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CORRELATION BETWEEN VESTIBULAR AND COCHLEAR FUNCTION IN NEWBORNS²

This paper examines the correlation between vestibular and cochlear responses, obtained in newborns immediately after birth, for the purpose of improving procedures of early detection of possible hearing and vestibular impairment. A group of reflexes which indicate whether the vestibular apparatus is already realizing its function were tested in 100 healthy, full-term newborns from regular pregnancies, on the third day upon birth. At the same time, hearing ability in all newborns was examined by transient otoacoustic emission (TEOAE). Testing each reflex in newborns, was carried out in three attempts by trained medical staff, whereas the examiner performed instructing, observation and data recording. The obtained data were recorded by means of a digital camera, then scored and statistically and descriptively processed. For each examinee in the sample, data on gender and body size on birth, body weight (BW), body length (BL) and head circumference (HC), were recorded. Research results indicate that 91% of babies have normal TEOAE finding bilaterally, whereas in 9% of newborns TEOAE was absent on both sides or just on one ear (bilaterally 3%, on the left

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side 4% and on the right side 2%). In the examined sample, maximal presence of reflexes in total (MOR+ATRV+VOR+LRIG) was established in 7% of newborns, while minimal presence was recorded just in 1%. Absence of these four reflexes together, was not established in any of the newborns. Reflexes in total were significantly more developed in babies with normal TEOAE results bilaterally, then in babies whose TEOAE findings were bilaterally or unilaterally absent ($p < 0.01$). It was also confirmed that a significant part of variance (13.8%) about presence of reflexes in total, can be established on the basis of TEOAE results. Absence of these four reflexes together, was not established in any of the newborns. BW, BL, HC and gender of infants, do not have significant influence on the presence of reflexes in total, regardless of the fact whether it is an isolated influence of the mentioned variables, their reciprocal interaction, or their interaction with TEOAE results. Giving instructions for recognition and further monitoring of newborns with delayed maturation of vestibular pathways is of special significance in practice. This is particularly important because of the possible associated disturbance of vestibular and cochlear function.

Key words: *vestibular reflexes, newborn, cochlear function, transient otoacoustic emission*

INTRODUCTION

The vestibular apparatus and cochlea are closely related both anatomically and developmentally. Disturbances of cochlear function, which can result in sensory-neural hearing loss, could accompany vestibular impairment because the cochlea and the vestibule share the continuous membranous labyrinth of the inner ear (Angeli, 2003). Proceeding from the standpoint that impaired vestibular function immediately after birth could indicate hearing impairment or delayed maturation of central nervous system (Adamović, 2010), and being aware of the fact that hearing impairment has negative consequences in speech and language development as well as the complete development of personality (Sovilj et al, 2004), we wanted to contribute, with this paper, to the recognition of a new diagnostic

procedure which will detect vestibular and hearing impairments at the earliest age.

Reports of vestibular deficits and related impairments in children are increasing in number. However, vestibular dysfunction in childhood appears to be an under-reported and overlooked entity (Harrop-Griffiths, 2009). The clinical course and prognosis in sensory-neural hearing loss may be even worse if vestibular system is also involved, especially due to near location of anatomical structures in the inner ear (Shinjo et al, 2007). A great number of studies testify to disturbed vestibular function in hearing-impaired children (Kaga et al, 2008; Maki-Torkko & Magnusson, 2005; Angeli, 2003; Potter & Silverman, 1984). According to Maki-Torrko and Magnusson (2005), evaluation of children with congenital or early acquired hearing impairment should include vestibular assessment. Vestibular function and balance skills of deaf children are of interest to physical or occupational therapists working with this group because the characteristics of these functions may differ from those in children with unimpaired hearing (Potter & Silverman, 1984). There are several reflexes which can be examined and which indicate whether the vestibular apparatus is already realizing its function. These are: the vestibulo-ocular reflex, the Moro reflex, the asymmetrical tonic neck reflex and head righting reflex (Barnes & Crutchfield, 1978). The suggested method for early detection of hearing impairment in newborns and infants used eyeballs moving reflex that appears as an answer to sound stimulus (Sumrak, 1990). Nowadays, screening of newborns and infants involves the use of non-invasive, objective physiologic measures that include otoacoustic emissions (OAEs) and/or auditory brainstem response (ABR) (Coates & Gifkins, 2003). Otoacoustic emissions are inaudible sounds from the cochlea when audible sound stimulates the cochlea. The outer hair cells of the cochlea vibrate, and the vibration produces and inaudible sound that echoes back into the middle ear. This sound can be measured with a small probe inserted into the ear canal. Persons with normal hearing produce emissions. Those with hearing loss greater than 25-30 dB, do not. OAEs can detect blockage in the outer ear canal, middle ear fluid, and damage to the outer hair cells in the cochlea. There are several OAE types (Subotić & Jovičić, 2005). Transient Otoacoustic Emission

