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Breastfeeding Improves the Outcome of Newborn Hearing Screening with Otoacoustic Emissions

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ABSTRACT

Transient Evoked Otoacoustic Emissions (TEOAE) is a validated technique in newborn hearing screening usually used in many countries. It reflects normal hearing or at least no more than 30 dBHL hearing loss. It has false positives when it is done before 24-48h hours because of the stucked fluid in middle ear, so hearing screening is preferred after this age. Breastfeeding has many advantages and some studies have demonstrated that prevents otitis media by means of opening Eustachian tube and clearing mucus in middle ear, perhaps because of immunological effects also. A few studies have related how newborn feeding can vary pass rate to TEOAE. The aim of this study was to investigate the relationship between newborn feeding and TEOAE newborn hearing screening results. Data were retrospectively collected from healthy vaginally delivered newborns of gestational age > 37 weeks and body weight > 2.5 Kg, at the Francesc de Borja Hospital maternity ward in Gandia (Spain). Newborn feeding history was compared with the pass rate to TEOAE performed within the first 48 hours of life. Results: the study group included 12,866 newborns. In this group, significant differences based on feeding of newborn (breastfeeding better than formula, $p<0.0001$) were found. Conclusion: Breastfeeding improves newborn hearing screening results with TEOAE.

INTRODUCTION

Universal newborn hearing screening is routinely performed because only 50% of babies born with hearing loss carry a hearing loss risk factor. Early detection leads to an efficient treatment of the affected neonates, resulting in a better final prognosis [1-3]. There are several techniques used in newborn hearing screening. Otoacoustic Emissions (OAEs) are low-level acoustic signals generated by the cochlea and passed through the middle ear into the external ear canal. OAEs are an objective indication of normal cochlear function, unlike pure-tone audiometry, OAE-based screening does not require any behavioral cooperation from the testee which makes it a very good screening method for infants. OAEs occur in nearly all ears with normal hearing and middle ear function. Transient Evoked Otoacoustic Emission (TEOAE) testing is one of the most frequently used techniques because of its accuracy, simplicity, speed and low cost as described in diverse studies [2,4-6]. Researchers have compared the sensitivity of evoked OAE testing with pure-tone audiometry and concluded that OAE testing is

more sensitive in detecting the early onset of cochlear pathologies before a change in hearing thresholds occurs [7].

A major drawback of TEOAE testing as a screening technique for newborns relates to the middle ear status, which can severely affect its pass rate. It must be kept in mind that also the presence of debris and vermix in the external ear meatus of the newborn can result in false positive screenings. This factor can lead to a greater than the actual hearing loss failure rate. Another crucial factor is the newborn's age at the moment of testing. Data strongly suggests that the prime testing window is beyond 24–48 hours of life, as fluid in the middle ear and in the external meatus is normally significantly reduced on the second day of life. For this reason, the TEOAE test is done as near as possible to discharge. The average stay in our hospital for mothers after a vaginal delivery is 48 hours and for cesarean section is more than 72 hours allowing a successful hearing screening implementation programs [2,7].

There are well-known hearing loss risk factors defined by the Joint Committee on Infant Hearing, the Commission for Early Detection of Hearing Loss (CODEPEH) based in Spain and others [8-10]. However, some studies have demonstrated the existence of other epidemiological factors that modify TEOAE test results [11]. One of such factors appears to be the feeding type (breastfed newborns seem to have better response to TEOAE) modifying pass rate to hearing screening test as described in some studies [11-13] without a clear explanation. The real effect on response and pass rate of the TEOAE screening test must be taken into account as more data on these phenomena are gathered [14,15].

The objective of this study is to answer the question of whether newborn feeding really can influence the TEOAE screening results.

MATERIALS AND METHODS

Significant differences in TEOAE amplitudes between groups can alter the pass rate of screening tests; therefore, the aim of this study was to compare newborn feeding history with influences on the pass rate to TEOAE test as a method for newborn hearing screening during the first 48 h of life. Data were collected between 2000–2019 from all healthy newborns without any known hearing loss risk factor in the maternity ward of Francesc de Borja Hospital in Gandia (Spain). This retrospective study was approved by the ethical committee of this Hospital on 15/July/2019 with code 12/2019.

Exclusion Criteria

The focus of the study was limited to healthy newborns without any syndrome or known disease. Additionally, newborns with Apgar lower than 7 at 5 min. were excluded. Only vaginally delivered newborns were included because timing is a crucial factor in response and neonates delivered by caesarean section stay in the hospital 72 hours so the TEOAE test is done around this age.

