Objectives: Diabetic patients were identified as well or poorly controlled based on American Diabetes Association guidelines and audiograms were evaluated to determine if hearing loss was greater than age matched non-diabetic patients.

Study Design: Retrospective chart review.

Methods: This is a retrospective chart review of 990 patients that had audiograms performed between 2000 and 2008. Subjects were classified as diabetic controlled, diabetic non-controlled and non-diabetic groups. Subjects were also classified by gender and age category (<60, 60-75, >75). A three way analysis of variance (ANOVA) was used to examine pure tone average (PTA), speech frequency PTA, high frequency PTA, and word recognition scoring (WRS).

Results: There were statistically significant differences in hearing between non-diabetic (average PTA 14.8 ± 6.9 for <60 year old and 23.6 ± 8.9 for 60-75 year old females) and well controlled diabetic (20.0 ± 10.7, 27.0 ± 11.6) and poorly controlled diabetic (22.1 ± 14.2, 29.6 ± 13.2) females in the <60 and 60-75 age categories. P-values were < 0.01 for both age groups comparing controls to uncontrolled and <0.05 for controls versus controlled for the young females. This difference was not seen in the male patients.

Conclusions: There was an statistically significant decrease in PTA in well and poorly controlled diabetes compared to non-diabetic females in the <60 and 60-75 age categories. Hearing loss in the male population was significantly worse in all age categories compared to females but did not demonstrate a decrease from well controlled or poorly controlled diabetes.

Level of Evidence: 2b

Introduction

Previous studies have evaluated the effect of diabetes on hearing. Dalton et al evaluated Non-Insulin Dependant Diabetics (NIDDM) and Insulin Dependant Diabetics (IDDM). The study suggested a weak association between NIDDM and hearing loss. Kakarlapudi et al showed that sensorineural hearing loss was more common in diabetics than non-diabetics and the severity of hearing loss was correlated with disease progression as reflected by serum creatinine. A prospective study concluded that diabetic patients younger than 60 years of age experienced early high frequency hearing loss similar to presbycusis. After age 60, the difference in hearing between diabetic and non-diabetic patients was reduced.

Methods

A retrospective chart review of patients treated within a tertiary care institution. Level of evidence 2b

Subjects were drawn from the an administrative data base between the years 2000 and 2008. A query produced all patients with pharmacy claims for diabetic medications, lab values for HbA1c, and audiogram data available during the review period. A subject’s average HbA1c was used to determine their level of control. For patients with multiple audiograms, the most recent audiogram was analyzed. The presence of diabetic medications and HbA1c data defined a diabetic subject. Any patient with normal range HbA1c data and not taking diabetes medication defined a non-diabetic subject. The most recent ADA HbA1c definition for a controlled diabetic is a HbA1c that is less than or equal to 7.0. An uncontrolled diabetic is defined as an average HbA1c that is greater than 7.0. A patient with an elevated HbA1c and not on any medication is, by definition, uncontrolled and those patients were placed into the uncontrolled arms.

In previous unpublished research, there was statistical interactions between gender, diabetes, and age when evaluating hearing loss. For the purposes of this study, males and females were evaluated separately. Each gender was then separated into arms based on age, diabetic status and level of control; resulting in a sample size of 55 subjects in each of eighteen arms.

Each subject’s audiogram was evaluated for three different Pure Tone Average (PTA) data. The Total Pure Tone Average (Total PTA) was the average of all frequencies evaluated. The PTA 5,1,2 was the average of the 500, 1000, 2000 Hz and 4000 Hz frequencies and the PTA 1,2,4 was the average of the 1000 Hz, 2000 Hz and 4000 Hz frequencies.

An analysis of variance (ANOVA) followed by contrast statements to examine the three pair-wise comparisons of interest. The ANOVA approach estimated the variability using all three groups. Also, due to performing multiple testing, Hochberg’s method was used to determine statistical significance. This procedure treats each ANOVA as a group and adjusts the rejection level for each of the three tests performed to ensure a 0.05 overall level is maintained.

Table and Figures

Table 1: Comparison of average age and HbA1c data

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>LOW HbA1c</th>
<th>HIGH HbA1c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled Female &lt; 60</td>
<td>50 9.27</td>
<td>49 9.03</td>
</tr>
<tr>
<td>Normal Female &lt; 60</td>
<td>48 5.77</td>
<td>50 5.96</td>
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<tr>
<td>Uncontrolled Female 60-75</td>
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<td>67 8.71</td>
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<tr>
<td>Normal Female 60-75</td>
<td>66 6.08</td>
<td>67 6.24</td>
</tr>
<tr>
<td>Uncontrolled Female &gt; 75</td>
<td>82 7.93</td>
<td>81 7.97</td>
</tr>
<tr>
<td>Normal Female &gt; 75</td>
<td>81 5.97</td>
<td>80 6.03</td>
</tr>
</tbody>
</table>

Discussion

There appears to be a correlation between diabetes and hearing loss based on a subject’s level of diabetic control as defined by HbA1c data. Age, gender and diabetes appears to be confounding factors that impact the degree of hearing loss experienced by patients.

When controlling for these interactions, diabetes shows significant effects on hearing in the younger female population. These effects were consistent regardless of level of diabetic control. When diabetes was uncontrolled, these effects continued into the middle aged female group. This is the first evidence of diabetes related hearing changes in a population over sixty years of age. In accordance with previous work, these differences disappeared as the subjects aged.

Males showed no differences at any age or compared to the control level. In 2008, Agrawal et al. showed that healthy younger male patients are much more likely to experience hearing loss than healthy younger female patients. The fact that the male subject showed no differences is more likely due to normal males having worse hearing than normal females at baseline. The normal male’s worse hearing could mask diabetes’ subtle effects noted in the younger female populations.

There was no significant difference in Word Recognition Score in any arm of the study. This finding remained consistent regardless of age, gender or presence of diabetes. Word recognition, consistent with other research, did not begin to decrease until a patient was over 75 years old.

Conclusion

Females under 60 years of age without diabetes demonstrate a significantly lower PTA compared to the controlled and uncontrolled patients with diabetes. In females 60-75 years old without diabetes had a significantly lower PTA than uncontrolled diabetics. There was no statistically differences in hearing for males based on age or diabetes control. There was no difference in word recognition scores based on diabetes, age or gender.

References