Abstract

Although it has been reported that smoking has deleterious effects on the middle ears of smokers, including their eustachian tubes, investigators have failed to find differences in the tympanometric characteristics of smokers and nonsmokers. In the present study, however, we found that the Valsalva-induced tympanometric peak pressure shifts of young smokers were less than those measured among young nonsmokers. A similar but less compelling finding was observed among elderly subjects.

Key Words: Nonsmokers, smokers, tympanometric peak pressure, Valsalva maneuver

Several investigators have reported deleterious effects of tobacco smoking on the middle ear (Falk, 1959; Sade, 1967; Cantrell, 1970; Zelman, 1973; Ibrahim and Fathi, 1983), which may cause conductive hearing loss (Weiss, 1970). Cantrell, Ibrahim and Fathi, and Sade, for example, suggested that smoking causes changes in the mucosa of the nasopharynx and middle ear, including the eustachian tube. Cantrell also reported eustachian tube dysfunction among smokers, which might be more specifically attributed to dysfunction of the cilia near the tubal orifice. Moreover, Ibrahim and Fathi suggested that smokers may create a negative nasopharyngeal pressure with each inhalation, which may stress the eustachian tube and cause hyperemia, thus further hindering eustachian tube functioning.

Marston et al (1980) compared middle ear immittance characteristics among young smokers and nonsmokers. They found no significant differences between groups on measures of susceptance, conductance, admittance, and phase angle. The researchers did not, however, more directly measure eustachian tube functioning with either the Valsalva maneuver, the Toynbee maneuver, inflation, or deflation. In these tests, attempts are made to open patients' eustachian tubes by asking them to swallow or auto-inflate their middle ears or by manipulating air pressure in the ear canal.

Riedel et al (1987) reported that of these four tests of eustachian tube functioning, the Valsalva maneuver yields measurable changes in middle ear characteristics large enough to rule out instrumental error as a possible explanation and "appears to be the best procedure for producing reliable and interpretable results in normal adult ears" (p. 212). The purpose of the present study was to determine whether Valsalva-induced tympanometric peak pressure shifts (hereafter simply Valsalva shifts) differ among smokers and nonsmokers.

METHOD

Subjects

Forty subjects participated in this study. Young subjects were 20 adults (40 ears) between the ages of 20 and 35 (mean age = 23 years). They were divided evenly between smokers (five men, five women) and nonsmokers (eight men, two women). Smokers were those who smoked at least one package of 20 cigarettes per day for 5 years. Nonsmokers were those who had never smoked. Elderly subjects were 20 adults (40 ears) between the ages of 53 and 82 years (mean age = 65 years). They too were divided evenly between smokers (nine men, one woman) and nonsmokers (nine men, one woman). Smokers were those who smoked at least one package of cigarettes per day for 30 years and nonsmokers were those who had never smoked. No subject
Table 1  Tympanometric Peak Pressure Means and 95 Percent Confidence Intervals for Young and Elderly Smokers and Nonsmokers in daPa

<table>
<thead>
<tr>
<th>Smokers</th>
<th>Nonsmokers</th>
<th>Smokers</th>
<th>Nonsmokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.3</td>
<td>3.5</td>
<td>10.3</td>
</tr>
<tr>
<td>Confidence interval</td>
<td>-7.8-18.4</td>
<td>-6.8-13.8</td>
<td>-1.0-21.6</td>
</tr>
</tbody>
</table>

reported a history of middle ear dysfunction, trauma, or surgery.

**Procedures**

We obtained acoustic immittance measures using a GSI-33 middle ear analyzer calibrated to the manufacturer’s specifications. Each subject’s baseline tympanometric peak pressure was measured using a 226-Hz probe and a positive-to-negative tracing sweep. Each subject then performed the Valsalva maneuver as described by Riedel et al (1987). Specifically, each subject was instructed to pinch his/her nares closed and inflate his/her cheeks until they sensed fullness or pressure in the ears and then to refrain from swallowing. Then, his/her tympanometric peak pressure was measured again. Each subject’s Valsalva shift was the difference between his/her baseline and post-Valsalva tympanometric peak pressures.

**Data Analysis**

Group comparisons between young smokers and young nonsmokers and between elderly smokers and elderly nonsmokers were carried out by means of Student’s t-test. Significance was evaluated at the 5 percent level of confidence.

**RESULTS**

Table 1 contains baseline tympanometric peak pressure means and 95 percent confidence intervals for smokers and nonsmokers. As shown, the baseline tympanometric peak pressure means of each group were near zero. There was no significant difference in baseline tympanometric peak pressures between young smokers and young nonsmokers or between elderly smokers and elderly nonsmokers ($p > .05$).

Table 2 contains Valsalva shift means and 95 percent confidence intervals for young and elderly subjects. There was a significant difference between the Valsalva shifts of young smokers and young nonsmokers ($p < .05$). Furthermore, the 95 percent confidence interval of the young smokers did not overlap (i.e., was less than) the 95 percent confidence interval of 47 to 79 daPa of normative subjects (Riedel et al, 1987), whereas the 95 percent confidence interval of the young nonsmokers did overlap those norms.

Apparently, our young smokers have, or are at risk for, partial eustachian tube dysfunction. Since the relationship between eustachian tube dysfunction and middle ear disease has been well documented (Dalhamn, 1968; Buckingham, 1970; Paparella, 1973; Bluestone, 1975; Dennis et al, 1976; Bluestone and Cantekin, 1981), it seems reasonable to be concerned that our young smokers may be more susceptible to middle ear disease than our young nonsmokers.

The difference between the Valsalva shifts of elderly smokers and nonsmokers did not reach statistical significance ($p > .05$), suggesting no difference in eustachian tube functioning among those subjects. This was somewhat surprising in view of the length of exposure for elderly smokers and the above findings for young subjects,
suggesting that more research is needed. However, the Valsalva shift 95 percent confidence interval of elderly smokers did not overlap (i.e., was less than) the 95 percent confidence interval of the aforementioned norms, whereas the Valsalva shift 95 percent confidence interval of elderly nonsmokers did overlap with those norms. Therefore, it seems reasonable to be concerned that our elderly smokers may also be more susceptible to middle ear disease than our elderly nonsmokers.

DISCUSSION

The present data reflect differences in eustachian tube functioning among smokers and nonsmokers. It may be useful, therefore, to investigate whether smokers with reduced Valsalva shift are at greater risk for middle ear disease and whether audiologists can identify at-risk patients by measuring their Valsalva shift.

REFERENCES


