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Distortion Product Otoacoustic emission in Caesarean Delivery and Normal Full Term Delivery

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Abstract:

Aim: the aim of the study was to analyze distortion product otoacoustic emission in infants of full term normal delivery and caesarean delivery within 24 - 72 hours. Method: The DPOAE was recorded in both ears of the babies with full term normal delivery and and caesarean delivery. the otoscopic evaluation was done in all the new born babies prior to the OAE recordings. the datas obtained was statistically analyzed and examined to determine DPOAE as a effective screening test in new born screening. Result and Conclusion: The importance of DPOAE in caesarean delivery and normal full term delivery was assessed using data from left and right ear of neonates at frequencies 1KHz, 2Khz, 3Khz and 4KHz. The evidences from the data shows that there are no significant differences between caesarean delivery and regular full term delivery and concluded that DPOAE is an excellent instrument that can be utilized as hearing screening tool for neonates.

CHAPTER 1

INTRODUCTION

Hearing is the perception of sound as vibrations of air particles resulting in the vibration of air molecules which forms a sound wave. Hearing is a phenomena in which a speaker produces a sound wave which is collected by the listener's ear and experienced as sound. Sound waves collected is channelled through the auditory canal which gets transferred to the ossicles as vibrations eventually reaching the inner ear where they are amplified and generate neural generation happens. According to the signal generated in the brain listener's perception of sound as well as the sensitivity of the sound is identified.

Hearing loss is defined as the inability to hear sounds partially or entirely. Children with hearing loss may experience difficulties with cognition, language learning and language development. Language development or acquisition begins at birth when children learn their native and non-native languages through perceiving under normal environment.

Hearing screening is procedure to know the hearing ability of an individual. The screening protocol is determined based on pass or fail criteria. Screening programs for neonates are conducted to detect their permanent loss and to provide the rehabilitation procedure in the early age. According to American Speech and Hearing Association {ASHA} (2015) Oto Acoustic Emission(OAE) and Auditory Brain Stem Response(ABR) takes priority in hearing screening for newborns and infants. Automated auditory brain stem response is a screener to evaluate auditory pathway to the brainstem infants and neonates.

Otoacoustic emission (OAEs) are sounds that result from energy generated in the cochlea that are propagated through the middle ear and into the ear canal where they can be measured using a sensitive microphone. Kemp (1978) described OAE and since then OAEs have become a standard part of diagnostic test battery and a screening for hearing loss

OAE development had stepped into a simple, non-invasive test that clinician can use to investigate potential hearing loss and to isolate potential causes of hearing loss even in patients who are otherwise unable to self-diagnose and self-report hearing problems. This has completely changed the approaches to finding and treating deafness in children by allowing newborns to be screened for hearing loss.

OAE testing is performed on very young infants who can't be relied on to respond predictably and accurately to the tone or in cases when the mechanical limitations of the inner ear are only detected as a result of certain symptoms. OAE screening is actually faster than pure-tone testing but requires a quiet environment for the equipment to operate correctly. OAE examination doesn't require patient participation and is a good test for patients who are very young or other disabilities that limit interaction. Screening itself is conducted with a small handheld device with a flexible probe on the end. The probe is inserted into the ear the device is activated and within 30 seconds a simple pass/fail result is automatically generated.

https://speechpathologygraduateprograms.org%2fotoacoustic-emissions.org

Kezirian, White, Yeuh, and Sullivan (2001) estimated the cost and cost effectiveness of universal newborn hearing screening and suggested that otoacoustic emission(OAE) testing at birth and followed by repeating test at follow up demonstrated low cost and had lowest cost effectiveness ratio.

Heidari, Manesh, Yeuh and Moradi- joo (2016) examined the cost effectiveness of Automated Auditory Brainstem Response(AABR) and otoacoustic emission(OAE) in universal hearing screening programme found that AABR dominates OAE because has cost effective compared to OAE.

