stage for right child evolution. We still miss legislative support in the Czech Republic which should order the duty to carry out general screening of hearing of newborns in medical institutions.

KEYWORDS

Newborn, screening, otoacoustic emissions, hearing, hearing impairments

INTRODUCTION

Hearing is one of the most important senses through which we gain a significant amount of information about the surrounding environment.

Hearing screening of newborns aims at early detection of imbalances or hearing defects, whose early detection can prevent improper or inadequate development of communication skills. The earlier hearing impairment is diagnosed, the greater the child has a chance of inclusion in everyday life. The importance of hearing screening is also confirmed by the fact that more than 80% of hearing defects are congenital or arise already in the perinatal period (1, 2).

Nationwide hearing examination is carried out already in many states. The United States are among countries where screening is conducted nationwide. Hearing was investigated in less than 5% of newborns here until 1993. However, in 1993, the National Institutes of Health recommended to perform hearing screening for all. Currently, more than 95% of newborns undergoes hearing screening, while 2–3 children of 1,000 are affected by a permanent hearing impediment (3). National hearing screening has not yet been introduced in the Czech Republic because of lack of sufficient legislative support.

The examination is fully covered by public health insurance and the decision on its implementation depends entirely on the particular medical facility. The first hospital, where the screening was initiated in 2006, was the hospital in České Budějovice. A year later, for example the hospital in Pardubice started this activity and the University Hospital in Ostrava joined the nationwide measurement of otoacoustic emissions (OAE) in 2008, followed by other hospitals in Moravskoslezský Region. The amount of maternity hospitals, which participate in the screening, continue to rise significantly (2, 4).

Thanks to the efforts of many experts, who are promoting nationwide testing of hearing, the standards have developer. Their aim is to unify procedures for screening hearing. These standards were published in the methodological guidelines issued by the Ministry of Health of the Czech Republic in 2012 (1, 5).

Examinations of transiently evoked otoacoustic emissions are used to perform neonatal screening for

hearing defects. If the emissions are clear, we can rule out hearing impairment with high probability. In case of unclear response, the follow-up examinations are performed, and if a negative result is confirmed, the child is sent to a higher specialized clinic.

The OAE examination can be performed 24 hours after birth, according to the recommendations of the Ministry of Health of the Czech Republic, it is appropriate to postpone the examination at 2 to 4 days after birth. For the measurement, we should ensure a peaceful environment and satisfied, sleeping newborn. Noise around or crying newborn can either extend or completely thwart the investigation (2, 5).

The actual examination takes an average of 3–5 minutes. During the measurement, a special probe is inserted into the newborn's ear canal, emitting a faint sound with the intensity of about 10 dB. The OAE screening results in clear response/unclear response. If the OAE emissions are evaluated as unclear, it is necessary to repeat the examination at least 24 hours after the first one. It is the first rescreening, which can eliminate the error in measurement. In the case of repeated negative result, the children are sent to a second hearing screening to otorhinolaryngology within 1 month (ENT), where an additional care is planned, in case of confirming the diagnosis of adverse, together with suitable correction of hearing loss, which should be guaranteed until 6 months of age (5, 6, 7).

Mostly trained paramedical staff of the neonatal department or ENT workplace carry out hearing screening. According to Komínek it is preferable to involve the medical staff form neonatal department in the screening, not the nurses from ENT, because healthcare professionals from neonatal department can also adjust the time of examination and wait for the moment when the child calms down or falls asleep (8, 9).

It is mainly an audiological nurse, who cares for children with hearing impairment and educates about mobility aids. The relevant ENT department provides initial training and ongoing trainings (5, 6).

Long-term auditory screening was performed only in high-risk groups of newborns, covering mainly newborns with low birth weight, low gestational age and postnatal risks, such as respiratory distress. However, if screening is carried out exclusively at risk infants, an average of 30–50% of hearing loss remains undetected according to Jakubíková (1, 9).

The incidence of severe hearing impairments in the Czech Republic is 1:1,000 in physiological newborns, occurrence of defects increases to 20 to 40 : 1,000 in newborns at risk. The incidence of hearing loss in our population is larger than some diseases, which are sought nationwide, for example, phenylketonuria with an incidence of 1:10,000, therefore the hearing screening should be paid more attention (9).

OBJECTIVE OF WORK

The main objective was to analyse and interpret the results of the research carried out in regional health care facility, focusing on detection of hearing loss on physiological and risk newborns. Another objective was to find common risk factors that could contribute to the emergence of hearing loss.

METHODOLOGY

We chose the method of retrospective study to collect data through the recording sheet of healthcare facility, where we had the opportunity to inspect after an approval from the organization. In case of unclear response in OAE, we also consulted the information portal of the facility in order to find the follow-up examinations, and in the case of confirmation of hearing loss, we consulted the information portal to find risk factors that might have contributed to the manifestation of hearing loss. We also established cooperation with ENT healthcare professionals who contribute to the OAE rescreening.

