CHAPTER 4

RESULTS AND DISCUSSION

4. 0. INTRODUCTION

This chapter presents the findings, analysis and discussion of the findings according to the specific objectives mentioned in Chapter 1. Of the 193 infants (386 ears) included in this study, 255 ears (66%) passed the Transient evoked Otoacoustic emissions (TEOAE) screening test and 131 ears (34 %) failed the test. Table 1 lists the results of the TEOAE screening tests (pass or fail) and the scores of the TEOAE tests (% score).

Tympanometry tests were used to assign the 386 ears to one of the two groups, A or B (Table 2). Group A included ears exhibiting clear external canals and visualized healthy tympanic membranes together with 'Type A' tympanogram. 'Type A' tympanograms were considered to be normal (Jerger, 1970).

Group B included ears showing wax or casseous materials with occlusion, abnormal middle ear pressure, middle ear fluid or abnormal tympanogram other than ' Type A'.

Table 1: Screening Outcomes From TEOAE Tests (Pass or Fail)

Screening outcome	Frequency	Percentage
Pass	255 ears	66%
Fail	131 ears	34%
Total	386	100%

Table 1 displays the results of the TEOAE hearing screening where a "pass" indicates the presence of normal hearing, whereas a "fail" indicates hearing impairment. Presence of TEOAE emissions is characteristic of normal cochlear function. TEOAE's are reduced or absent in cases of conductive or cochlear hearing impairment. The TEOAE tests indicated that 255 ears of the 386 ears had no hearing problem while 131 ears had some form of hearing problem.

Table 2: Tympanometry Test Results

Groups	No of ears	Percentage
Group A	325 ears	84.2%
Group B	61 ears	15.8%
Total	386	100%

Table 2 shows the results obtained from the Tympanometry tests. Of the total 386 ears, 325 ears (84.2%) were considered having normal tympanogram and assigned to Group A, while 61 ears (5.8%) showed abnormal tympanogram and were assigned to Group B (Table 2). 325 ears were considered normal while 61 ears showed at least one middle ear abnormality.

4. 1 DESCRIPTION OF FINDINGS AND DISCUSSION IN RELATION TO EACH RESEARCH QUESTION

Research Question 1

Is there a relation between Transient Evoked Otoacoustic Emissions (TEOAE) screening results and External / Middle ear conditions?

Regarding the relation between TEOAE score and external/ middle ear status, out of group A (325 ears), with normal middle ear function, 236 ears (72.6%) had TEOAE passes, while 89 ears (27.4%) failed the test. In group B, out of 61 ears, 19 ears (31.2%) had TEOAE passes while 42 ears (68.8%) failed the test (Table 3). Ears that passed the TEOAE test have normal hearing whereas ears that failed the test shows some form of hearing impairment.

Table 3: Results of TEOAE and Tympanometry screening scores

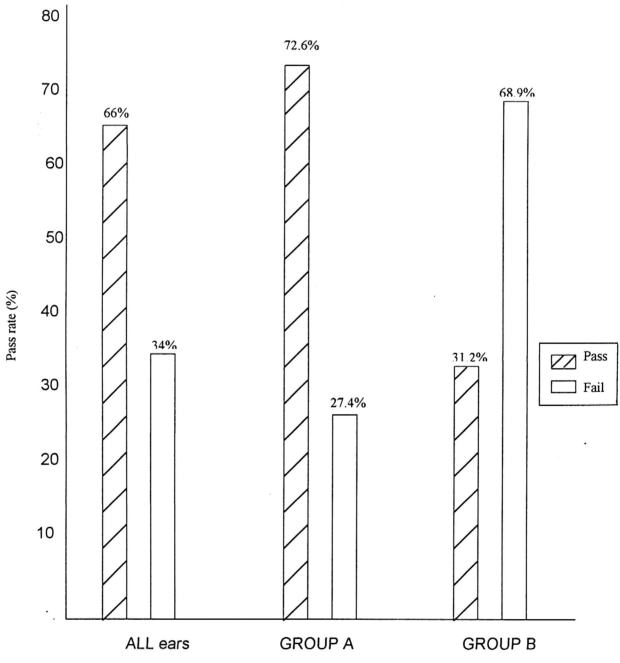
Results	Group A (325 ears)		Group B (61 ears)	
	No. of ears	%	No. of ears	%
Pass	236	72.6%	19	31.2%
Fail	89	27.4%	42	68.8%
Total	325	100	61	100