Arora, Jati, Nagarkar, Galhotra, Agrawal, Mehta and Naik (2021) study the outcome, experience and challenges faced during the implementation of the universal newborn hearing screening program in a medical college set up of Raipur, Chhattisgarh

with Otoacoustic emission and Auditory Brainstem Response study reveals the prevalence of hearing loss was 2 per 1000 live births for bilateral hearing loss and 1 per 1000 live births for unilateral hearing loss. Implementing universal newborn screening in a vast country like India is a challenging task because of a high birth rate, diverse socio-economic and cultural background with limited resources.

Universal hearing screening is established for early intervention and management procedures to determine the day to day well being of the child. There are several studies that had been done to analyze the effectiveness of DPOAE and TEOAE in normal full term delivery which had been done over western countries. This study particularly focuses on DPOAE in neonates who were born as normal full term delivery and cesarean delivery (c-section).

‘also determined the prevalence of hearing impairment with a two tier screening

CHAPTER 2

REVIEW OF LITERATURE

Hearing is ability to perceive the auditory stimuli which is understood through vibrations, variations in the pressure along with the time in the surrounding medium, also with the organ ear. Hearing loss is a particular condition where person finds difficulty in perceiving the particular auditory stimuli. The term hearing impaired or hard of hearing is considered to a person when the ability of perceiving speech sounds on that particular frequencies are diminished.

The discovery that outer hair cells have an outstanding electromotile ability has transformed the perception of the cochlea as a passive organ that converts mechanical vibrations of sound into brain activity (Brownwell, Bader, Bertrand & Ribuaupierre, 1985; Brownwell, 1986, 1990). The findings of OAE as a screening and diagnostic technique have a stronger impact on comprehending the auditory system and the properties of sound perception in the inner ear. Kemp (1978) who discovered the screening tool OAE gives a clearer notion of how to identify how well the outer hair cells in the cochlea are working.

Hearing loss can severely have an adverse impact on the child speech, language and cognitive development when the condition is particularly not identified. Vashistha, Aseri, Singh and Verma (2016) established the prevalence of hearing impairment in high-risk infants and found hearing impairment was observed in 15 out of 100 babies where 7 had unilateral and 8 had bilateral hearing loss.

World Health Organization (WHO) in 2018 estimates the magnitude of disabling hearing loss, 460 million people in the world have hearing impairment. The prevalence of hearing impairment was observed as 93% adult (242 million male and 190 million female) and 7% of children (34 million). The prevalence of deafness in South Asia is 2.4% (12.3 million) in children and 18.7% in adults (120 million). In India, 63 million people (6.3%) suffer from various categories of hearing impairment. As per the surveys conducted in national wide hearing impairment is considered as the second most common cause of disability.

https://global estimation prevalence of hearing loss WHO 2018.org

Hearing screening in newborns has a stronger influence on early detection and intervention for children with hearing impairment or who are hard of hearing. The American Academy of Pediatrics (AAP) backed a 1994 statement of the Joint Committee on Infant Hearing (JCIH) that suggested the objective of universal identification of hearing loss in newborns before 3 months of age, with a clear intervention programme starting no later than 6 months (which suggests amplification devices, medical suggestions, therapeutic management, family centred programs). In compared to children who do not receive adequate intervention and management at the proper time, children who receive adequate intervention and management at the appropriate time will have a better reaction. Otoacoustic emission(OAE) is a screening tool as well as a diagnostic tool that is generally used to detect the functioning of cochlea through outer hair cells. There are certain sounds generated by the inner ear when the cochlea is stimulated by a sound. These sound helps the outer hair cells to vibrate. Vibration generally produces an inaudible sound which reflects back to the middle ear where this particular sound is picked up and measured with a small probe which is inserted in the canal.

https://doi.org/10.1542/pir.23-5-155

OAEs the screening tool as according to the conventional nomenclature there are two categories which reflects the cochlear process.

1. Spontaneous OAE

2. Evoked OAE

Spontaneous OAE indicates, without an external acoustic stimulation which consists of energy at one or more frequencies emitted by normal ear and can be recorded in the ear canal with a very sensitive microphone. The clinical value of SOAEs is limited since they are not invariably produced by normal ears which does not imply on cochlear dysfunction.