In order to eliminate other possible confounding factors [16] only newborns older than 37 gestational weeks with a birth weight greater than 2.5 kg were included. There were no differences between feeding groups based in gender.

Protocol

The bilateral TEOAE screening was performed as close as possible to 48 hours of life. Sometimes an initial TEOAE test near discharge at 48 hours was done, even though the baby was a little fussy, because the baby and the screener were both available at that moment. However, if the baby "failed" it is assumed it was because the baby was fussy and another test was done a few hours later, immediately before discharge; most of these babies passed the test. Thus, in this case, the second test was the most valid result, included in this study. If the baby passed, no more testing was done. All nurses performed the screening, on every shift, every day of the week, depending on availability. The screening was performed in the newborn room with as little background noise as possible after parental verbal consent was obtained. Testing usually took place after feeding time to ensure the newborn was calm. No sedation was administered.

Techniques

The TEOAEs were recorded with an ECHOCHECK OAE Screener® based on the ILO88 (Otodynamics Ltd. Hatfield, U.K.) system and connected to the ILO ECP® neonatal probe. This emits a standard click-type non-linear stimulus of 1 ms duration. The intensity of which is 84 ± 3 dB SPL (sound pressure level) 80 times per second and receives and averages the responses produced by the cochlea to OAEs from 1-4kHz with a primary response band of 1.6-3.2 kHz., but with the frequency 1.6 kHz filtered to avoid noise contamination.

The device is small and portable. Its settings automatically adapt to the size of the external auditory canal. It has luminous signals that confirm that the stimulus is reaching the ear correctly and that the noise level is admissible for the test (less than 47.3 dB SPL on average, although in certain frequencies may be higher). "Pass" results indicate that there are TEOAEs. A normal result (pass) requires a signal/noise level response above 6 dB with a minimum of 512 valid responses for at least 5 sec. The duration of the test usually oscillates between 45 sec and a maximum of 5 min.

A newborn with normal bilateral response was accepted as a pass; otherwise it was deemed a fail [17].

STATISTICAL ANALYSIS

The dependent variable is the TEOAE result before discharge at 48 hr. of life (pass/refer).

The independent variable is newborn's feeding registered in maternal history (breast/formula).

Following frequency analysis of the variables, a univariate analysis was completed between the TEOAE results and the study variables with the Chi-squared test and risk estimate with odds ratio. Statistical analyses were only conducted on patients that had data available for either of the study variables (feeding vs TEOAE results). The significance level was established at $p < 0.05$. The data were analyzed using Excel® 2016 and SPSS® version 20.

RESULTS

(Table 1) shows that breastfeeding was the feeding type in the majority of newborns (73%). In spite of this, there are enough cases in both groups. (Table 2) shows that significant ($p<0.0001$) higher percentage of fails to TEOAE was found in formula fed newborns (mean 9.7% vs 7 % breastfed). The odds ratio of failing for formula fed newborns was 1,434 (1,249-1,648).

COMMENTS

The percentage of breastfed babies in our study (which does not include 3% mixed feeding) was 73.16%. Although this appears not to be very high, the large study period(19 years) must be considered. Over the last years, education on breastfeeding has raised figures to around 75%-80%, more in line with current trends. The good thing is that the comparison group with formula was therefore also sufficiently large. There are some studies that show a better pass rate to TEOAE screening in newborns fed with breast milk. In a former study, in a different group of newborns, about diverse perinatal factors influencing TEOAE results we preliminary informed about a significant difference in response between breast and formula fed newborns [11].

Table 1: Newborn feeding type.

		Frequency	Valid Percent
Feeding	Formula	3469	27.0
	Breast	9397	73.0
	Total	12866	100.0
Missing		5	
Total		12871	

Table 2: Crosstab feeding vs TEOAE results.

			TEOAE		Total
			TEOAE FAIL	TEOAE PASS	
Feeding	Formula	**Count**	**331**	**3083**	**3414**
		% within Feeding	9,7%	90,3%	100,0%
		% within TEOAE	33,8%	26,3%	26,8%
	Breast	**Count**	**648**	**8658**	**9306**
		% within Feeding	7,0%	93,0%	100,0%
		% within TEOAE	66,2%	73,7%	73,2%
Total		**Count**	**979**	**11741**	**12720**
		% within Feeding	7,7%	92,3%	100,0%
		% within TEOAE	100,0%	100,0%	100,0%
Pearson Chi-Square		Value	df	Asymp. Sig. (2-sided)	
		26,244	1	0.0001	
Risk Estimate		Value	95% Confidence Interval		
			Lower	Upper	
Odds Ratio for feeding (Formula / Breast)		1,434	1,249	1,648	