(TEOAE) is impulsively provoked otoacoustic emission. Pulse duration is about a hundred micro-seconds (usually 80), and intensity is about 80 decibels. Dominant frequency is usually measured in the area of 0.5 to 4 Hz (Kemp, 1978). TEOAE is most suitable for hearing screening in children, from the aspect of simplicity, speed and prevalence which is 100% in the population with normal hearing. TEOAE method reliably indicates cochlear dysfunction. The person with cochlear hearing impairment cannot have positive TEOAE result (Mikić et al, 2005; Gravel & Tocci, 1998; Pantelić et al, 2004). Auditory brainstem response is an auditory evoked potential that originates from the auditory nerve. It is often used with babies. Electrodes are placed on the head, and brain wave activity in response to sound is recorded. ABR can detect damage to the cochlea, the auditory nerve and the auditory pathways in the stem of the brain (Babac, 2005; Coates & Gifkins, 2003).

The most common cause of vestibular hypofunction on both sides is ototoxicity due to certain antibiotics (gentamicin, streptomycin) which selectively damage the vestibular hair cells, often preserving auditory function. It is estimated that 3-4% of the population who receive gentamicin will sustain damage to both vestibular systems (Kahlmeter & Dahlager, 1984). Vestibular function deficits in hearing-impaired children are often overlooked and not thoroughly investigated, in contrast to the adult population. Early detection of peripheral vestibular dysfunction in pediatric population can not only help clinicians and parents understand why children experience balance disturbances but also facilitate children's learning of compensation strategies for balance control (Goebel, 2003; Snashall, 1993; Valente, 2007). Infants and children that are congenitally deaf, commonly suffer from vestibular failure in both ears, and the impairment of postural control, locomotion and gait. The development of gross motor functions, such as head control, sitting, and walking is likely to be delayed, but fine motor function is usually preserved unless disorders of the central nervous system are present. These children can eventually catch up with their normal peers in terms of development and growth as a result of central vestibular compensation (Kaga et al, 2008). Due to the high percentage of pathological findings

in their study, Zhou and collaborators (2009) emphasize that children with loss or severe hearing impairment, should undergo examination of vestibular function. Vestibular deficits can affect not only a child's health but also the child's ability to learn, as well as the child's overall academic achievement (Mehta & Stakiw, 2004). In this sense, it is important for professionals working with children to recognize signs and symptoms associated with vestibular disorders, because appropriate diagnosis and treatment are crucial for positive outcomes. Ljobimov Ljvovič (2010) emphasizes the importance of applying the model of continuous monitoring of a child with disabilities, from the earliest stages of disorders, to its stable period of adaptation in the environment.

PURPOSE

To investigate the correlation between vestibular and cochlear responses obtained in infants immediately after birth, for the purpose of improving procedures of early detection of possible hearing and vestibular impairment.

RESEARCH METHOD

Research was conducted at the Institute for Obstetrics and Gynecology of Clinical Center of Serbia (IOG CCS). Prior to the implementation of the research, Ethics Committee approval was issued (num. 345/5).