Evoked OAE are elicited or evoked through an acoustic stimulus where the cochlear dysfunctions are critically analysed. Evoked OAE consist of three types.

1. Stimulus frequency OAE(SFOAE)

2. Transient evoked OAE(TEOAE)

3. Distortion product OAE(DPOAE)

Stimulus frequency OAE are elicited or evoked with a constant pure tone at low intensity level and generally changed slowly across a region of frequencies. This type of evoked OAE is considered to be least studied for experiment and clinically since the devices for recording SFOAE are commercially not available.

TEOAEs, evoked by clicks. A series of click stimuli are presented at 80-85 dB SPL and response recorded. In DPOAEs two tones are simultaneously presented to the cochlea to produce distortion products. They have been used to test hearing in the range of 1000-8000Hz.

OAEs are used as a screening test of hearing in neonates and to test hearing in uncooperative or mentally challenged individuals after sedation. Sedation does not interfere with OAEs. They help to distinguish cochlear from retrocochlear hearing loss. OAEs are absent in cochlear lesions (ototoxic sensorineural hearing loss).They detect ototoxic effects earlier than pure tone audiometry. OAEs are also useful to diagnose retrocochlear pathology, especially auditory neuropathy. Auditory neuropathy is a neurologic disorder of CN VIII. Audiometric tests(SNHL) for puretones, impaired speech discrimination score, absent or abnormal auditory brainstem response, show a retrocochlear type of lesion but OAEs are normal

According to American Academy of Audiology Childhood Hearing Screening Guidelines (2011) generally include Pure tone screening, Tympanometry, Acoustic reflex and Reflexometry, Speech Materials, OAE

OAE GUIDELINES ACCORDING TO AMERICAN ACADEMY OF AUDIOLOGY CHILDHOOD HEARING SCREENING:

- Use only for preschool and school age children for whom pure tone screening is not developmentally appropriate (ability levels < 3 years).
- Calibrate daily.
- DPOAE levels at 65 dB SPL. It is best to maintain primary levels for DPOAEs at or below 65 dB SPL (for example, 65/55 or 65/65) to maximize the response.
- TEOAE levels at 80 dB SPL. Stimulus levels for TEOAEs should be maintained at 80 dB ±3 dB to avoid contamination of the ear canal response. At very high intensities, a stimulus artifacts are seen in the ear canal response. False TEOAE responses may be seen with clicks presented at high intensities (e.g., 90 dB SPL).
- Select DPOAE or TEOAE cut off values carefully. Pass/ fail criteria should be chosen carefully to maximize sensitivity and specificity. A combination of parameters (e.g. waveform reproducibility, TEOAE amplitude, and TEOAE signal to noise ratio) may be used as criteria. For DPOAEs, criteria may be based on minimum DPOAE amplitude and SNR. These cut off values may be frequency specific. Clinicians are encouraged to collect normative data and establish cut off criteria with their own equipment.
- Screening programs using OAE technology must involve an experienced audiologist. An audiologist familiar with OAE technology should be involved in decision making regarding screening technology and in tracking program outcomes.
- Children failing OAE testing should be screened with tympanometry. Performing tympanometry in conjunction with OAE screening with subsequent referral for audiological evaluation for children failing OAE only and rescreening for children failing both OAE and tympanometry may reduce the need for multi-stage screening and improve loss to follow up.

https:// American Academy of Audiology Hearing Screening Guidelines.org

JOINT COMMITTEE ON INFANT HEARING (JCIH) HIGH RISK INDICATORS:

JCIH (2007) stated eleven risk factors which are associated with hearing loss. The complete and accurate obtaining of details which may include the history, new born screening results and any other specific problems which are related to the hearing loss, if present. JCIH had recommended in their guidelines as that the child with or without the risk have to be monitored with the risk indicators during the routine medical visit which are scheduled periodically by American Academy of Pediatrics(AAP). According to JCIH the risk factors associated with children are delayed onset, progressive and congenital hearing loss.