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The objective in this study was to analyze pass rate to TEOAE newborn hearing screening depending on feeding type in a selected group of healthy newborns vaginally delivered, term and normal weight, without hearing risk factors as near as possible to 48h of life before discharge from maternity ward in order to avoid some confusing factors cited in other studies [12-16]. Age near to 48 h was selected because it is known that before 24h of life the fail rate is much higher than in elder ones [18]. Healthy term babies in maternity ward were selected because some studies show that immaturity, low birth weight and therapy in intensive care unit ward are important reasons of disturbance in otoacoustic emissions [19] and compared to term infants, late preterm infants (35-37 weeks) had 2-fold higher rates of failure on 1st OAE (up to 42 h of life) and needed repeated hearing tests [20].

Our results show that there are very significant differences in TEOAE results depending on the type of feeding. There was a significant lower proportion of failing TEOAE results in the breastfed group compared with formula fed ones (7% vs 9.7%; P<.0001) and an Oddsratio (OR) of 1.43 (CI 1.25-1.65) for failing the test was calculated in the formula group. These results can express a higher rate of hearing loss in formula fed infants as shown recently by Van Kerschaver [12] in a study with a population of 103,835 term newborns in Flanders, Belgium, that were tested by a Universal Neonatal Hearing Screening (UNHS) programme. Using automated auditory brainstem responses (AABR), they concluded that there was a significant association between breastfeeding and the prevalence of Congenital Hearing Impairment (CHI) failing AABR. This effect remained after adjustment for the origin of the mother and other factors. Breastfed newborns were less likely to have CHI than their bottle-fed counter parts. Although feeding type is linked to education level, origin of the mother, environmental factors, but also to poverty and smoking habits, logistic regression analysis has shown that feeding type appears as an independent variable, which contributes to the prevalence of CHI. This study remains inconclusive on the exact mechanism of the complex relationship of feeding type with CHI. Since poor people are less likely to breastfeed, they hypothesize that breastfeeding, through the path of poverty is linked to CHI. This can be an explanation for our results, but we think there are other physiologic reasons for that.

We think that the main reason for this difference is probably better explained based on middle ear status because diverse studies have demonstrated that breastfeeding alone can be considered a protection factor against middle ear changes. For example, Garcia [13] published an article where Otoacoustic Emissions (OAE) were carried out in 60 infants between zero and four months old. The breastfed infants had a higher occasion of normal tympanometries and normal otorhinolaryngological assessment enabling better OAEs, with statistically significant differences.

The mechanism for these differences lies in the theory that an earlier opening of the Eustachian tube and/or a better middle ear clearance based on the position of baby while feeding (supine or semi-upright) or the suction movements during breastfeeding can explain this. There has also been the suggestion that it is the method of feeding (bottle versus breast) that creates an increased risk of Otitis Media (OM), regardless of whether the bottled milk is formula or expressed breast milk.

Boone [21] showed that one month of breastfeeding was associated with 4%reduced odds of ever having otitis media, and 17% reduced odds for infants breastfed for 6 months. Among infants who were fed no-formula in the first 6 months postpartum, the odds of experiencing otitis media increased by approximately 14% for infants fed expressed milk for 1 month and by 115% with 6 months of expressed milk feeding. This finding suggests that feeding mode rather than substance fed underlies the differences in otitis media risk [21].

Also, Tully et al [22] reported a 59.6% rate of abnormal tympanograms following supine bottle-feeding compared to a 15.0% rate of abnormal tympanograms in infants fed in a semi-upright position, regardless of the contents of the bottle. They argued that supine bottle-feeding results in aspiration of milk into the middle ear cavity resulting in blockages that may be linked to an increased incidence of OM. However, Rosenfeld [23] has argued that whilst supine feeding may result in abnormal tympanograms for infants, these infants did not have a history of OM, and therefore the effect of supine feeding on children prone to OM has not yet been established. It has also been established that the mechanics of infant sucking for bottle-fed or mixed-fed babies are different to breast-fed babies, with fewer sucks and longer pauses observed for