Criteria for the selection of the tested sample

The research was performed on the sample of N=100 newborns, comprising N=53 male babies and N=47 female babies. Criteria for the selection of the tested sample were the following:

- a) regular pregnancies and childbirth
- b) healthy newborns
- c) full-term newborns
- d) maximum value of Apgar scores (9 or 10)
- e) infant age at the time of testing – the third day upon birth

f) approximately the same number of male and female babies.

In all newborns, body weigh on birth (BW), body length (BL) and head circumference (HC), were noted.

Method of examining the cochlear function

Taking into account all the comparative advantages of using Transient Otoacoustic Emission (TEOAE) testing, from the aspect of simplicity, speed and prevalence of 100% in the population with normal hearing ability (Gravel & Tocci, 1998; Pantelic et al, 2004), we decided that this technique is the method of choice at examining cochlear function in infants on the third day upon birth. For this purpose, automated miniature device latest technology, type Echoscreen-TDA by German manufacturer Fischer-Zoth, has been used. After being switched on, and before measurement, accuracy of the transducer was checked in the artificial cavity. If the calibration is proper, probe with a rubber olivo is placed into the ear of the child. Nonlinear click with intensity of 85dB SPL, has been used (Babac, 2005; Subotić et al, 2005). Course and outcome of the tests were monitored on the display. The test result is shown in two categories, as PASS and FAIL. TEOAE test is performed after feeding, at the usual time of sleep. Recording was done in a baby cot, or on the baby changing table desk. Hearing assessment by TEOAE, is not possible if the newborn is crying. In this case, waiting for the baby to calm down and fall asleep again, was necessary.

Method of examining the vestibular function

Assessment of vestibular function in the examined sample, on the third day upon birth, was carried out by four tests:

1. Testing of the Moro Reflex (MOR)

A trained examiner holds the baby so that it lies in his/her stretched arms. Then he/she puts the baby in the half-sitting position, holding its head with one hand, and its back with the other. Then he/she quickly lowers the baby's head for about 30 degrees, supporting the head so that it does not fall backwards. First, the baby spreads

out upper extremities and cries (upper extremity abduction), then it unspreads them towards the body (upper extremity adduction).

2. Testing of the Asymmetrical Tonic Neck Reflex (ATNR)

Baby is placed on its back in supine position. The examiner passively turns newborn's head to the right and then to the left side, waiting in both positions for 15 seconds. If the head turns to the right, the left upper and lower extremities flex and the right upper and lower extremities extend. If the head turns to the left, the right upper and lower extremities flex and the left upper and lower extremities extend (Herize, 1988).

3. Testing of the Head Righting Reflex (HRR)

Examiner holds a newborn under the axilla in the vertical position (mouth horizontal). The head of the baby usually sinks downward in response to the pull of gravity. If the head falls forward, weak, repeated countermovements which temporarily lift the head into the normal vertical position may occur (Peiper, 1963).

4. Testing of the Vestibulo-Ocular Reflex (VOR)

Baby lies in a trained examiner's stretched arms (baby lies on its back and its head is positioned in anteflexion, 30 degrees downwards). The examiner turns 180 degrees to the right side. Baby's eyes deviate to the left. The examiner returns into primary position. Then the examiner turns 180 degrees to the left side. Baby's eyes deviate to the right (Lavin, 1985).

Each test consisted of three attempts, and it was noted if the reflex was present, incomplete or absent. There was a five-second break between each attempt. Testing of MOR, ATNR, HRR and VOR in all newborns was carried out by trained medical staff, whereas the examiner performed instructing, observation and data recording. The obtained data were recorded by means of a digital camera, then scored and statistically and descriptively processed.

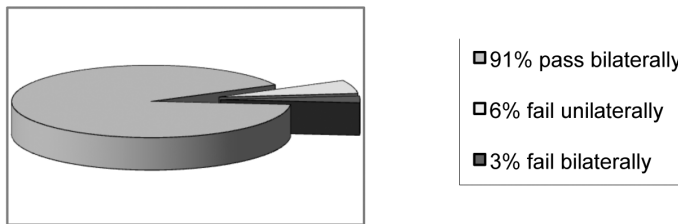
The room where vestibular tests were performed had to be bright and warm (about 26°C). The tested baby should be rested and relaxed.