RISK FACTORS ASSOSIATED WITH DELAYED ONSET, PERMANENT AND CONGINETAL HEARING LOSS:

- Caregivers concern regarding hearing, speech, language or developmental delay
- Family history of permanent hearing loss
- Neonatal intensive care for more than 5 days, or any other factors including: extra-corporeal membrane oxygenation(ECMO), assisted ventilation, exposure to ototoxic medications(gentamycin and tobramycin) or loop diuretics(furosemide/lasix) apart includes: hyperbilirubinemia that requires exchange transfusion
- In utero infections, includes cytomegalovirus(CMV), herpes, rubella, syphilis and toxoplasmosis
- Craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies
- Physical findings such as a white forelock that are associated with a syndrome known to include sensorineural hearing loss or permanent conductive hearing loss
- Syndromes associated with hearing loss or progressive or late – onset hearing loss, includes neurofibromatosis, osteoporosis and usher syndrome; other frequently identified syndromes include Alport, Pendred, Jervell and Lange-Nielson
- Neurodegenerative disorders, such as Hunter Syndrome or sensory motor neuropathies, such as Friedriech ataxia and Charcot-Marie-Tooth syndrome

- Culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral(especially herpes virus and varicella) meningitis
- Head trauma, especially basal skull or temporal bone fractures that requires hospitalization
- Chemotherapy

https:// JCIH Risk assessment.org

Western studies:

Yousefi, Ajalloueyan, Amirsalari and Hassanali (2013) investigated the specificity and sensitivity of transient evoked otoacoustic emission in neonatal hearing screening compared with auditory brainstem response and recommended that TEOAEs are suitable primary hearing screening procedure for neonates all over the country.

Barbosa, Durante and Granato (2014) determined the threshold for the emergence of distortion product otoacoustic emission (DPOAE) on frequencies of 2000 and 4000 Hz witha the stimulus varying from 20 to 65 dB SPL, to establish a slope values obtained in the growth curves results shows significant difference in the thresholds for emergence of DPOAE depending on the criteria used.

Silva, Delecrode, Kemp, Martins and Cardoso (2015) compared DPOAE and TEOAE on neonates within the range from 6 to 54 days of age and who were born in low risk maternity hospital and assessed for hearing loss and concluded that the failure rate was higher in distortion product otoacoustic emission when compared with transient evoked otoacoustic emission.

Kanji, Shangase and Moroe (2018) reviewed of the most current research in objective measures used within newborn hearing screening protocols with the aim of exploring the actual protocols in terms of the types of measures used and their frequency of use within a protocol, as well as their outcomes in terms of sensitivity, specificity, false positives, and false negatives in different countries world wide evidence to suggest that the inclusion of AABR within a NHS programme is effective in achieving better hearing screening outcomes. The use of AABR in combination with OAEs within a test-battery approach or cross-check principle to screening is appropriate

Ngui, Tang, Prepageran and Lai (2019) studied the effectiveness of distortion product otoacoustic emission (DPOAE) and automated auditory brainstem response (AABR) as first screening tool among non-risk newborns in a hospital with high delivery rate result revealed that pass rate for AABR (67.9%) was higher than DPOAE (50.1%). Both DPOAE and AABR pass rates improved significantly with increasing age (p-value<0.001). The highest pass rate for both DPOAE and AABR were between the age of 36–48 h, 73.1% and 84.2% respectively. The mean testing time for AABR (13.54 min ± 7.47) was significantly longer than DPOAE (3.52 min ± 1.87), with a p-value of <0.001.