bottle-fed babies [24]. Infant jaw movement facilitates opening and closing of the Eustachian tube [25,26], and the reduced sucking movements in bottle-fed infants may result in less ventilation of, or reduced clearance of fluid from, the middle ear. This reduced ventilation of the middle ear in bottle-fed infants may be another mechanism for increased risk of OM in this group. There are also physiological mechanisms explaining the association between breastfeeding and reduced risk of OM. Strong negative pressure is generated by breastfeeding, in contrast to bottle-feeding. Suck, swallow and breathing patterns are also different from bottle-feeding infants [27,28]. All this can explain a better response to TEOAE newborn hearing screening because breastfed newborn will have a better middle ear status from the beginning and this fact correlates with the good evidence from systematic reviews and meta-analysis for a protective effect of breastfeeding on the risk of OM in the first 2 years of life (28). In addition to the biochemical components in human milk, breast feeding clearly protects from otitis media as concluded for example a study of Brennan-Jones [29] who informed that in a total of 1344 children, that participated in a 6-year cohort follow-up, and were given ear and hearing assessments showed a positive association between formula feeding and Otitis media in early childhood showing a protective effect of breastfeeding.

LIMITATIONS

The Echocheck Screener results do not provide actual TEOAE response amplitude values. The TEOAE test without normal results indicates a hearing loss greater than 30 dB HL. Additional studies using actual response amplitude data are needed to consider the amount of difference in response. The nonlinear protocol used in the current study is the most common method to record TEOAEs [29]. This method uses three clicks of one polarity with a subsequent single click with three times the amplitude and opposite polarity. The test can detect cochlear responses in the presence of linear artifacts related to the clicks. However, part of the actual OAE recording is eliminated as all linear components of the response are removed. Therefore, nonlinear measurement may not be able to detect the OAE response completely; this process results in a low signal-to-noise ratio of TEOAEs in general. Perhaps it is necessary that linear measurement of TEOAEs should also be recorded in addition to using a nonlinear protocol in order to clarify this issue in future research.

The Echocheck Screener explores a frequency range from 0 to 4 kHz. Further studies are required to determine if there is any effect in some of the frequencies outside of this range, such as differences in higher frequencies that cannot be detected with this device. Given that healthy newborns were examined for this study, it remains unknown if formula feeding increases the susceptibility to other neonatal hearing loss factors. Additionally, perhaps there are other unknown perinatal factors that can vary response in formula fed newborns. More studies in this area are needed.

CONCLUSION

Breastfeeding is an important factor related to a normal response in otoacoustic emissions test. It may improve final results of newborn hearing screening reducing the number of neonates who need to be rescheduled for a repeated test, as well as the associated anxiety and the possibility of losing patients during follow-up. These are major problems in neonatal hearing screening. This is another good reason to insist on newborn breastfeeding.

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AUTHOR CONTRIBUTIONS

Conceptualization: Sequi-Canet. JM and Sequi-Sabater. JM; Data curation: Collar-Castillo J.; Supervision: Orta-Sibu N.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Cubells Fuente JM, Gairí Tahull JM. (2000). Neonatal screening of deafness through evoked acoustic otoemissions Neonatal hearing screening by evoked otoacoustic emissions. An Pediatr. 53: 586-591.
2. Sequi Canet JM, Sala Langa MJ, Collar Del Castillo JI. (2016). Results from ten years newborn hearing screening in a secondary hospital. An Pediatr. 85: 189-196.
3. Neumann K, Chadha S, Tavartkiladze G, Bu X, White KR. (2019). Newborn and Infant Hearing Screening Facing

Globally Growing Numbers of People Suffering from Disabling Hearing Loss. Int J Neonatal Screen. 5: 7