Statistical analysis

Statistical analysis was performed using the following statistical measures and procedures: frequencies and percentages, median, arithmetical mean and standard deviation, significance of differences between the percents, hi-square and its significance, significance of differences between arithmetical means (t-test), two-way analysis of variance.

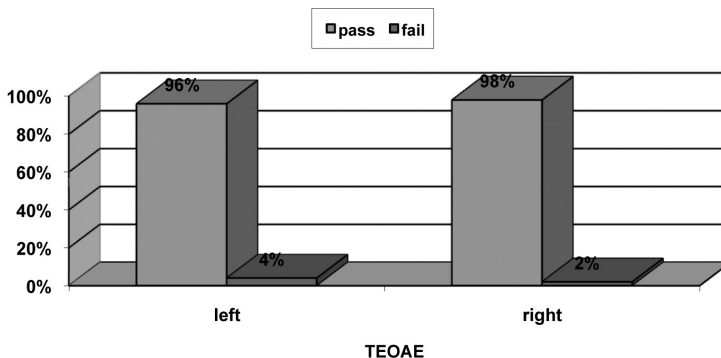
RESULTS

Graph 1 – Results of Transient Otoacoustic Emission (TEOAE)



The obtained results regarding Transient Otoacoustic Emission (TEOAE) in newborns, shown in graph 1, indicate that 91% of babies have normal TEOAE finding bilaterally, while in 3% of newborns TEOAE was absent on both side. In 6% TEOAE was absent just on one ear (left 4% and right 2%).

Graph 2 – TEOAE results shown on the left and the right side



In graph 2, it can be seen that significantly higher percentage of newborns, passed TEOAE test on the left and on the right ear compared to the percentage of newborns in whom TEOAE response on both side was absent. It was indicated by the hi-square values of 86.64 per left, and 92.16 per right ear, which are statistically significant on the level of 0.01.

It was also observed that a slightly higher percentage of babies failed the test on the left ear (4%) compared to babies who failed on the right ear. The difference of 2 percent is not statistically significant, which is indicated by the value of hi-square of 0.09. Results of this analysis can be seen in table 1.

Table 1 – Comparison of TEOAE results on the left and on the right ear

results with:	TEOAE	
	pass (194)	fail (6)
left ear (100)	96,0 % (96)	4,0 % (4)
right ear (100)	98,0 % (98)	2,0 % (2)

$\chi^2= 0,09$

During the examination of each individual reflex, three attempts were conducted, where it is written down if the reflex is present, incomplete or absent. Results are expressed on a scale ranging from 0 to 2 points, where a score of 0 points indicates the absence of reflex tested in all three attempts, score of 1 indicates that the reflex is incomplete, while a score of 2 points indicates the presence of reflex in all three measurements. Adding the results determined by testing MOR, ATNR, HRR and VOR, the scale ranges from 0 to 8 points, which indicates the degree of presence, absence or incompleteness of all four reflexes together in infants, has been obtained.

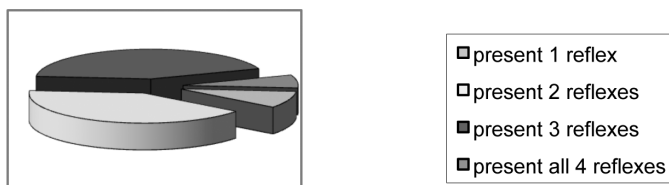
On the scale range from 0 to 8 points, observing the degree of presence of reflexes in total, minimal recorded result totals 2.42 points and it was recorded in only one baby (1%). Maximal presence of reflexes in total (of 8 points) was recorded in 7% of babies. Average value of reflexes in total is 5.87 points on average (with SD of 1.29 points). Median value totals 5.96 points, so distribution was moved to the right, towards higher scores on the scale. These results are shown in Table 2.