Sheng, Zhou, Wang, Yu, Liu, Liang, Zhou, Wu, Tang and Huang (2021) Compared the hearing screening results of two-step transient evoked otoacoustic emissions (TEOAE) and one-step automatic auditory brainstem response (AABR) in non-risk newborns, and to explore a more suitable hearing screening protocol for infants discharged within 48 h after birth in remote areas of China suggested that pass rate of TEOAE and AABR increased significantly with the increase of first screening time ($P < 0.05$), and the false positive rate decreased significantly with the increase of first screening time ($P < 0.05$). The failure rate of first screening of AABR within 48 h was 7.31%, which was significantly lower than that of TEOAE (9.93%) ($P < 0.05$). The average time spent on AABR was 12.51 ± 6.36 min, which was significantly higher than that of TEOAE (4.05 ± 1.56 min, $P < 0.05$). The failure rate of TEOAE two-step screening was 1.59%, which was significantly lower than one-step AABR

Su, Leung, Morton, Dickinson, Vandal, Balisa and Purdy (2021) evaluated the feasibility of implementing an objective screening protocol that includes otoscopy, distortion product otoacoustic emission screening (DPOAEs), and tympanometry reveals that combination of otoscopy, DPOAEs, and tympanometry was well accepted by the 3-year-old children. DPOAE amplitude and signal-to-noise ratio results significantly differentiated between different tympanometry results, providing support for this combination of measures to accurately screen for hearing loss and/or middle ear disease.

Indian studies:

Rajiv and Mathur (2007) evaluated TEOAE as a screening modality for hearing impairment in neonates and concluded that TEOAE is simple and rapid test with relatively higher acceptability.

Vignesh, Jaya, Sasireka, Sarathy and Vanthana (2015) estimated the prevalence and referral rates in well born and high risk babies using two step hearing screening protocol with Distortion Product Otoacoustic Emissions (DPOAE) and Automated Auditory Brainstem Response (AABR) study reveals that using two step protocol especially AABR along with DPOAE at the initial level of testing significantly reduces referral rates in new born screening programs. Also AABR decreases the false positive responses hence increasing the efficiency of screening program.

Jhony, Shany and Gupta (2017) aimed on the efficacy of TEOAE and DPOAE in hearing screening of new born infants and concluded that both DPOAE and TEOAE can be used for new born screening for detecting the hearing ability in infants in the early stages.

Parab, Khan, Kulkarni, Ghaisis and Kulkarni (2018) studied to find out the prevalence of hearing loss in neonates in the rural taluka of Maval, Pune, Maharashtra, India and revealed that the overall prevalence of hearing loss in neonates in Maval taluka of Maharashtra was found to be 3.54 per 1000 live births, in normal born neonates (well babies) was 1.689 per 1000 births, in high risk babies was 10.69 per 1000 high risk births. The prevalence of low birth weight neonates, hyperbilirubinemia neonates and neonates with craniofacial abnormalities developing hearing impairment was found to be 5.9, 3.56 and 1.18 per 1000 high risk births respectively.

Kaipuzha, Pulimoottil and Karthikeyan (2019) determined the prevalence of hearing loss among newborn infants and to assess the effectiveness and utility of otoacoustic emission (OAE) as a screening tool to detect hearing impairment in newborns and the relationship between selected risk factors and hearing loss reveals 20.95% newborns failed the first screening test, 11.77% failed the second test, and 61.91% of these infants failed the third OAE test. Of the 26 infants who failed the third test, 15 had abnormal results on BERA. Overall, the prevalence of hearing loss was 0.48%.

Raghuwanshi, Gargava, Kulkarni and Kumar (2019) studied the role of Otoacoustic emission test in neonatal screening at tertiary center concluded that OAE is a good screening test for hearing loss of neonates, but the results must be confirmed with BERA test.

Need for the study:

According to the statistical prevalence of Kerala Social Security Mission, Government Of Kerala in 2015, approximately 5 lakh deliveries are happening in each year in Kerala. The necessity of providing early identification and intervention strategies for neonates and infants is considered as an important aspect of living.

There were several studies conducted to measure the impact or the effective measures of DPOAE and TEOAE tests which are conducted in normal full term delivery and cesarean delivery.

The current study focuses on the analyzing DPOAE in new born babies who were born as normal full term delivery and Caesarean delivery babies in Kerala within 24-72 hours.

