Prevalence of otological disorders in diabetic patients with hearing loss

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Diabetes mellitus

• Prevalence all over the globe is increasing at an alarming rate.
• India is the “Diabetes capital of the world”.
• Increased propensity for developing a broad spectrum of irreversible complications.
Diabetes with hearing loss

- Alterations in glucose levels affect nearly every organ system in the body.
- Affects the auditory system - leads to the onset of hearing loss.
- Prevalence of hearing loss in diabetic patients is increasing (Mitchell et al., 2009).

Adapted from http://www.audiologyspecialists.com/anatomy-of-the-ear
Otological disorders

Diseases of Ear

External Ear
- Cerumen impaction
- Congenital ear anomalies
- Otitis externa
- Otomycosis
- Referred otalgia

Middle Ear
- Acute suppurative otitis media
- Chronic suppurative otitis media
- Otitis media with effusion
- Otosclerosis

Inner Ear
- Cervical vertigo
- Congenital hearing loss
- Meniere's disease
- Presbycusis
- Sudden sensorineural hearing loss
- Traumatic lesions
- Ototoxicity
Sound transmission pathway

- **External ear**
  - Pinna
  - Auditory canal
  - Tympanic membrane
  - Ossicles
  - Oval window

- **Middle ear**
  - Cochlea
  - Hair cells
  - Auditory nerve

- **Inner ear**
  - Brain

Sound

- Mechanical energy
- Electrochemical energy

Pathological changes caused by diabetes in the auditory system

1. Structures of the cochlea
2. Auditory nerve
3. Blood supply to cochlea
4. Central auditory processing

Microvascular and neuropathic changes in the cochlea

- Blood Glucose levels
- Inner ear
- Chemical changes
- Impact Nerve ability to carry sound
- 8th/cochlear/auditory nerve

Nerve damage associated with auditory system

- Blood sugar level
- Inner ear
- Injury
- Vasculature
- Sensorineural hearing loss
Hearing impairment is a common sensory disability to comprehend sound in auditory pathway of one or both ears.

Patterns of hearing loss:
- Conductive (outer and/or middle ear)
- Sensorineural (inner ear)
- Mixed (outer/ middle/inner ear)
- Central (brain stem lesions)
<table>
<thead>
<tr>
<th>Degree of hearing loss</th>
<th>Hearing loss range (dB HL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>-10 to 15</td>
</tr>
<tr>
<td>Minimal</td>
<td>16 to 25</td>
</tr>
<tr>
<td>Mild</td>
<td>26 to 40</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 to 55</td>
</tr>
<tr>
<td>Moderately severe</td>
<td>56 to 70</td>
</tr>
<tr>
<td>Severe</td>
<td>71 to 90</td>
</tr>
<tr>
<td>Profound</td>
<td>91+</td>
</tr>
</tbody>
</table>

Importance of the study

• Hearing loss and diabetes (DM2) are significant health issues in the elderly population.

• Studies on hearing loss in diabetes have not received attention in South Indian population.

• For determining the magnitude and onset of hearing loss in diabetic population of South India.
Objectives

• To determine the demographic and otological parameters in diabetic subjects affected with hearing loss.

• To investigate the prevalence of otological diseases and hearing loss patterns in adults suffering from diabetes in South Indian population.
**Subjects**

- 174 diabetic cases affected with hearing loss and 420 non-diabetic constituted the study subjects
- MAA ENT Hospitals, Hyderabad, Telangana State, India
- Age $\geq 40$ years were included in the study.
- Confirmatory diagnosis was done by the general physician and ENT specialist.
- Otological examinations were carried out to diagnose the disorders.
- Hearing loss was evaluated using pure tone audiometry and average for the frequencies at 0.5, 1, 2, 4 and 8 kHz was recorded.
The data obtained was coded for statistical evaluations.

Analysis was performed using the Statistical Package for Social Sciences PASW STATISTICS 18.0 software (SPSS Inc., Chicago, IL, USA).

Continuous data is represented as means and standard deviations.

Categorical data as proportions and percentages for illustrations.