The survey was carried out between January and February 2015. There were 1516 newborn babies hospitalized in selected medical facility in 2014. 1510 newborns underwent examination of hearing; six newborns were not tested because of death. In the context of the research, the respondents were divided into physiological newborns and risk ones.

According to Sedlářová, a healthy newborn is *„A newborn baby with good postnatal adaptation, who was born between the 37th and 41st week of normal pregnancy"* (8).

The research group was divided intentionally in order to determine representation of unclear auditory reflexes in both groups of newborns, although it is not possible to achieve an equal representation of both groups at one workplace at a specified time.

Acquired data were compiled in Microsoft Office Excel Acquired data were compiled using Microsoft Office Excel and then evaluated using descriptive statistics. We used variables of absolute frequency (n_i) and relative frequency (f_i), which is expressed in percentage. The total number is expressed as the total frequency (Σ). The formula for calculating the relative frequency is $f_i\,(\%) = n_i/n \times 100$ (10).

Statistical evaluation and hypothesis testing was performed using STATISTICA © (10). Determined hypothesis was tested through Pearson's chi-square test at a significance level of 5% ($\alpha = 0.05$). The decision to reject a null hypothesis was based on achieved value of p (11).

Determined hypothesis: „Incidence of hearing loss in high-risk newborns is higher than in physiological newborns in selected medical device during the specified period."

RESULTS

1516 infants were hospitalized in selected regional healthcare facility in 2014. 1,510 neonates underwent the OAE screening, while 1,258 (83.31%) of them were physiological and 252 (16.69%) risk ones. The OAE during the first examination resulted clear in 1 197 physiological newborns (95.15 %), conversely OAE resulted unclear in 61 (4.85 %) newborns. The second and less numerous group consists of high-risk newborns, where the both side clear OAE were detected in 239 cases (94.84 %). The OAE resulted unclear in 13 newborns.

The results show that unclear OAE occur in both groups of newborns in almost identical representation, namely in 5.09% in physiological newborns and 5.43% in risk ones (Table 1).

After the first screening, both side clear OAE was detected in more than half of newborns. In case of physiological newborns, there were 35 cases (57.38 %); in risk newborns there were four cases (30.77 %). Altogether, there were 35 newborns sent to the second rescreening at ENT department (Table 2).

Table 1 Summary of the results of OAE screening in newborns

Clear OAE at 1st screening	Physiological newborns		Risk newborns	
	n_i	f_i (%)	n_i	f_i (%)
Both side clear	1 197	95.15	239	94.84
Unclear at right ear	23	1.83	8	3.18
Unclear at left ear	18	1.43	2	0.79
Both side unclear	20	1.59	3	1.19
Σ	1 258	100	252	100

Table 2 Summary of the results of 1st OAE rescreening in newborns

Clear OAE at 1st screening	Physiological newborns		Risk newborns	
	n_i	f_i (%)	n_i	f_i (%)
Both side clear	35	57.38	4	30.77
Unclear at right ear	7	11.48	6	46.15
Unclear at left ear	11	18.03	0	0
Both side unclear	8	13.11	3	23.08
Σ	61	100	13	100

Legend to Tables 1 a 2:
OAE – otoacoustic emissions, n_i – absolute frequency, f_i – relative frequency, Σ – sum

The OAE were re-examined in 23 physiological newborns (88.46%) in the second rescreening at the department of ENT and three neonates were not examined at all (11.54%). In one of these three respondents the OAE was not detected due to malfunctioning of equipment and the examinations was postponed. The other two respondents were absent. In these cases, the facility personnel contacted a paediatrician. Risk neonates were present in the full number of nine respondents (100 %). The examinations at ENT department were thus attended by 32 newborns.

The OAE was clear in 18 cases in physiological newborns (78.23 %) and two cases in risk newborns (22.22 %) during the second rescreening. The most serious hearing disorder, which occurred, was a double-sided deafness. It was diagnosed at physiological newborns (8.70%), who were sent to Prague for hearing examination by somatosensory evoked potentials (SSEPs). These infants will have their hearing threshold examined, and according to the results, a hearing aid will be set. Double-sided deafness was diagnosed also in two cases at risk newborns (22.22%). The first case was a newborn with atresia of the left ear canal and unclear OAE results for the right ear. The newborn was sent for the SSEP examination to Prague. The second of risk infants was included in the program of cochlear implants. Moderately severe hearing loss occurred in one physiological (4.35%) and 1 risk (11.11%) newborn baby. In the case of the risk neonate, there was a moderate hearing loss at the right ear, while a slight hearing loss with conversion component was diagnosed for the left ear. The most frequent defect at risk newborns was the unilateral hearing loss of right ear, namely in four cases (44.44%). In case of physiological newborns, this defect was diagnosed in only one case (4.35%). The last group consists of infants with left-sided hearing loss that occurred in one physiological newborn (4.35%). Unilateral hearing impairment can be caused by a transfer defect which can be, for example, accumulation of earwax in the ear canal, and therefore children with unilateral hearing loss continue to be controlled at 1 year of age (Table 3).