CHAPTER 3

METHOD

Aim of the study:

The aim of the present study was to analyze the Distortion Product Otoacoustic Emission (DPOAE) in infants of full term normal delivery (FTND) and cesarean(C-Section) delivery within 24 – 72 hours

Participants:

The DPOAE were recorded from fifty Full Term Normal Delivery (FTND) babies and fifty cesarean delivery.

Inclusive criteria

- Normal born Neonates in Obstetrics and Gynaecology ward.
- No significant prenatal history.
- No significant Medical and Neurological deficit.
- No significant family history of speech and hearing deficits.

Exclusive criteria

- Ototoxic medication during pregnancy, aminoglycosides, Vancomycin, Frusemide etc
- RH incompatibilities.
- Infectious Diseases
- Sepsis.
- In utero infections (TORCH-S) such as Toxoplasmosis, Other Agents, Rubella (also known as German measles), Cytomegalovirus, and Herpes Simplex.
- Low birth weight (< 2.5kg)
- Delayed Birth Cry/Absent.
- Birth Asphyxia.
- Family History of hereditary childhood hearing loss.
- Craniofacial Anomalies.
- Hyperbilirubinemia.
- Apgar score of 4-6 at 1& 5 minutes.
- Hydrocephalous.
- Seizures.
- Miscellaneous Syndromes likely to affect Hearing.
- Neonatal intensive care of more than 5 days or any of the following regardless of length of stay: Extracorporeal Membrane Oxygenation (ECMO) therapy, assisted ventilation, exposure to ototoxic medications or loop diuretics and hyperbilirubinemia that requires exchange transfusion.
- Neonatal Maturity - > 34 weeks

Procedure:

The DPOAE was recorded in both ears of the babies with full term normal delivery and caesarian delivery. The otoscopic examination was done all the new born babies prior to the OAE recordings.

Protocol:

DPOAE is an auditory examination in which an acoustic signal is detected in the ear canal of a person with normal outer hair cell (OHC) function, and the auditory system is stimulated with a pair of pure tones at frequencies (F1) & (F2). The resulting distortion product tone will have a frequency range of 2F1-F2. The DPOAE results show that the outer hair cells are working. DPOAE protocol are as follows:

Table 3.1

Showing the protocol for DPOAE

Intensity level L1, dBSPL	65dBSPL
Intensity Level L2, dBSPL	55dBSPL
Noise Level	-10
SNR Pass Criteria	6dB
Frequency Of Pass	70%

With the above measurements DPOAE were recorded in both ears for 100 new born babies with cesarean and normal delivery (50 each) while sleeping. The hearing test was carried out in a sound-treated audiology room, in accordance with ANSI S 3 guidelines. Smooth replaceable ear tips were used to insert the OAE probes. The ear tips were chosen based on a visual examination of the infant's external ear canal size.The ear tip must be put farther into the ear canal to assess DPOAE measurements. Because the ear tip is put deeper into the ear canal, larger emissions can be measured due to the smaller ear canal volume. When the probe tip is properly put into the ear canal, the instrument displays a green tick mark, and if the noise level exceeds that, the device displays a red cross mark, indicating that the probe tip should be reinserted. The testing ear is selected in the instrument when the probe tip is correctly achieved, and DPOAE is performed according to the aforementioned standard methodology. DPOAE measurements were performed by switching the instrument's mode and selecting the ear to be measured. The apparatus recorded the data obtained throughout the evaluation, such as stimulus shape, stimulus spectrum, DP gramme, Pass/Fail, and so on. A tick mark indicates pass frequencies, whereas a cross mark indicates fail frequencies in the instrument.

Data analysis:

The obtained data of DPOAE in new born babies (Caesarean and Full Term Normal Delivery) were a'nalysed and examined to determine DPOAE as a screening testin new born screening.

The statistical analysis was done using Mann Whitney and Wilcoxon signed rank test.