Table 2 – The basic results on reflexes in total (MOR+ATNR+HRR+VOR)

Reflexes in total	
Min	2,42 (1 %)
Max	8,00 (7 %)
Med	5,96
AS	5,87
SD	1,29

In Graph 3, the total representation of reflexes compared to the examined sample is shown.

Graph 3 – The presence level of reflexes in total in newborns



The obtained results regarding presence of reflexes in total in newborns, indicate that most of the examined sample, exactly 43% of babies have presence of 3 reflexes (scores from 6.00 to 7.67). In 41% of babies, the presence of 2 reflexes was established (scores from 4.17 to 5.92). Presence of just 1 reflex (scores from 2.42 to 3.99) was recorded in 9% of newborns, while in 7% of the examined sample all 4 reflexes were totally present (maximal score of 8 points).

Table 3 – Reflexes in total regarding TEOAE

TEOAE	Reflexes in total		
	AS	SD	babies (num)
1) pass bilaterally	6,01	1,20	91
2) fail unilaterally	4,76	1,36	6
3) fail bilaterally	3,78	0,92	3

t-test and significance :

as1 : as2 => t = 2,44 (p= 0,02)

as1 : as3 => t = 3,17 (p= 0,01)

as2 : as3 => t = 1,11 (p> 0.05)

Data in table 3 show that average value of reflexes in total presence, in babies that pass TEOAE test bilaterally, is 6.01 points, and 4.76 points in babies that fail TEOAE test unilaterally. The difference of 1.25 points on average, on the scale range of 0-8 points, is statistically significant which is indicated by t-test value of 2.44, with certainty of 98%. The average value of total reflexes presence in babies that fail TEOAE test bilaterally is 3.78 points, and the difference of 2.23 points on average, relating to group of babies that pass TEOAE bilaterally, is also statistically significant (t-test=3.17) with certainty of 99%. The difference of 0.98 points on average, on the scale range of 0-8 points, between group of babies that fail TEOAE test unilaterally and those who fail TEOAE test bilaterally, is not statistically significant which is indicated by t-test value of 1.11.

Two-way analysis of variance was applied by crossing the variables that represent a potential source of variance in the presence of reflexes in total: TEOAE and GENDER, TEOAE and BW, TEOAE and BL, TEOAE and HC of the examined infants.

Values of F-test given in table 4 show that variance, provoked by TEOAE results regarding total results variance of four examined reflexes (F=8.14), is statistically significant on the level 0.01 and conclusion certainty of 99%, while BW of babies and interaction of these two variables do not have a significant influence on the presence of reflexes in total.

Table 4 - Reflexes in total regarding TEOAE and body weight (BW)

TEOAE:	lower BW (56)	higher BW (44)	total
pass bilat. (91)	as = 6,09 (51)	as = 5,91 (40)	as = 6,01
fail unilat. (6)	as = 5,58 (2)	as = 4,35 (4)	as = 4,76
fail bilat. (3)	as = 3,78 (3)	/	as = 3,78
total:	as = 5,95	as = 5,77	as = 5,87 (N=100)
REFLEXES IN TOTAL (MOR, ATNR, HRR and VOR)			
variables:	df	F	significance
TEOAE	2	8,14	(p=0,01)
BW	1	1,71	(p> 0.05)
interaction	1	0,94	(p> 0.05)

Data in table 5, shown below, indicate that maximal presence of reflexes in total is in the subsample of babies that pass TEOAE test bilaterally (6.09 points for greater BL and 5.94 points on average for less BL) then in the group of babies that fail TEOAE test unilaterally (4.94 points for greater BL and 4.42 points on average for less BL), and the minimal presence in babies that fail TEOAE test bilaterally (3.78 points on average for less BL). Values of F-test (7.29, 0.39 and 0.11), indicate that variance provoked by TEOAE results regarding total results variance of all tested reflexes is statistically significant on the level 0.01, while BL of newborns and interaction of these two variables have negligible influence on the presence of reflexes in total.