Hearing defect was diagnosed in five newborns (0.40%) of the total 1,258 (100%) of physiological newborns and in case of three newborns (0.24%), the hearing impairment was not confirmed because of the failure of second rescreening at the department of ENT. All risk neonates were examined and the hearing defect occurred in seven cases (2.78%) of the 252 newborns (100%). Altogether, there was a hearing impairment diagnosed in 12 (0.79%) newborns hospitalized in a health care facility during 2014. These were seven girls and five boys.

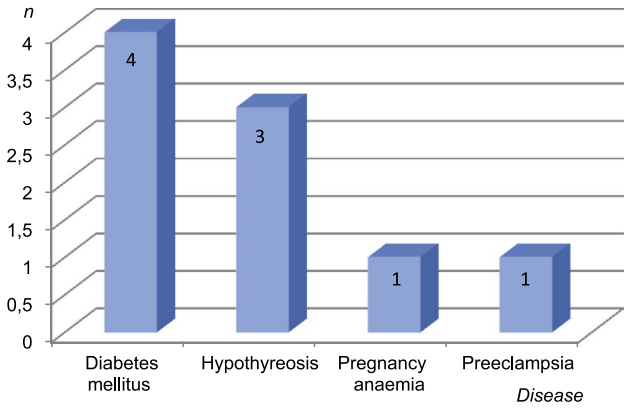
Our aim was to find common factors that could affect the unclear OAE results in newborns with confirmed impaired hearing.

Seven (58.33%) newborns with hearing loss have a clear family medical history. Conversely, the incidence of medical history burden was at five newborns (41.67%). Disease of the mother, which was found in four cases (21.05%), is among the factors that can affect the unclear OAE results. In one of the mothers, there was a positive presence of Streptoccoca agalactiae (5.26 %) in the vagina with inadequate intrapartum prophylaxis (Figure 1). In one case (5.26%), use of toxic substances was present. This woman indicated that she had smoked approximately five cigarettes a day during pregnancy. The pregnancy was terminated by caesarean section for intrauterine growth retardation. Intrauterine infection, hypoxia, asphyxia and the newborn weight to 1500 grams, which were among the other monitored factors, did not appear repeatedly in medical histories of the newborns. In three infants (15.79%), there was a hyperbilirubinemia described.

Table 3 Results of the survey for 2014

Rok 2014	Physiological newborns		Risk newborns	
	n_i	f_i (%)	n_i	f_i (%)
Screened newborns – 1st screening	1 258	100	252	100
Unresolved rescreening	3	0,24	0	0
Reversible deafness	2	16	2	0,79
Moderately severe hearing loss	1	0,08	1	0,4
Right-sided hearing loss	1	0,08	4	1,59
Left-sided hearing loss	1	0,08	0	0

Legend: n_i – absolute frequency, f_i – relative frequency



Legend: n_i – absolute frequency

Figure 1 The incidence of the disease in the medical history of mother at newborns with hearing loss

As part of the research, we also examined whether there is a statistically significant link between the incidence of hearing loss at risk newborns and physiological ones. The investigation based on test data confirmed more frequent occurrence of hearing loss at risk newborns (Table 4). Calculated value $x^2 = 15.088$ is therefore higher than the critical value $x^2_{0.05}(1) = 3.841$, therefore, the alternative hypothesis was accepted (10, 11).

Table 4 The incidence of hearing loss for 2014

Newborns	Clear OAE	Hearing impairment	Σ
Physiological	1253	5	1258
Risk	245	7	252
Σ	1498	12	1510

Legend: OAE – otoacoustic emissions, Σ – sum

DISCUSSION

Hearing is one of the five basic human senses. Through the hearing, we collect information about the surroundings, we learn new skills and it warns us of impending danger. It also contributes to the development of speech and the right mental development. Hearing defects and faults cause difficulties in developing intellectual and communication skills, and thus make a successful socialization into society harder. According to experts, it is ideal to detect a hearing loss before 6 months of age (9).

In the presented article, hearing defect was detected in 12 neonates (0.79%) of 1,510 children examined in 2014 in selected medical facility. Statistical analysis confirmed higher incidence of hearing impairment in risk newborns (2.78%) in comparison with physiological newborns (0.40%), where, however, defects also occur.

