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Effect of Type II Diabetes on Speech Perception in Noise

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Abstract:
There is dearth of literature targeting the behavioral correlates to central auditory processing among individuals with Diabetes. As communication being crucial aspect of human existence and losing the skill to effectively communicate adversely affects quality of life (QoL).So the present study was undertaken with the aim to examine the effect of type II Diabetes on speech perception in noise. A total of 80 subjects equally divided in to experimental and control group participated in this research. Experimental group consisted of 40 individuals with Diabetes (TYPE II) diagnosed for minimum five years between the age range of 28 – 60 years, with a mean age of 44years with equal gender representation. The effect of Diabetes on speech perception abilities among individuals with greater than 5 years of diabetic age, results revels a statistically significant difference between both the groups with p value < 0.01 for speech perception task and also there was association between the age of diabetes and the quick SIN scores for individuals with diabetes. We hypothesize that reduced sensory processing ability which could be due to involvement of various structures of central nervous system might have contributed to poor speech understanding abilities in diabetics individuals.

Key words: *Type II diabetics, Speech perception in noise, Hearing loss, Hyperglycemia*

1. Introduction

The American Diabetes Association (2010) has defined Diabetes mellitus as a group of metabolic diseases characterized by hyperglycemia, which is a result of alterations in the secretion and/or action of insulin. Diabetes mellitus comprises of a heterogeneous disorder characterized by high blood glucose levels. The National Diabetes Data Group and the World Health Organisation (1998) have identified four major types of Diabetes i.e. insulin-dependent Diabetesmellitus, non-insulin-dependent Diabetes mellitus, gestational Diabetes mellitus, and Diabetes secondary to other conditions. India leads the world with more number of diabetic individuals making the dubious distinction of being termed the "Diabetes capital of the world" (Mohan et.al. 2007). According to the Diabetes Atlas, published in 2006 by the International Diabetes Federation the number of people suffering with Diabetes in India is currently around 40.9 million and is expected to rise to 69.9 million by 2025, unless urgent precautionary steps are taken. Some of the potential complications of Diabetes includes Heart and blood vessel disease, peripheral neuropathy, Diabetic retinopathy, foot damage, skin and mouth infectious conditions, osteoporosis, Alzheimer's disease and brain-damaging inflammation ((Robinson et al,2010).

Deficitson the auditory system, exhibiting themselves in peripheral as well as central locihave been reported in Diabetes (Type II), Among individuals with Diabetes between the ages of 50 and 69 years, more than 70% have high-frequency hearing impairment and one third have low- or mid-frequency hearing impairmentandalso Diabetes individuals may experience hearing loss at early ages itself as suggested by U.S. data. Studies with otoacoustic emissions have shown early changes in micromechanical properties of outer hair cells and auditory evoked brainstem response in individuals with diabetic complications (Gupta et al,2010).Sharma et al in 2000 statedthat the occurrence of delayed wave latencies in diabetics was 64%, 72% and 84% at 2 KHz, 4 KHz and 6 KHz respectively; suggesting theinvolvement of central neural axis.Itis suggested that brainstem evoked response audiometry carried outat higher frequency like 6 KHz can beused for earlydetection ofcentral involvement in individuals with diabetis.

Communicationbeingcrucial aspect of human existencehas a major role in the quality of life of an individual. Speech perception is one of important factors for the effective communication.Research in speech perception seeks to understand how human listeners recognize speech sounds and use this information to understand spoken language. Considering the trend of the emerging results about the relation between the Diabetes and auditory system, it seems convincing to realize that the Diabetes tends to affect the structure from cochlea and brainstem till the cortex. Bainbridge et al, (2011) have stressed that early diagnosis of changes in hearing sensitivity and nerve function in diabetic patients could provide incentives for adoption of control measures and monitoring of disease complications. Early monitoring and intervention of hearing problems could provide better quality of life for diabetic patients. Hence thepresent study was planned with an aim of examining the effect of Diabetes (Type II) on speech perception in noisewith followingobjectives.

- To examine the difference, if any, in the performance of individuals with and without type II Diabetes on Speech in Noise by calculating SNR loss.
- To investigate if there is any correlation between the age of onset of Diabetes and the Speech in Noise by calculating SNR loss among individuals with type II Diabetes.

2. Methods

The study was conducted in a multidisciplinary hospital from January 2012 to January 2013.

