Changes in Taste Function Related to Obesity and Chronic Otitis Media With Effusion

Il Ho Shin, MD; Dong Choon Park, MD; Chul Kwon, MD; Seung Geun Yeo, MD, PhD

Objective: To evaluate changes in taste threshold in patients with chronic otitis media with effusion (COME) and their relationship with body mass index. A relationship has been suggested between pediatric obesity and COME, and we hypothesized that changes in taste function may occur in children with COME and that such changes may be associated with changes in body weight.

Design: A prospective, nonrandomized, case-control study.

Setting: A university tertiary care center.

Subjects: The experimental group comprised 42 children with COME who underwent tympanostomy tube insertion, and the control group, 42 children without otitis media with effusion. Patients were enrolled between September 2007 and August 2009.

Main Outcome Measure: Taste threshold was measured by electrogustometry, and 4 standard taste solutions (sucrose, sodium chloride, citric acid, and quinine hydrochloride) were used in chemical taste tests.

Results: Body mass index was significantly higher in the COME than in the control group ($P=0.02$). Electrogustometry showed that the anterior part of the tongue had a significantly higher taste threshold in the COME than in the control group (anterior right, $P=0.03$; anterior left, $P=0.04$), and chemical taste test results showed that sweet and salty tastes were significantly lower in the COME group (sweet, $P=0.02$; salty, $P=0.04$).

Conclusion: These results showed that COME can cause changes in taste and that these changes may be related to pediatric obesity.


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CHILDHOOD OBESITY AND chronic childhood conditions have increased over the last several decades, particularly for asthma and behavior and learning problems. To our knowledge, the relationship between chronic otitis media and obesity has not been examined. Otitis media with effusion (OME) is a disease with a high incidence in childhood and is a common cause of hearing disturbances in children. Although most children have a good prognosis, 10% of affected children develop recurrent or persistent OME.1,2

Many factors are involved in the development of OME, including host factors such as bacterial infection, eustachian tube dysfunction, allergic and immunologic status, sex, race, and other genetic variations; environmental factors such as communal living, a nonhygienic lifestyle, and indirect exposure to smoke; and anatomical and physiological factors accompanying cleft palate such as Down syndrome and other conditions.3 In addition, obesity has been reported to be associated with the development of OME.4 For example, we found that body mass index (BMI) and total serum cholesterol concentration were significantly higher in children with chronic and recurrent OME than in control children, suggesting an association between pediatric obesity and OME.4

Patients with chronic otitis media have been reported to have a higher taste threshold on the affected side of the tongue than on the normal side, and the taste threshold on the affected side was reduced after surgery for otitis media.3 These findings suggested that in children with chronic otitis media with effusion (COME), the function of the chorda tympani nerve may have deteriorated in the inflammatory environment of the middle ear, leading to a deterioration in taste. These changes in taste may alter food consumption, thereby causing changes in BMI. We therefore assessed changes in taste and BMI in children undergoing ventilation tube insertion for COME.

METHODS

We enrolled 42 children (24 boys and 18 girls) aged 3 to 7 years (mean [SD], 5.48 [1.55] years) who underwent ventilation tube insertion for COME at the pediatric ear, nose, and throat clinic of Kyung Hee University, Seoul, South Korea, between September 2007 and August 2009.
2009. The control group consisted of 42 pediatric patients (24 boys and 18 girls) aged 4 to 7 years (mean [SD], 6.38 [1.48] years) with no history of otitis media who underwent tonsillectomy or adenoidectomy for snoring or frenotomy or were admitted for epistaxis during the same period. Children in the control group underwent otoscopic examinations, impedance audiometry, and pure tone audiometry to confirm the absence of pathologic conditions in the middle ear and eustachian tube. Children with head or neck deformities or systemic diseases or those suspected of having congenital or acquired immune deficiencies were excluded.

We carefully explained to both children and their parents that the test was a single noninvasive assessment, and we described the aim of our study. We included only subjects who gave signed informed consent and who were also approved by the Kyung Hee University institutional review board.