Chi-square test and binary logistic regression analysis was used for evaluating the association of various parameters.
### Table 1. Distribution of gender, age and otological parameters in diabetic and non diabetic study subjects

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Diabetic (n=174)</th>
<th>Non-diabetic(n=420)</th>
<th>OR(95% CI)††</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>60(34.5)</td>
<td>182(43.3)</td>
<td>1.00(Reference)</td>
</tr>
<tr>
<td>Male</td>
<td>114(65.5)</td>
<td>238 (56.7)</td>
<td>1.45(1.03-2.04)*</td>
</tr>
<tr>
<td><strong>Age(years)†</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of onset(years)†</td>
<td>56.2±11.31</td>
<td>54.4±10.62</td>
<td>1.00(Reference)</td>
</tr>
<tr>
<td>40-60</td>
<td>108(62.1)</td>
<td>307 (73.0)</td>
<td>1.00(Reference)</td>
</tr>
<tr>
<td>&gt;60</td>
<td>66(37.9)</td>
<td>113(26.9)</td>
<td>1.65(1.17-2.32)**</td>
</tr>
<tr>
<td><strong>Laterality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>62(35.6)</td>
<td>191(45.5)</td>
<td>1.00(Reference)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>112(64.4)</td>
<td>229(54.5)</td>
<td>1.51(1.07-2.11)*</td>
</tr>
<tr>
<td><strong>Mean PTA(dBHL)</strong></td>
<td>50.5±17.34</td>
<td>49.4±17.54</td>
<td>1.00(Reference)</td>
</tr>
<tr>
<td>&lt;40dB</td>
<td>71(40.8)</td>
<td>167(39.7)</td>
<td>1.00(Reference)</td>
</tr>
<tr>
<td>&gt;40dB</td>
<td>103(59.2)</td>
<td>253(60.3)</td>
<td>0.95(0.68-1.33)</td>
</tr>
<tr>
<td><strong>Associated symptoms</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tinnitus</td>
<td>56(32.2)</td>
<td>161(36.0)</td>
<td>0.83(0.59-1.17)</td>
</tr>
<tr>
<td>Vertigo</td>
<td>24(13.8)</td>
<td>69(15.3)</td>
<td>0.97(0.60-1.56)</td>
</tr>
</tbody>
</table>

*a. †-Independent sample t test(mean ± standard deviation);  
b. Values in paranthesis are percent frequency; NC-Not calculated.  
c. †† - Chi-square test
Table 2. Association of gender and otological parameters with age of onset in diabetic subjects affected with hearing loss

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Total</th>
<th>40-60 years</th>
<th>&gt;60 years</th>
<th>P-value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender†</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>114(65.5)</td>
<td>59(51.8)</td>
<td>55(48.2)</td>
<td>0.036</td>
<td>1.00 (Reference)</td>
</tr>
<tr>
<td>Female</td>
<td>60(34.5)</td>
<td>41(68.3)</td>
<td>19(31.7)</td>
<td></td>
<td>0.49 (0.26-0.96)*</td>
</tr>
<tr>
<td><strong>Laterality†</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>2(35.6)</td>
<td>43(44.3)</td>
<td>19(24.7)</td>
<td>0.007</td>
<td>1.00 (Reference)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>112(64.4)</td>
<td>54(55.7)</td>
<td>58(75.3)</td>
<td></td>
<td>2.43 (1.26-4.67)**</td>
</tr>
<tr>
<td><strong>Degree of hearing loss(Decibels-dB)†</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$40$ dB</td>
<td>26(14.9)</td>
<td>10(13.0)</td>
<td>16(61.5)</td>
<td>0.519</td>
<td>1.00 (Reference)</td>
</tr>
<tr>
<td>&gt;$40$ dB</td>
<td>148(85.1)</td>
<td>67(87.0)</td>
<td>81(83.5)</td>
<td></td>
<td>1.32 (0.56-3.11)</td>
</tr>
<tr>
<td><strong>Types of hearing loss††</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conductive hearing loss</td>
<td>77(44.3)</td>
<td>24(31.2)</td>
<td>53(54.6)</td>
<td>&lt;0.001</td>
<td>1.00 (Reference)</td>
</tr>
<tr>
<td>Sensorineural hearing loss</td>
<td>67(38.5)</td>
<td>23(23.7)</td>
<td>44(57.1)</td>
<td></td>
<td>4.23 (2.10-8.48)***</td>
</tr>
<tr>
<td>Mixed hearing loss</td>
<td>30(17.2)</td>
<td>9(11.7)</td>
<td>21(21.6)</td>
<td></td>
<td>0.95 (0.38-2.37)</td>
</tr>
</tbody>
</table>