A total of 80 subjects participated in this research. The subjects were equally divided in to experimental and control group. Experimental group consisted of 40 individuals with Diabetes (Type II)diagnosed for minimum five years between the age range of 28 – 60 years, with a mean age of 44years with equal gender representation. Control group consisted of age and gender matched individuals without Diabetes. All the subjects of the experimental and control group underwent a routine Audiological test battery, Mini-mental state examination (MMSE)(Folistein et al 1975) and the Canadian Diabetes screening checklist (CAN RISK) (Public Health Agency of Canada, 2009) for assessing their eligibility for the study. The Pure tone thresholds were obtained at octave intervals between 250 Hz to 8000 Hz for air conduction stimuli and between 250 Hz to 4000 Hz for bone conduction stimuliusing Hughson-Westlake method (CarhartandJerger, 1959). Immitance evaluation included 226 Hz tympanometry and measurement of acoustic reflexes to rule out any middle ear pathology.Pure tone thresholds less than or equal to 25 dB HL and A or As type tympanogram with reflex present or elevated were included in the study. MMSE was used as a screening tool to assess cognition ability of individuals. A score of greater than 25 was considered as having no cognitive deficit. Canadian Diabetes screening checklist questionnaire was used as to rule out the risk of possessing Diabetes in control group.A score lesser than 7 was considered as having no diabetes or low risk of developing diabetes. Subjects of both the groups, who qualified for the study, underwent for speech perception test Quick SINin Kannada (Ajithet al2009). This was administered in a soundproof room with adequate illumination by havingsubjects seated in a comfortable position. The recorded material was presented binaurally via head phone using Laptop with good sound cardat Signal to Noise Ratio (SNR) of +20dBSNR to -10 dBSNR. With these ranges of SNRs, it was intended to measure the SNR loss. Total 3 sets of sentences out of 12 sets were used, each set had seven sentences, one sentence at each signal-to-noise ratio (SNR) of 20, 15, 10, 5, 0,-5 and -10dB. The following formulas were used for calculating SNR loss.SNR loss =22.5-(-6.17)-total number of words corrected

3. Results and Discussion

The main aim of the present study was to examine the effect of Diabetes (Type II) on speech perception abilities among individuals with greater than 5 years of diabetic age. To accomplish this, speech perception abilities of subjects with and without diabetes were identified through Quick SIN in Kannada.

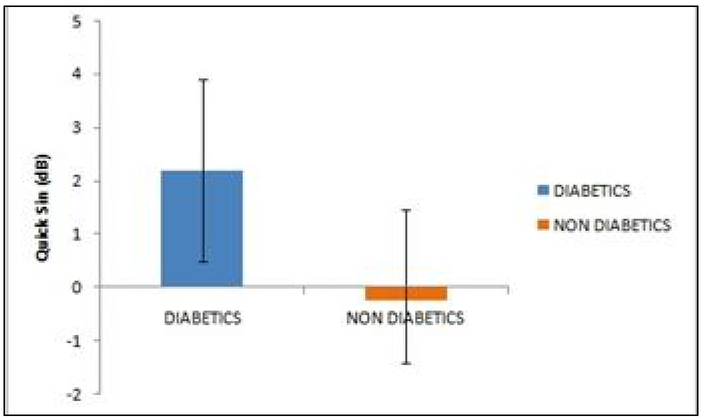

Figure 1: Mean and standard deviation of Quick SIN values in SNR loss for the diabetics and Non diabetics

As can be understood from the above figures, the group having individuals with no Diabetes outperformed the group of individuals with diabetes. There exists a statistically significant difference between both the groups with p value < 0.00 for speech perception task. Therefore these results correlate with the previous findings by Morales, et al (2005) who found out that the long term complication of the type 2 diabetes mellitus is subclinical hearing loss and impaired auditory brainstem responses.

The second objective of the present research was to evaluate the presence of correlation, if any, between the age of diabetes and the quick SIN scores for individuals with diabetes.

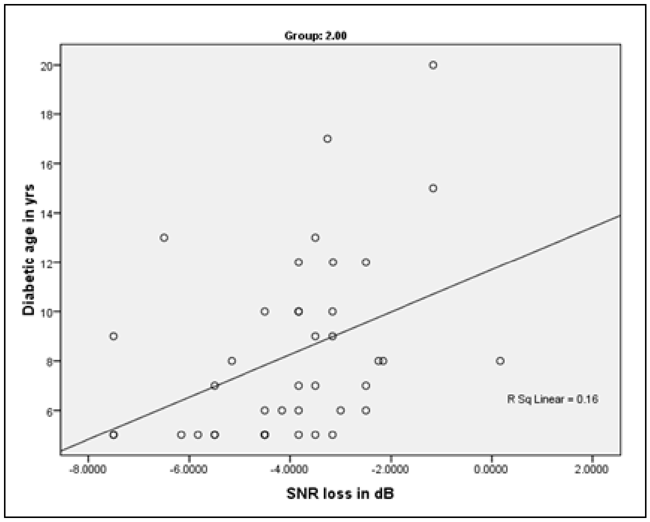

Figure 2: Correlation between Diabetic age and Quick SIN values

As can be understood from the above figures, the correlation coefficient value (r=.409 & p<.01) revealed that the diabetes age of the individuals positively correlated with Quick SIN tasks reaching a level of statistical significance for the Quick SIN tasks. This indicates that as the diabetes age of the individuals increased there was a corresponding increase in Quick SIN scores i.e. their speech perception seemed to deteriorate.