Otitis media with effusion was diagnosed by the presence of amber-colored tympanic membranes on otoscopic examination. Significant differences were observed only in the anterior part of the tongue (right anterior, P= .03; left anterior, P=.04). Significant differences were observed only in the anterior part of the tongue (right anterior, P= .03; left anterior, P=.04).

All statistical analyses were performed using SPSS version 12.0 (SPSS Inc, Chicago, Illinois), with between-group comparisons assessed by the t test. P<.05 was considered statistically significant. This study was approved by the Kyung Hee University Hospital institutional review board.

### RESULTS

The mean (SD) BMI of the COME group was significantly higher than the control group (20.6 [4.6] vs 17.7 [3.3]; P=.02) (Figure 1).

We found that the taste mean (SD) thresholds on the anterior right (14.3 [6.7] dB vs 8.0 [3.7] dB; P=.03) and left (13.3 [6.3] dB vs 8.5 [3.8] dB; P=.04) sides of the tongue were significantly higher in the COME than in the control group (Figure 2). In contrast, the mean (SD) taste thresholds on the posterior right (9.9 [5.2] dB vs 8.0 [3.8] dB; P=.12) and left (9.6 [5.6] dB vs 8.1 [3.6] dB; P=.17) sides of the tongue were not significantly different between the groups.

#### Table. Concentrations of Taste Test Solutions Used in This Study

<table>
<thead>
<tr>
<th>Substance</th>
<th>COME</th>
<th>Control</th>
<th>COME</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>0.05</td>
<td>0.016</td>
<td>0.05</td>
<td>0.0009</td>
</tr>
<tr>
<td>Sodium Chloride</td>
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<td>0.025</td>
<td>0.09</td>
<td>0.0024</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>0.2</td>
<td>0.1</td>
<td>0.165</td>
<td>0.004</td>
</tr>
<tr>
<td>Quinine Hydrochloride</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*Data are given as grams per milliliter.*

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**Figure 1.** Mean (SD) body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) in the chronic otitis media with effusion (COME) and control groups. The difference between these 2 groups was statistically significant (P=.02).

**Figure 2.** Mean (SD) electrogustometry (EGM) thresholds of each part of the tongue in the chronic otitis media with effusion (COME) and control groups. A, Right anterior; B, left anterior; C, right posterior; and D, left posterior.

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Control

(0.10 [0.09] g/mL vs 0.06 [0.06] g/mL; 0.22 [0.12] g/mL vs 0.16 [0.11] g/mL; derwent the chemical taste test.

However, 28 COME subjects and 24 controls un-
cantly in the COME and control groups (Figure 2).

ear cavity persists for longer than 3 months, the rate of

3 months.1,2 If, however, effusion fluid within the middle

develop OME, most show spontaneous resolution within

approximately 66% of patients with acute otitis media

be attributable to other noninfectious causes. Although

fusion may develop following acute otitis media or may

inflammation, thus inducing airway hyperresponsive-

tivity gene, stimulates the production of factors related to

asthma have suggested that leptin, produced by an obe-

sity has been associated with increased risks of hyper-
tension, diabetes mellitus, atherosclerosis, fatty liver, car-

diovascular disease, and other adult diseases, as well as

equal activity increases. If, however, the rate of reduction

of obesity is slow in children up to 2 years of age, there

is a high possibility that these children will continue to

be obese.

Childhood obesity is associated with increases in the

number and size of adipocytes and may thus lead to adult

obesity. Moreover, the lifestyle habits acquired during

childhood are carried over into adulthood. Childhood obe-

sity is the most common form of obesity in children, and

many factors affect obesity and COME, and we could not

explore all relevant parameters because the number of

subjects was limited. Thus, we evaluated BMI only in each

group, without subject matching.