a. Values in paranthesis are percent frequency
b. †-Chi-square test, ††-binary logistic regression analysis
Figure 1. Prevalence of otological disorders in diabetic and non diabetic study subjects

- ASOM
- CSOM
- OME
- Otosclerosis
- Meniere's disease
- Presbycusis
- SSNHL

Diabetic
Non diabetic
Figure 2. Distribution of otological diseases at different age groups in diabetic and non diabetic study subjects.
Figure 3. Prevalence of otological diseases in the study subjects with laterality in diabetic and non diabetic study subjects

<table>
<thead>
<tr>
<th>Disease</th>
<th>Diabetic</th>
<th>Non diabetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASOM</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>CSOM</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>OME</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Otosclerosis</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Meniere's disease</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>SSNHL</td>
<td>30</td>
<td>10</td>
</tr>
</tbody>
</table>

% Frequency

Unilateral

Bilateral
Figure 4. Distribution of hearing loss patterns in otological diseases of diabetic and non diabetic study subjects.
Figure 5. Prevalence of hearing loss at lower(<40dB) and higher frequency (>40dB) in otological diseases of diabetic and non diabetic study subjects.
Results

• Male preponderance (1.9) was observed.

• Prevalence of hearing loss was more in subjects >60 years of age (55.7%).

• Prevalence of bilateral hearing loss was more in diabetic subjects.

• 85.1% of study subjects showed hearing loss at higher frequency (>40 dBHL).

• Hearing loss was more prevalent in presbycusis (61.3%) and acute suppurative otitis media (27%) among diabetic cases.

• 32.2% of the diabetic subjects showed tinnitus.

• 44.3% of the diabetic subjects showed conductive type followed
by 38.5 % of sensorineural and 17.2% of mixed hearing loss.

Association of hearing loss with age of onset of diabetes

• Bilateral form of hearing loss was observed to be more in subjects >60 years of age group.

• Sensorineural hearing loss was significantly associated with increase in age.

Otological disorders

• Prevalence of presbycusis was predominant at higher age group.

• Bilateral form of hearing loss was noticed in Meniere’s disease and presbycusis.

• Otitis media, otosclerosis and sudden sensorineural form of hearing loss showed unilaterality.
• Sensorineural form of hearing loss was noticed to be high in Meniere’s disease, OME and otosclerosis.

• Conductive hearing loss was noticed more in ASOM.

• Presbycusis, CSOM and OME were observed to have hearing loss at >40dBHL.

• Hearing loss at lower frequency (<40dBHL) was noticed at ASOM, otosclerosis and Meniere’s disease.
Conclusion

• Presbycusis and otitis media were the predominant otological disorders found in diabetes patients with hearing loss.

• Sensorineural form of hearing loss was found to significantly associated with the elderly age group (>60 years).

• Conductive form of hearing loss was more prevalent in subjects suffering from ASOM.

• Sensorineural form of hearing loss was high in Meniere’s disease, OME and otosclerosis.

• Hearing disability (>40dB) was more in otological disorders of otosclerosis, Meniere’s disease and presbycusis.

• ASOM and sudden sensorineural hearing loss showed prevalence even at lower decibel range(<40dB).
Significance of the study

• The study helped to establish the prevalence otological disorders to be more prevalent in diabetic subjects is caused by the dysfunction of middle and inner ear.

• Diabetes is associated with hearing disorders in above 60 years age group than between 40-60 years.

• Effective control of diabetes is to be considered to reduce the incidence of deafness in above 60 years.
Acknowledgement

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• Hong O, Buss J, Thomas E. Type 2 diabetes and hearing loss. Dis Mon 2013; 59: 139-46.


Thank you