The overall result of the present study indicates that individuals with diabetes do seem to possess a significant speech perception deficit as compared to their age matched non diabetic group. To understand the effect of diabetes on these auditory processes, it is very important to realize the neurophysiological correlates of these processes. Overlapping neuroanatomical structures might bring about a justifiable relation between the two variables.

Research on identifying the neural correlates of perceiving speech in noise has also gained momentum recently. Evidences seem to emerge at various levels of central auditory nervous system exploring the contribution to speech perception in noise. Wong et al., (2010), reported bilateral activation of caudal middle frontal gyrus, pars opercularis, pars triangularis, rostral middle frontal gyrus, superior frontal gyrus (covering dorsal and ventral aspects of Pre frontal cortex), precuneus, and superior temporal region (auditory cortex) as predictors for speech perception ability in presence of noise in unfavorable condition on the Quick SIN (0 dB SNR condition). The involvement of brainstem structures for perceiving speech in noise has also been studied recently (Song, Song et al, 2012). They correlated the performance on SIN with the speech evoked ABRs of the subjects. Poorer performanceon standardized Quick SIN measure proved greater susceptibility to the degrading effects of noise on the neural encoding of the F0. Particularly phase-locked activity was diminished to the fundamental frequency in the portion of the syllable known to be most vulnerable to perceptual disruption (i.e., the formant transition period). Their results suggest that the perception of speech in noisy conditions to some extent depends on contribution of brainstem representation of the F0.

The results of the present study depict that individuals with diabetes exhibited decreased Quick SIN performance as compared the individuals without diabetes. Above discussion indicates various neurophysiological correlates of Quick SIN. When considered together, it is clear that structures of brainstem as well as the cortex are involved in processing these skills. Literature on type 2 Diabetes reveals that there exists a definite deviation in the brainstem responses among these individuals. ABR findings with central diabetic neuropathy were initially correlated by Taylor et al., (1981). Nakamura et al., (1991) described multiple lesions in the area of the pons and the thalamus in diabetic patients with pathological ABRusing magnetic resonance imaging. There are reports of impaired peripheral nerve conduction velocity and ABR very early in diabetes (Fedele, et al, 1984). Evidences are also observed for central neuropathy in type 2 Diabetes (Virtaniemi et al., 1993; Toth et al., 2001). The interpeak latency of I – III, III – V and I – V have been found to be delayed in diabetic group. This suggests delayed transmission of the auditory stimulus in the auditory pathway of individuals with diabetes at the level of brainstem and the midbrain. The delay also indicates a neuropathy at the brainstem and midbrain level (Gupta et al. 2004). Initialphases of auditory stream segregation occur subcortically (Pressnitzer et al., 2008), and timing cues necessary for speech perception and auditory stream segregation are preserved in the brainstem via neural synchrony (Kraus and Nicol, 2005; Tzounopoulos and Kraus, 2009). It is well established that delayed and reduced auditory evoked responses from cortical is due to neural synchrony degradation in noise (Warrier et al., 2004; Billings et al., 2009; Russo et al., 2009) and brainstem structures (Hall, 1992; Cunningham et al., 2001; Russo et al., 2004). So, presence of neuropathy at the level of these structures, as in individuals with diabetes, might further explain the results of the present study.

Therefore, the impaired brainstem and midbrain processing among individuals with diabetes cannot be overlooked, which has also been observed in this study. Quick SIN are dependent on the various central auditory nervous system structures which have been found to be affected in individuals with diabetes. But it should also be noted that results of present study can only be correlated with the brainstem and midbrain (to some extent) processing. This is because of the limited literature on the higher auditory potential among individuals with diabetes.

Although all the subjects with diabetes in the present study, had more than 5 years of duration of diabetes, there still appears a significant correlation between their diabetic age and the performance on Quick SIN tasks. Individuals with greater diabetes age exhibited poorer performance over the Quick SIN tasks. This could be attributed to a greater impact of diabetes on various structures of central nervous system, auditory function and cognitive factors, which have been discussed to be important for these tasks. Long term diabetes has been associated with recurrent attacks of hypoglycemia which causes additional damage to range of brain areas (Lu et al., 2010).

4. Conclusion

Speech perception ability in adverse listening condition was investigated in the present study in type II diabetes individuals. The results of present study indicated deficits in their auditory processing abilities which may be possibly due to involvement of various structures of central nervous system that would have contribute to reduced speech perception abilities in diabetics individuals.

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