Table 5 – Reflexes in total regarding TEOAE and body length (BL)

TEOAE:	less BL (55)	greater BL (45)	total
pass bilat. (91)	as = 5.94 (50)	as = 6.09 (41)	as = 6,01
fail unilat. (6)	as = 4.42 (2)	as = 4,94 (4)	as = 4,76
fail bilat. (3)	as = 3,78 (3)	/	as = 3,78
total:	as = 5,77	as = 6.00	as = 5,87 (N=100)
REFLEXES IN TOTAL (MOR, ATNR, HRR and VOR)			
variables:	df	F	significance
TEOAE	2	7.29	level 0,01
BL	1	0.39	not significant
interaction	1	0.11	not significant

The obtained results of F-test (6.09, 1.30, 0.95), shown in table 6, indicate that variance provoked by TEOAE results regarding total results variance of all tested reflexes, is statistically significant on the level 0.01, while HC of newborns and interaction of these two variables, do not have a statistically significant influence on the presence of reflexes in total.

Table 6 – Reflexes in total regarding TEOAE and head circumference (HC)

TEOAE:	smaller HC (58)	biger HC (42)	total
pass bilat. (91)	as = 5.98 (52)	as = 6.06 (39)	as = 6,01
fail unilat. (6)	as = 4.22 (3)	as = 5.30 (3)	as = 4,76
fail bilat. (3)	as = 3,78 (3)	/	as = 3,78
total:	as = 5,77	as = 6.00	as = 5,87 (N=100)

REFLEXES IN TOTAL (MOR, ATNR, HRR and VOR)

variables:	df	F	significance
TEOAE	2	6.09	level 0,01
HC	1	1.30	not significant
interaction	1	0.95	not significant

Table 7 – Reflexes in total regarding TEOAE and different gender

TEOAE:	males (53)	females (47)	total
pass bilat. (91)	as = 5.78 (47)	as = 6.26 (44)	as = 6,01
fail unilat. (6)	as = 4.94 (4)	as = 4.42 (2)	as = 4,76
fail bilat. (3)	as = 4.00 (2)	as = 3.33 (1)	as = 3,78
total:	as = 5,65	as = 6.12	as = 5,87 (N=100)

REFLEXES IN TOTAL (MOR, ATNR, HRR and VOR)

variables:	df	F	significance
TEOAE	2	12.28	level 0,01
gender	1	0.15	not significant
interaction	2	0.70	not significant

Data in Table 7, indicate that maximal presence of reflexes in total is in the subsample of babies that pass TEOAE test bilaterally (6.26 points on average for female and 5.78 points for male babies) then in the group of babies that fail TEOAE test unilaterally (4.94 points for male and 4.42 points on average for female newborns), while the reflexes in total have the minimal presence in babies that fail TEOAE test bilaterally (4.00 points of average for male and 3.33 points for female babies). Values of F-test (12.28, 0.17 and 0.70), indicate that variance provoked by TEOAE results regarding total results variance of all tested reflexes, is statistically significant on the level 0.01, while gender of newborns and interaction of these two variables, have negligible influence on the presence of reflexes in total.

DISCUSSION

By analyzing the obtained TEOAE results in our study, it can be seen that 91% of babies have normal TEOAE finding bilaterally, whereas in 9% of newborns TEOAE was absent on both or just on one ear (bilaterally 3%, on the left side 4% and on the right side 2%). Heinemann and Bohnert (2000) examined 100 infants in both ears, during the third day, and got a pass rate for OAE for 95.5%. Results of Babac (2005) suggest impermanence after the initial TEOAE screening of 86.3%. Neumann et al (2006), record completion rate of 97.0% in the group of infants who were included in the neonatal hearing screening program, in 2005, in Germany. According to data presented by several authors, we can conclude that our pass rate on bilateral TEOAE test, is within the scope of data from foreign and domestic literature.