As stated earlier Group A included ears with normal external/ middle ear status with 'Type A' Tympanogram. Group B included ears with at least one external/middle ear abnormality and other than 'Type A' Tympanogram

Ears with no external or middle ear abnormalities (group A) had a higher TEOAE pass rate (72.6%) than those with abnormal tympanograms

(group B) (31.2%). Figure 16 shows the TEOAE pass rates for all ears combined, group A and group B.

Figure 2: Graphical representation of percentage of ears passing and failing in TEOAE screening in the two tympanogram category of Group A and Group B for 386 ears.



This study showed a relationship between TEOAE screening and Tympanometrically determined external and/middle ear conditions with higher pass rate in group A compared to group B with abnormal tympanograms. The pass rate difference between group A and group B was found to be highly significant as seen in Table 4.

Table 4: Chi – Square Analyses of TEOAE Pass Rates of groups A and B

	TEST					
	PASS		**FAIL**		**TOTAL**	
Group	FREQ	%	FREQ.	%	FREQ.	%
A	236	611	89	23.1	325	84.2
B	19	4.1	42	10.9	61	15.8
	255		131		386	100.0

Chi - square= 39.39 df = 1 p< .01

Table 4, Chi – square analysis indicates that there is significant difference in the number of passes among the two groups (χ^2=39.39, p<.01)

The above test results indicate that external and middle ear conditions have profound effects on the results of TEOAE screening test as a significant number of passes in the TEOAE screening test were seen in group A, which had normal external/middle ear status and tympanogram as compared to group B which included ears with external/middle ear conditions and abnormal tympanogram. The present study indicated that TEOAE screening and tympanometry are all strongly and significantly associated. In the above study, TEOAEs are found to be sensitive to middle ear conditions which and have a great impact on the presence of TEOAE's. The effect of external and middle

ear conditions affecting the TEOAE's should be considered as an important factor in the TEOAE hearing screening procedure.

The present study also showed a strong relationship between theTEOAE pass rate and normal tympanograms with normal external and middle ear condition. Only a small percentage of ears in group B with abnormal tympanometry had TEOAE passes in the screening. This was similar to a study by Sutton (1995), to investigate the relationship between TEOAEs and tympanometry. He found that a significant number of neonates and infants have shown abnormal tympanometry with middle ear fluid as a strong indicator of TEOAE failure. His study was performed on 84 special care neonates as part of a larger study of middle ear effusion in neonates and infants. Results indicated that TEOAE and tympanometry are all strongly and significantly associated. In Sutton's(1995) study, the prevalence of abnormal tympanogram which may indicate middle ear effusion or dysfunction was seen in 20% of babies in this group.

Erwing et al, (1991) found that OAEs were observable in only 12% of children with flat tympanogram and that they were always absent when conductive loss exceeded 20dB. Kennedy et al's (1991) study reported on neonatal tympanometric results on 10 babies with middle ear effusion or fluid later in their first year, showed that 4 out of 5 ears that were reported with flat tympanogram failed the OAE test.

Choi et al, (1999) did a study on 89 patients in a children's hospital, to determine whether Transient evoked OAE's are affected by the status of the

tympanic membrane and middle ear conditions. The study showed a significant association between a normal middle ear and the presence of emissions. This concurs with the current study which gave similar results but in a different age group.

The current study also showed a higher pass rate in group A having normal tympanogram than those with at least one abnormality in group B which were detected by tympanometry and ear examination (Table 3). Amr El – Refaie, (1995) in his study found similar results with significant differences in passable TEOAE scores between the 2 groups; 94.7% in group A and 14.3% in group B indicating the influence that external/middle ear may have on TEOAE screen scores.