‘’ CHAPTER 4

RESULT AND DISCUSSION

The aim of the study was to analyse distortion product otoacoustic emission(DPOAE) in normal full term delivery(NFTD) and Caesarean (C-Section) delivery in neonates within 24-72 hours. The study was carried out in 100 babies. The data obtained was statistically analyzed and the result obtained are as follows.

A. Significance of DPOAE in C-Section and NFTD

Table 4.1

Showing the significance of DPOAE for NFTD and C- Section deliveries in left and right ear

Parameter				Mean	Std. Deviation	50th (Median)	IQR	Mann whitney test p value	
DPOAE	1K	Left	NFTD	0.19	9.59	0.70	-8.4--7.75	0.409	NS
			C SECTION	-2.22	9.34	-3.00	-8.85--3.1		
		Right	NFTD	-1.08	9.99	-2.60	-9.3--8.05	0.684	NS
			C SECTION	0.07	8.67	0.30	-6.4--7.4		
	2K	Left	NFTD	-1.62	9.46	-2.50	-7.75—2	0.567	NS
			C SECTION	-2.89	8.32	-2.70	-10.15--3.1		
		Right	NFTD	1.07	11.11	0.30	-7.3--10.85	0.265	NS
			C SECTION	-2.24	10.41	-5.60	-10.4--5.2		
	3K	Left	NFTD	-3.46	8.04	-5.20	-9.25--1.35	0.669	NS
			C SECTION	-4.78	8.12	-5.10	-11.15--0.7		
		Right	NFTD	-2.78	6.36	-2.30	-7.9--1.7	0.265	NS
			C SECTION	-2.98	8.49	-5.00	-10.15--3.7		
	4K	Left	NFTD	1.94	10.28	2.10	-5.55--9.85	0.691	NS
			C SECTION	-0.96	10.15	-4.60	-7.45--7.6		
		Right	NFTD	3.34	10.06	5.90	-5.15--11.55	0.404	NS
			C SECTION	1.52	8.75	0.30	-6.8--7.85		

NS – Non Significant

From table 4.1 the result suggest that there is no significance in DPOAE results for NFTD and C- Section deliveries across left and right ear.

B. Comparison across frequencies in DPOAE for NFTD and C-Section

Table 4.2

Shows the comparison for C – Section and NFTD across frequencies in DPOAE

Group	Side			Wilcoxon signed rank test p value	
NFTD	Left	1K	2K	1.000	
			3K	1.000	
			4K	.004	HS
		2K	3K	1.000	
			4K	.157	
		3K	4K	.023	SIG
	Right	1K	2K	.052	
			3K	.069	
			4K	.002	HS
		2K	3K	1.000	
			4K	.240	
		3K	4K	.152	
C SECTION	Left	1K	2K	.170	
			3K	1.000	
			4K	.047	SIG
		2K	3K	1.000	
			4K	1.000	
		3K	4K	.642	
	Right	1K	2K	1.000	
			3K	.183	
			4K	.007	HS
		2K	3K	1.000	
			4K	.066	
		3K	4K	.252	

SIG – Significant, HS – Highly Significant

The table shows the comparison across each frequencies in normal full term delivery (NFTD) and Caesarean (C-Section) delivery in left and right ear

1. **Comparison of frequencies in normal full term delivery(NFTD):**

- It is clear evidence that there is highly significant difference for the frequencies in 1KHz – 4KHZ in right and left ear where significant level for right ear (p= .002) and left ear(p= .004).
- Significant differences is observed across the frequencies in 3KHz – 4KHz in left ear where left ear(p= .023)

2. **Comparison of frequencies in Caesarean (C-Section) delivery:**

- It is evident that there is a significant difference determined 1KHz – 4KHz in left ear where left ear (p=.047)
- Highly significant difference is observed in 1KHz - 4KHz in right ear where right ear (p= .007)

DISCUSSION

Hearing screening in infants and newborns is critical for early intervention and treatment of a child's hearing ability and impairment. Otoacoustic emission is the most essential method for the aforesaid screening. The current review focuses on the benefits of DPOAE in neonates during normal full-term birth and Caesarean (C-section) delivery.