Unilateral neonatal deafness was diagnosed in six cases (50%). As these are often hearing impairments with conversion component that adjust spontaneously, there are no compensatory aids indicated for the moment and it is necessary to wait till the next inspection, which takes place in the first year of life. Moderately severe hearing loss was diagnosed in two cases (16.67%). These individuals are considered by the possibility of using hearing aids. However, only they are only watched for the moment and doctors are waiting for further development of the child. Parents of both children were instructed and keep observing the child's reaction to speech. Double-sided deafness was observed in four cases (33.33%). One of the children has been included in the program of cochlear implants and the other three were sent for the SSEP

examination to Prague, which will be used for precise adjustment of hearing aids.

Also Komínek points at higher incidence of hearing loss in risk groups of newborns (2012), stating that the incidence of severe hearing impairments in the population of risk newborns is 20–40: 1000 in contrast to physiological newborns, where 1 newborn out of 1,000 births is afflicted with a severe hearing impairment (12).

Sekeráková and Skybalová (2011) conversely presents up to 40% undetected defects, if the screening is performed only in risk groups of newborns. Hearing defect is then revealed between 2 and 4 years, which may adversely affect development of an individual. The nationwide hearing screening therefore has justified significance (13).

Čáchová (2009) evaluated the incidence of hearing loss in 2 seasons in the hospital of České Budějovice. Within the group of risk newborns, the defect was diagnosed in 15 (1.6%) of 923 examined babies. Hearing defect occurred in 20 (0.5%) cases out of a total of 3,749 examined physiological newborns (14).

Study of Hlavníčková et al. (2009), searching for hearing impairments in the hospital of České Budějovice in 2007, includes 2,235 examined newborns. The group of physiological newborns was represented by 1837 babies (82%), and hearing defect was discovered in 7 of them (0.39%). 30 newborns from this group did not undergo the rescreening because they were failed to arrive. 398 (18%) babies were included in the group of risk newborns, and hearing defect was discovered in 8 of them (2.09 %). Also in this group, there were 15 newborns, who failed to arrive for the rescreening (15).

The most common factor in our investigation, which could have an impact on the occurrence of hearing loss in newborns, was a preterm birth (26.32%) and caesarean section (26.32%), whose impact on auditory disorders in newborns has not yet been demonstrated. We also observed in three cases of newborns, who previously suffered from hyperbilirubinemia (15.79%).

In the personal medical history of mothers of children with hearing loss, the most frequently repeated disease was diabetes mellitus (44.44%), whose relationship with hearing impaired has been addressed in several studies in the USA. Those long-term surveys, as stated by Dlouhá (2012), have demonstrated the influence of diabetes mellitus on formation of perceptual auditory defects (16, 17).

Other disease that affect the formation of hearing loss is for example hypothyroidism, which occurred in three mothers (33.33%). Both gestational anaemia (11.11%) and preeclampsia (11.11%) occurred in one case.

Two of the 12 newborns, who have been diagnosed with hearing impairment, were affected by congenital defect, namely cleft lip and ear canal atresia.

The individual with right cleft lip and palate was subsequently diagnosed with unclear OAE result for the right ear. Dlouhá points to a connection between developmental defects and impaired hearing (2012), Children with a cleft in the orofacial region also suffer from hearing defect in 80-90% according to her (18). Unilateral atresia of left ear canal has been detected in the second newborn that, according to Jakubíková (2006) occurs 3 times more often than the both-sided type (1). The OAE were measured only for the right ear because of atresia, and resulted unclear. Risk factors that occurred in this newborn, can affect the development of his hearing impairments. These include premature birth at 33 weeks of pregnancy, low birth weight (1,800 grams) or icterus of prematurity.

We should not forget the fact that up to 97% of hearing impaired newborns are born to hearing parents (19). This was confirmed also in our research, where none of the parents suffered from hearing loss.

LIMITATIONS

Research findings are valid only for our research; they cannot be generalized for the whole Czech Republic.

CONCLUSION

The number of maternity hospitals, in which the nationwide hearing screening is performed in all newborns, continues to rise, nevertheless hearing tests are carried out in less than half of maternity hospitals in the Czech Republic. The results of the survey clearly demonstrate the importance of this measurement. Up to 30% of hearing defects would not have been diagnosed on time without a nationwide screening. The results of our research show that hearing defects have incidence in both physiological and risk newborns. We can therefore conclude that measurement of OAE, which occurs in all newborns in the selected healthcare facility, has a significant importance in early detection of hearing loss. We can therefore hope that nationwide hearing screening in newborns will soon obtain a legislative support thus reducing the number of individuals with a hearing defect detected at a late age.

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