It has been reported that TEOAEs can be present with minor pressure changes in the external/middle ear. In the present study a greater failure rate of 68.9% from a total of 61 ears was seen in group B, caused by external/ middle ear conditions as compared to failure rate of 27.4% from a total of 325 ears seen in group A which has normal external/middle ear status (Table 5). This highlights the influence that the external/middle ear status may have on the screening.

Table 5: Summary data for 131 ears who failed the TEOAE screening in Group A and Group B

	All ears 386	**Group A 325 ears**	**Group B 61 ears**
OAE failures	131 ears (34%)	89 ears (27.4%)	42 ears (68.9%)

Chang (1992) has reported failure rates of roughly 18% in neonates during the first 3 days of life using TEOAE testing. This is higher than the 10% of the neonates who are reported to fail on Auditory Brain stem screening test (ABR). Steven et al, (1989) in his study reported failure rates for TEOAE screening between 3% and 30 %. Occasional reports of failure rates as high as 45% has been mentioned by El - Refaie et al, (1996) in his study. This concurs with the current study which gave overall similar failure rates in the TEOAE screening.

Research Question 2

To what extent does TEOAE tests successfully identify infants with hearing loss?

As stated earlier in the initial evaluation of the TEOAE screening, 255 ears (66%) passed the TEOAE screening and 131 ears (34%) failed the TEOAE screening. All the failure ears with abnormal TEOAE and abnormal Tympanometry in the screening were followed up for ear examination for clearing of wax, treatment of middle ear conditions and ABR testing.

In the present study the total number of ears passing the TEOAE examination increased from 66% to73.9% after follow up ear examination for clearing of wax/debris and treatment of middle ear function in group B, and from evaluation by ABR test in group A.

In the 42 ears (68.9%) in Group B failures that were followed up by Ear specialist for clearing of the ear for wax removal and treatment for the

temporary middle ear conditions, post examination TEOAE and tympanometry test indicated improved hearing in some infants (Table 6). 16 ears (38.1%) showed normal hearing and 26 ears (62%) conductive hearing loss. This concurs with the reported study by Chang (1992) in which the post cleaning OAE pass rate increased from 76% to 91% after debris was removed from ear canal thus supporting his hypothesis that debris in the external ear canal attenuates the OAE signal.

Table 6: Post Examination Audiological test results of TEOAE in GroupB

	Outcome of Follow-up Post examination TEOAE	
TEOAE Screening Group B failures	Conductive Loss	Normal Hearing
42 ears (68.9%)	26 ears (62%)	16 ears (38.1%)

Of the 89 ears (27.4%) that failed the TEOAE screen in group A, 12 ears (13.5%) were found to have normal hearing on follow up by ABR test (Table 6).The first stage failure rate in the TEOAE screen of 12 ears in group A could have been influenced by factors other than sensorineural loss. The failure rate could have been influenced by probe fitting problems. Fitting the probe is actually the single most important part of an acoustic emissions measurement. Further more some children were not asleep and physiologic noise (swallowing movements) could have influenced the TEOAE recording.

White et al, (1994) reported 37 neonates identified with a conductive hearing loss in a group of infants referred for diagnostic audiological evaluation. In the current study, 26 ears showed conductive loss on the

TEOAE failures that were followed up. Middle ear dysfunction can indeed confound the interpretation of TEOAE's. Didier Aidan's (1999) study found a "pass" rate of 92.7% on neonates when retested (114 of 123). This result substantially exceeds the White et al, second - test "pass"rate (208 of 403).

In the current study the sensitivity or the accuracy by which the screening detected impaired ears was 92.8%. Mark. E. Lutman's (1989) study on evoked Otoacoustic emissions in adults on 514 ears gave a sensitivity of 98.8%. The TEOAE screening test is highly sensitive with the literature reporting sensitivities ranging from 93% to 100%. In view of this the results of the present study concurs with the above studies.