From the above review the evidences observed where as follows:

- **Significance of DPOAE in C-Section and NFTD**

  The significance of DPOAE in Caesarean (C–Section) delivery and normal full term delivery (NFTD) was determined based on the evidences in frequencies 1KHz, 2KHz, 3KHz, 4KHz which was examined in both left and right ear of neonates. The evidences based on the data determine that there is no significant differences in both normal full term delivery (NFTD) and Caesarean(C–Section)

- **Comparison across frequencies in DPOAE for NFTD and C-Section**

  Comparison across frequencies in DPOAE for NFTD and C-Section were determined as 1KHz - 2KHz, 1KHz - 3KHz, 1KHz – 4KHz, 2KHz – 3KHz, 2KHz- 4KHz and 3KHz – 4KHz in both left and right ear across Caesarean (C- Section) and normal full term delivery(NFTD). The comparison indicated:

- Highly significant difference for the frequencies in 1KHz – 4KHz in right and left ear for normal full term delivery (NFTD)
- Significant differences is observed across the frequencies in 3KHz – 4KHz in left ear in normal full term delivery(NFTD)
- Significant difference determined 1KHz – 4KHz in left ear in Caesarean (C-Section) delivery
- Highly significant difference is observed in 1KHz - 4KHz in right ear in Caesarean (C-Section) delivery

‘’ From the present study reveals that DPOAE is an effective tool that can be used as hearing screening for neonates. The present study is according with Jhony, Shany and Gupta (2017) aimed on the efficacy of TEOAE and DPOAE in hearing screening of new born infants and concluded that both DPOAE and TEOAE can be used for new born screening for detecting the hearing ability in infants in the early stages.

‘’ CHAPTER 5

SUMMARY AND CONCLUSION

Hearing screening programme for newborns have been proven to be the most effective means of detecting irreversible congenital hearing loss and initiating auditory therapy before the age of three months. The most current public health preventive screening programme engaging the entire population is newborn hearing screening. However, it is not a conclusive diagnosis, and more research is required.

In screening programme, elicited otoacoustic emissions are quick, non-invasive, and simple to use. It is critical to understand the variability of transient evoked otoacoustic emissions (TEOAE) and distortion product otoacoustic emissions (DPOAE) in order to evaluate hearing status across time.

The goal of this study was to examine distortion product otoacoustic emissions (DPOAE) in infants who were delivered normally and with those who were delivered with Caesarean section within 24 – 72 hours. DPOAE was measured in 100 full-term babies. The DPOAE screening test findings were determined and statistically analysed.

The importance of DPOAE in caesarean (C-section) delivery and normal full term delivery (NFTD) was assessed using data from the left and right ear of neonates at frequencies of 1KHz, 2KHz, 3KHz, and 4KHz. The evidence from the data shows that there are no significant differences between Caesarean (C-section) and regular full-term birth (NFTD).

DPOAE is an excellent instrument that can be utilized as a hearing screening tool for neonates, according to the findings of this study. The current research is based on the findings of Johny, Shany, and Gupta (2017), investigated the efficacy of TEOAE and DPOAE in hearing screening of newborn infants and concluded that both DPOAE and TEOAE can be utilized for newborn screening to detect hearing capacity. Thus the study can be concluded that DPOAE is an effective tool that can be used for hearing screening

in neonates with Caesarean (C-Section) delivery and Normal Full Term Delivery(NFTD)

Implication of the study

The study provides an understanding of neonatal screening techniques, which will aid an audiologist for screening purposes and obtaining correct results. A failure in screening tests may indicate the need for additional audiological testing.

Limitation of the study

1. Only four frequencies were used in this investigation.

2. There were 100 babies in the population studied.

Future recommendation:

1. The population for the study can be increased

2. TEOAE can be analyzed in Normal Full Term Delivery(NFTD) and Caesarean delivery(C-Section)

3. TEOAE and DPOAE in NFTD and C- Section deliveries

4. Male and female comparison can be compared

CHAPTER 6

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