However, some authors record pass rate for the OAE, which ranges from 57% to 87% (Barker et al, 2000; Gabbard et al, 1999). It should be noted however, that the two studies were carried out on newborn infants under 24 hours. Thornton (1999) points out that if the TEOAE test is conducted in the first few hours after birth, the rate of false positive findings in suspected hearing loss will be significantly higher. If there is vernix in the external auditory canal, and a negative pressure or fluid in the middle ear, the interpretation of obtained findings is complicated (Margolis, 2002). Insufficient ventilation of cavity timpani in the first few hours after birth, also masked and exacerbated otoacoustic emission screening results. At the same time, it is considered that the immaturity of the function of outer and hair cells and problems in the middle ear, equally affect poor results of screening in the first few hours after birth (Mikic et al., 2005). These findings suggest that the proper timing of the TEOAE test (preferably on the third day after birth), can avoid the alarmingly high rate of false positive responses, and significantly reduce the number of children who are subjected to second-level screening process and complete audiological diagnostics (Van Zanten, 1999). So, if we consider that TEOAE testing should not be implemented before the third day after birth, the results of relatively low completion rate of 57%, that were obtained in researches by Barker (2000) and Gabbard (1999) and their collaborators, should be put under suspicion.

However, it must be emphasized that the absence of TEOAE responses, is not a confirmation of hearing impairment in tested newborns, but only an indication of suspected hearing loss that is a subject for second-level screening test. For that reason, in clinical practice the first screening test is performed on the third day after birth, while the infant is still in the hospital. If a newborn does not pass the first TEOAE test, the secondary screening retest is scheduled in 15 days, and no later than a month. In case of failing at this retest, the child is sent to audiological center for complete audiological diagnostics which should be completed no later than the third months of life, when the other audiological methods will be applied, and the diagnosis of hearing impairment is being refuted or confirmed.

There are very little data on diagnostics and general physiology of the vestibular apparatus function and its central pathways in newborns (Chen et al, 2007). For that reason, we decided that examinees in our sample are healthy, full-term newborns, born from regular pregnancies, so that we could set the standards that will be the basis for future examinations of vestibular function in newborns immediately after birth.

By observing the basic results related to the presence level of reflexes in total in the examined newborns, it can be noticed that 7% of the sample has all four reflexes. Minimal presence was noted in 1% or just in one baby, while in 92% of the sample, total reflexes were incomplete or without the full range of motion. The absence of reflexes in total, is not established in any of the newborn. This high rate of infants whose reflexes were incomplete, indicates that the function of the vestibular apparatus and its central pathways in the first days after birth, is not quite matured. This is in full accordance with quotes from literature that a child is born with a developed vestibular sense, but that maturation of vestibular reflexes and its central pathways continues after birth and develops relatively quickly during the first months of life (Barkovich et al, 1988). By analyzing data on average presence of reflexes in total in babies with different TEOAE results , it was found that the presence of all four reflexes together, is significantly higher in infants who passed TEOAE test bilaterally than in infants who have failed the test in one or both ears. These findings are compatible with

the allegations of Barnes and collaborators (1990), who point out that many diseases affecting the vestibular system, are associated with changes in hearing. The frequencies at which hearing is diminished and the pattern of hearing loss, sometimes help to determine the diagnosis in patients with disturbed function of vestibular apparatus.

As we can see, the analysis of variance that shows a close connection between various achievements on TEOAE test, with a total degree of the presence of reflexes in newborns, are in complete accordance with previously presented results by several authors whose research also confirms disturbed vestibular function in hearing impaired children (Kaga et al, 2008; Maki-Torkko and Magnusson, 2005; Angeli, 2003; Potter and Silverman, 1984).