We have reported that BMI and serum total choles-

terol concentration were significantly higher in chil-
dren undergoing tympanic ventilation tube surgery for

COME than in children without otitis media and that

childhood obesity may be associated with the develop-

ment of OME.4 However, many factors affect obesity and

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ters because the number of subjects was limited. Thus,

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matching.

Serum concentrations of proteins associated with in-

flammation, including tumor necrosis factor, interleu-

kin 6, and C-reactive protein, as well as erythrocyte sedi-

mentation rate, have been reported to be higher in obese

than in normal-weight individuals, suggesting that obe-

sity is a subclinical inflammatory condition.11,12 These

changes in cytokine concentrations may also be associ-

ated with the development of otitis media in obese chil-

dren. Studies on the association between obesity and

asthma have suggested that leptin, produced by an obe-

sity gene, stimulates the production of factors related to

inflammation, thus inducing airway hyperresponsiveness.13 Similar mechanisms may be involved in the rela-

ship between obesity and otitis media.

The eustachian tube is divided anatomically and his-

tologically into 6 parts, with the longest cartilaginous seg-

ment, the tensor veli palatine, playing a very important role in eustachian tube opening. The Ostmann fat pad

is located on the superolateral side of the tensor veli palat-

e. In obese individuals, the volume of this fat pad may

be increased, because of fat deposition, hindering eustachian tube opening during contraction of the tensor veli palatine. Because of such incomplete opening, the eustachian tube may not be vented normally, resulting in structural dysfunction and stasis of the middle ear fluid.14 Assessment of this hypothesis would require radiologic examination of the anatomic and physiologic condition of the eustachian tube or eustachian tube function tests.

If the deterioration in taste observed in COME is in-

duced by chronic stimulation of the chorda tympani nerve

caused by the inflammatory condition in the middle ear,

eating habits may be altered, leading to weight gain. To

assess this association more comprehensively, we exam-

ined taste thresholds in children with otitis media. Elec-

trogustometry showed that the taste threshold in the an-

terior area of the tongue was significantly higher in the

Figure 3. Mean (SD) specific taste thresholds of the entire mouth in the chronic otitis media with effusion (COME) and control groups. A. Sucrose; B, sodium chloride; C, citric acid; and D, quinine hydrochloride. Sensitivity to sweet and salty tastes was significantly decreased in the COME group (sweet, P=.02; salty, P=.04).

Figure 3). However, the thresholds for sour (0.10 [0.07] g/mL vs 0.09 [0.05] g/mL; P=.13) and bitter (0.0022 [0.0019] g/mL vs 0.0030 [0.0037] g/mL; P=.08) tastes did not differ significantly between the 2 groups (Figure 3).

COMMENT

Otitis media with effusion is a disease without acute symp-
toms, such as fever or otalgia, in which effusion fluid is

retained in the middle ear cavity. Otitis media with ef-

fusion may develop following acute otitis media or may

be attributable to other noninfectious causes. Although

approximately 66% of patients with acute otitis media

develop OME, most show spontaneous resolution within

3 months.1,2 If, however, effusion fluid within the middle

ear cavity persists for longer than 3 months, the rate of

spontaneous resolution is only 20% to 30%, even after

several years. The age at which pediatric obesity devel-

ops is similar to the age at which OME becomes preva-
lent.6 Infant obesity disappears in the years when physi-
cal activity increases. If, however, the rate of reduction