4. Wong LY, Espinoza F, Alvarez KM, Molter D, Saunders JE. (2017). Otoacoustic Emissions in Rural Nicaragua: Cost Analysis and Implications for Newborn Hearing Screening. Otolaryngol Head Neck Surg. 156:877-885.
5. Akinpelu OV, Peleva E, Funnell WR, Daniel SJ. (2014). Otoacoustic emissions in newborn hearing screening: a systematic review of the effects of different protocols on test outcomes. Int J Pediatr Otorhinolaryngol. 78: 711-717.
6. Chiou ST, Lung HL, Chen LS, Yen AM, Fann JC, et al. (2017). Economic evaluation of long-term impacts of universal newborn hearing screening. Int J Audiol. 56: 46-52
7. Sequí Canet JM, Collar del Castillo J, Lorente Mayor L, Oller Prieto A, Morant Barber M. (2005). Organization of neonatal auditory screening with otoemissions in secondary hospitals: feasible, efficient and effective. Pediatric Act Esp. 63: 465-470.
8. American Academy of Pediatrics, Joint Committee on Infant Hearing. (2007). Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. Pediatrics. 120: 898-921
9. Onoda RM, de Azevedo MF, dos Santos AM. (2011). Neonatal Hearing Screening: Failures, hearing loss and risk indicators. Braz. J. Otorhinolaryngol. 77: 775-783.
10. Trinidad-Ramos G, de Aguilar VA, Jaudenes-Casaubón C, Núñez-Batalla F, Sequí-Canet JM; Comisión para la Detección Precoz de la Hipoacusia (CODEPEH). (2010). Early hearing detection and intervention: 2010 CODEPEH recommendation. Acta Otorrinolaringol. 61: 69-77.
11. Sequi-Canet JM, Sala-Langa MJ, Collar Del Castillo JI. (2014). Perinatal factors affecting the detection of Otoacoustic Emissions in vaginally delivered, healthy newborns, during the first 48 hours of life. Acta Otorrinolaringol. 65: 1-7.
12. Van Kerschaver E, Boudewyns AN, Declau F, van de Heyning PH, Wuyts FL. (2013). Socio-demographic determinants of hearing impairment studied in 103 835 term babies. Eur. J. Public Health. 23: 55-60.
13. Garcia MV, Azevedo MF, Testa JR, Luiz CB. (2012). The influence of the type of breastfeeding on middle ear conditions in infants. Braz J Otorhinolaryngol. 78: 8-14.
14. Butcher E, Dezateux C, Knowles RL. (2018). Risk factors for permanent childhood hearing impairment. Arch Dis Child. 1-3.
15. Roizen N. (2003). Non genetic causes of hearing loss. Ment Retard Dev Disabil Res Rev. 9:120-127.
16. Cavalcante JM, Isaac Mde L. (2013). Analysis of otoacoustic emissions in neonates at term and preterm. Braz J Otorhinolaryngol. 79: 582-588.
17. Kemp DT, Ryan S, Bray P. (1990). A Guide to the Effective Use of Otoacoustic Emissions. Ear Hear. 11: 93-105.
18. Torrico P, Gómez C, López-Ríos J, de Cáceres MC, Trinidad G, Serrano M. (2004). Age influence in otoacoustic emissions for hearing loss screening in infants. Acta Otorrinolaringol Esp. 55: 153-159.
19. Kocoń S, Wiatr M, Stręk P, Składzień J, Muszyński P, et al. (2013). Analysis of factors affecting the abnormal otoacoustic emissions in infants. Otolaryngol Pol. 67: 209-213.
20. Smolkin T, Anton Y, Ulanovsky I, Blazer S, Mick O, Makhoul MI, Makhoul IR. (2013). Impact of gestational age on neonatal hearing screening in vaginally-born late-preterm and early-term infants. Neonatology. 104:110-115.
21. Boone KM, Geraghty SR, Keim SA. (2016). Feeding at the Breast and Expressed Milk Feeding: Associations with Otitis Media and Diarrhea in Infants. J Pediatr. 174: 118-125.
22. Tully SB, Bar-Haim Y, Bradley RL. (1995). Abnormal tympanography after supine bottle feeding. J. Pediatr. 126: S105-S111.
23. Rosenfeld RM. (2003). Clinical pathway for acute otitis media. In Evidence-Based Otitis Media, 2nd edition, Rosenfeld RM & Bluestone CD. (eds), pp280-302.
24. Moral A, Bolibar I, Seguranyes G, Ustrell JM, Sebastiá G, et al. (2010). Mechanics of sucking: comparison between bottle feeding and breastfeeding. BMC Pediatr. 10: 6.
25. Bluestone CD. (2008). Impact of evolution on the eustachian tube. Laryngoscope. 118: 522-527 .
26. Bluestone CD, Doyle WJ. (1988). Anatomy and physiology of eustachian tube and middle ear related to otitis media. J. Allergy Clin. Immunol. 81: 997-1003.

27. Brown CE, Magnuson B. (2000). On the physics of the infant feeding bottle and middle ear sequela: ear disease in infants can be associated with bottle feeding. Int J Pediatr Otorhinolaryngol. 54: 13-20.
28. Bowatte G, Tham R, Allen KJ, Tan DJ, Lau M, et al. (2015). Breastfeeding and childhood acute otitis media: a systematic review and meta-analysis. Acta Paediatr. 104: 85-95.
29. Brennan-Jones CG, Eikelboom RH, Jacques A, Swanepoel D, Atlas MD, et al. (2017). Protective benefit of predominant breastfeeding against otitis media may be limited to early childhood: results from a prospective birth cohort study. Clin Otolaryngol. 42: 29-37.