CONCLUSION

The obtained research results led to the following conclusions:

- 91% of babies have normal TEOAE finding bilaterally, whereas in 9% of newborns TEOAE was absent on both side or just on one ear (bilaterally 3%, on the left side 4% and on the right side 2%).
- In the examined sample maximal presence of reflexes in total (MOR+ATRV+VOR+LRIG) was established in 7% of newborns, while minimal presence was recorded in just 1%. Absence of these four reflexes together, was not established in any of the newborns.
- Three reflexes are present in most of the examined sample (43%). The presence of two reflexes was established in 41% of babies. Presence of just one reflex was recorded in 9% of newborns, while in 7% of the examined sample all four reflexes were totally present (maximal score of 8 points).
- reflexes in total (MOR, ATNR, HRR and VOR) are significantly more developed in babies with normal TEOAE results bilaterally, than in babies whose TEOAE findings were bilaterally or unilaterally absent (levels: 0.01 and 0.02).

- a significant part of variance (13.8%) about the presence of reflexes in total, can be established on the basis of TEOAE results (level 0.01 with certainty of 99%).
- BW, BL, HC and gender of infants, do not have significant influence on the presence of reflexes in total, regardless of the fact whether it is an isolated influence of the mentioned variables, their reciprocal interaction, or their interaction with TEOAE results.

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KORELACIJA VESTIBULARNE I KOHLEARNE FUNKCIJE KOD NOVOROĐENČADI

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Sažetak

U radu se ispituje povezanost vestibularnih i kohlearnih odgovora dobijenih kod beba neposredno po rođenju, u cilju usavršavanja procedure rane detekcije mogućeg oštećenja slušne i vestibularne funkcije. Kod stotinu zdrave, terminske novorođenčadi iz urednih trudnoća, trećeg dana po rođenju, ispitana je grupa refleksa koji ukazuju da li vestibularno čulo već ostvaruje svoju funkciju. Istovremeno, funkcija kohlee kod novorođenčadi ispitana je putem tranzijentne otoakustičke emisije (TEOAE). Testiranje refleksa kod beba izvodilo je iz tri pokušaja obučeno medicinsko osoblje, dok je ispitivač vršio instruiranje, opservaciju i beleženje podataka. Dobijeni podaci su dokumentovani digitalnom kamerom, potom bodovani, statistički i deskriptivno obrađeni. Za svakog ispitanika iz uzorka, uzeti su podaci o polu kao i o telesnoj težini (TT), telesnoj dužini (TD) i obimu glave (OG) na rođenju. Rezultati istraživanja su ukazali da je obostrana prolaznost na TEOAE testu unutar ispitanog uzorka, utvrđena kod 91% novorođenčadi. Kod 3% beba TEOAE odgovor je obostrano izostao, dok je 6% ispitanika palo TEOAE test samo sa jedne strane (4% levo i 2% desno). Maksimalna prisutnost refleksa ukupno (MOR+ATRV+VOR+LRIG) utvrđena je kod 7% novorođenčadi, dok je samo 1% ispitanika ove reflekse imalo minimalno prisutne. Odsutnost sva četiri refleksa, nije utvrđena ni kod jednog novorođenčeta. Svi refleksi su značajno prisutniji kod beba koje su imale obostrano uredan nalaz TEOAE u odnosu na bebe kod kojih TEOAE odgovora obostrano ili samo sa jedne strane nije bilo ($p < 0.01$). Takođe, utvrđeno je da se značajan deo varijanse (13.8%) o prisutnosti refleksa ukupno, može odrediti na osnovu rezultata TEO-

AE testa. Pol, TT, TD i OG novorođenčadi nemaju značajan uticaj na prisutnost ispitivanih refleksa, bilo da se radi o pojedinačnom uticaju tih varijabli, o njihovoj međusobnoj interakciji ili interakciji sa rezultatima TEOAE testa. Poseban značaj za praksu je u uputstvima prema kojima bi se novorođenčad sa zakasnelom maturacijom vestibularnih puteva, izdvajala i pratila zbog mogućnosti postojanja udružene smetnje vestibularne i kohlearne funkcije.

Ključne reči: vestibularni refleksi, novorođenče, kohlearna funkcija, tranzijentna otoakustička emisija

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