of obesity is slow in children up to 2 years of age, there

is a high possibility that these children will continue to

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otitis media than in the control group, suggesting that this change in taste may be associated with the chorda tympani nerve, which controls taste in that area. Such a relationship may be a coincidence, or could reflect differences in food preferences caused by taste changes, as we hypothesized. To prove such a relationship, many factors such as eating patterns, the child care environment, lifestyle, and disease history need to be considered and controlled. This is a limitation of our study. The chorda tympani nerve branches from the facial nerves, passes through the middle ear cavity between the malleus and the incus, exiting the tympanum via the canal of Huguiер, and runs between the pterygoid muscles. It is not yet clear how chronic inflammation within the middle ear cavity can exert effects on taste. In contrast to other facial nerves, the chorda tympani nerve is not protected by surrounding bones but is exposed to the middle ear cavity and therefore may be influenced by inflammatory tissues or molecules. Findings from histopathologic examination of the temporal bones of patients with chronic otitis media showed degeneration of the chorda tympani nerve; the outstanding histologic characteristic was fibrosis of the perineurium, with replacement by granular tissues as otitis media progressed.15 These findings suggest that inflammation in the middle ear cavity spreads to the chorda tympani nerve and injures that nerve. Thus, the higher threshold observed in the otitis media group may be caused by retraction of the tympanic membrane, the stasis of effusion in the middle ear cavity, and/or the secretion of toxic substances.

By simultaneously performing quantitative EGM, which can detect even mild taste disturbances, and qualitative chemical taste tests, we were able to assess both the extent of taste disturbance and its characteristics in pediatric patients with and without COME.16 Data from adults showed that taste was altered in patients with COME, as measured by EGM, but most of these patients were not aware of any changes in taste before testing.3 We considered that the most important difference between adults with chronic otitis media and children with COME was the duration of disease, which is far greater in adults. Thus, any real difference in taste at the beginning of disease may be rendered unimportant by operation of a long-lasting compensation mechanism. However, in children, differences in chemical taste test results may be attributed to a shorter period of disease associated with incomplete development of any compensation mechanism. We found that the thresholds of sweet and salty tastes were significantly higher in the otitis media than in the control group. Although the thresholds of bitter and sour taste were also somewhat higher in the otitis media group, these differences were not statistically significant. Taste has been reported to differ from other sensations by having a compensation mechanism. Thus, if the chorda tympani nerve has deteriorated functionally, at the level of the central nervous system, suppression of taste on the contralateral side is released, increasing the sensitivity of the glossopharyngeal nerve and maintaining the taste sensitivity of the entire oral cavity.17 Under temporary fasting conditions, there are changes in taste stimulation, peripheral taste receptors, and the sensitivity of the taste nerve, thus increasing sensitivity to tastes that are important for biological nutrition, such as sweet and salty tastes, whereas little change is noted in the sensitivity to tastes that are present in toxic materials.18 Our findings of significant elevation in the thresholds for sweet and salty tastes, together with nonsignificant changes in the thresholds of bitter and sour tastes, are in good agreement with previous results.

Our study was performed in pediatric patients, most of whom have shorter attention spans than adults. Because the times required to measure taste thresholds were long, concentration deteriorated and the children became fatigued. To maximize patient compliance, parents or guardians were allowed to be present nearby. Moreover, sweet taste was tested first and bitter taste last. The number of subjects completing the chemical taste tests was rather small, and thus additional studies are required. However, our finding of significant elevations in the thresholds of sweet and salty tastes in the COME group is in accordance with the EGM-measured deterioration of thresholds in the anterior part of the tongue. This suggests that the ability of patients with otitis media to taste sweet and salty foods at the same intensity as experienced by control patients would require ingestion by the former of sweeter and saltier foods, resulting in an excessive intake of calories and liquids, increasing fat deposition and fluid retention and ultimately resulting in obesity.

In conclusion, EGM results showed that taste thresholds on the anterior part of the tongue were higher in pediatric patients with COME than in control patients, whereas chemical taste test results showed that the thresholds of sweet and salty tastes were elevated in the COME group. These findings suggest an association between changes in taste and increased BMI in pediatric patients with COME.

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Author Contributions: Drs Shin and Park contributed equally to this work. Dr Shin had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Yeo. Acquisition of data: Kwon. Analysis and interpretation of data: Shin, Park, and Yeo. Drafting of the manuscript: Shin, Park, Kwon, and Yeo. Critical revision of the manuscript for important intellectual content: Yeo. Administrative, technical, and material support: Shin, Park, and Kwon. Study supervision: Yeo.

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