Joseph Kee, Bradley Mc Pherson et al,(1998) mentioned that the neonatal EOAEs differ slightly from adult EOAEs in that they tend to be larger in amplitude and contain more high frequency energy, although there is a great deal of overlap between the two age groups. So there is no reason to suspect that the relationship between EOAEs and hearing sensitivity will differ markedly between adults and neonates.

Research Question 3

Is there a significant number of infants detected having Sensorineural loss in the OAE screening ?

89 ears that failed in the TEOAE screening in Group A, were subjected to further follow up by Auditory Brainstem Response test (ABR). Of this, as shown in Table 7, 77 ears (86.5%) indicated various degrees of sensorineural Loss which was due to cochlear dysfunction and not attributed to external / middle ear conditions.The remaining 12 ears showed normal hearing.

Table 7: Auditory Brainstem Response Test (ABR) follow up on TEOAE failures in group A

	Outcome of Follow-up using ABR Threshold measurement	
TEOAE Screening Group A failures	Sensorineural	Normal Hearing
89 ears (27.4%)	77 ears (86.5%)	12 ears (13.5%)

The above findings in Table 7 indicate the TEOAE screening failures in group A and the results of the follow -up by ABR test.

The neonatal hearing screening in Aidan's study (1999) done on a large scale cohort of 1421 neonates identified two neonates with bilateral sensorineural loss, confirming their prevalence of confirmed sensorineural loss in neonates to be 1.4 in 1000. The present study detected 20% having sensorineural hearing loss in the TEOAE screening. Choi's (1999) study on 169 ears in the age group of 8 months to 18.1 year detected 3.1% having sensorineural hearing loss.

Inspite of the number of false positives in the screening test, repeatable findings of measurable TEOAEs is highly correlated with normal Auditory Brainstem Response test. False negative results however are very rare. Choi et al, (1999) found that the presence of hearing loss is the most significant predictor of TEOAE results.

Delayed diagnosis of hearing loss may have several consequences. Firstly it has been suggested on the strengths of experiments on animals and through analogy with the human visual system, that early hearing deprivation may impair the brain's capacity to respond to and recognise the sounds of speech.

Secondly, if a hearing loss of some severity and early onset is not diagnosed in the first years of life, there will be a period of development where the child learns with little or no experience of sound. Although certainly this will affect the child's experience of hearing, speech and language development, it will also affect experience of environmental sounds which play a part in the child's growing and understanding of social events. The child whose diagnosis is delayed will not get benefit from early amplification and the child's parents may interpret the child's lack of response to their communicative approaches in other ways.

Research has shown the link between successful communication and attachment formation in young hearing impaired children (Greenberg & Marvin,1979). Even when a diagnosis is achieved relatively early, towards the end of the first year of life, the child's earliest development proceeds in the absence of full access to information from environmental sound. The first year is also critical because it is the period in which communication and relationships within the family are established. Successful communication and interaction can be established through non-verbal means but parents without experience of communicating with the hearing impaired often need

encouragement and support and a knowledge of the child's needs to be able to adapt their approach to interaction.

The degree to which the language and social development of a child is affected by a hearing impairment depends mostly, but not entirely, upon the type and severity of the hearing loss. Other factors, in addition to the child's intelligence, which will influence the nature of social and language development are the communication systems in use in the family which allow them to understand, attend to and adapt to the child's communication difficulties and any additional disabilities which the child may have.

Clearly there are some consequences which follow from a developmental impairment of communication, no matter what the cause of the disability. For example, children with communication disabilities typically have difficulties in making relationships and interacting with their peers.

The sounds that the preverbal infant hears also have an important role in helping to make the world predictable. The child is able to learn from experience that the sound of one event anticipates another. The absent sound cues can contribute to an experience which makes the world seem unpredictable and arbitrary place. People appear to behave in unexpected ways because the sounds that help to make sense of their behavior are missing and events, linked through time by sound, loose their integrity.