

# Xylitol-Gum Chewing for the Management of Otitis Media with Effusion

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## Abstract

**Introduction:** Otitis media with effusion (OME) is the collection of fluid in the middle ear without signs or symptoms of an acute infection. It is cured by treating the cause and restoring normal eustachian tube function. By activating jaw movement and inducing frequent swallowing, chewing gum could be effective in the conservative management of OME. **Objectives:** To determine the recovery rate after chewing xylitol gum for the treatment of OME, and the factors associated with OME cures in adults. **Materials and methods:** A non-randomized, controlled trial was conducted on 30 OME patients May 2018–December 2019. The subjects chewed 2 tabs of gum for 5–10 minutes, 3 times daily, for up to 3 months. Physical and audiometric examinations were performed at 2, 6 and 12 weeks. **Results:** Thirty patients were enrolled. Their mean age was  $55.0 \pm 20.19$  years. OME resolution was found in 23/43 ears (53.49%). Myringotomy was performed in 13/43 ears (30.23%). Two factors were associated with shorter resolution times. Firstly, a patient age of 40–60 years, compared with other ages ( $p$ -value = 0.030). Secondly, an initial average air-bone gap of [?] 20 dB, compared with larger gaps ( $p$ -value = 0.027). **Conclusions:** Xylitol-gum chewing did not increase the overall OME resolution rate. Nonetheless, it is still a choice for OME management as it tends to shorten the resolution time, with only minor side effects being experienced by some patients. **Keywords:** Otitis media with effusion, otitis media, OME, xylitol chewing gum, gum chewing, xylitol gum, gum

## Introduction

Otitis media with effusion (OME) is a condition in which the middle ear contains fluid but without any signs or symptoms of an acute infection. It may occur following an upper respiratory tract infection or spontaneously due to poor eustachian-tube function.<sup>1</sup>

Finkelstein et al.<sup>2</sup> found that the incidence of adult-onset OME is far less than in children, and that it commonly follows rhinosinusitis, nasopharyngeal lymphatic tissue hypertrophy, and smoking, resulting in an inflammation of the eustachian tube lumen.<sup>3</sup> According to our electronic database, an average of 100 patients per year were diagnosed with OME at our clinic during 2011–2016. Of those, 50%–60% were aged 12 years or older.

OME and eustachian tube dysfunction lead to hearing impairments ranging from normal hearing to a moderate hearing loss (0–55 dB HL), with an average hearing threshold of 28 dB.<sup>1</sup> In addition, chronic OME without treatment may result in retraction of the tympanic membrane, atelectatic ear, ossicular erosion, tympanic membrane perforation, or even cholesteatoma formation.<sup>1,4</sup> Therefore, patients with OME should receive proper management in order to prevent such complications.

Regarding the results from previous literature, conservative treatment by medical therapies (such as antihistamines, decongestants, antireflux therapy, and topical nasal steroids) is ineffective in both the short and long term.<sup>5</sup>

As for adult OME, the aim of treatment is to eliminate the cause of eustachian tube dysfunction and to restore eustachian tube function. Swallowing and chewing are two possibilities that can help to recover normal tube function. Nevertheless, no previous studies have investigated the relationship between the applicable use of gum-chewing and OME in adults.

Gum-chewing activates jaw movement and induces frequent swallowing. In the resting position, the eustachian tube is collapsed due to the passive effect of the cartilage, the elastic fibers, and the pressure of the surrounding tissues.<sup>6,7</sup> In contrast, the activation of 2 peritubal muscles—the levator veli palatini and the tensor veli palatini—stimulates the swallowing mechanism, thereby opening the eustachian tube.<sup>8</sup>

Gum is easily obtained in the marketplace and is low-priced. It is made from the resin of a tree, to which a variety of ingredients, including xylitol, are added to sweeten its flavor. Xylitol has long been used in food, pharmaceutical, and oral-health products.<sup>9</sup> It has minimal effect on blood sugar and insulin levels, with 40% fewer calories than regular gum and a low glycemic index. Xylitol is safe for consumption by diabetic patients.<sup>9</sup>

## Objectives

The primary purpose of this study was to establish the resolution rate of OME after xylitol-gum chewing was used for the conservative treatment of adult patients diagnosed with OME. The secondary aim was to identify the factors affecting the improvement of OME after xylitol-gum chewing.

## Materials and methods

Thirty patients were enrolled. They were aged 12 years or older, and they had presented with aural fullness, hearing loss, ear popping, and/or ear discomfort. Ear microscopy was used by an otologist to establish a diagnosis of OME. Once OME was confirmed, the patients were sent for pure tone audiometry, given 84 tabs of xylitol gum, and requested to chew 2 gums for 5–10 minutes or until they were tasteless, 3 times a day. The patients were also provided with a logbook to record how many gums they used and how frequently they were chewed.

Excluded from the study were patients with craniofacial anomalies, nasopharyngeal lesions, diabetes mellitus, previous ear and/or nasal cavity surgery, prior head and neck radiation, or an inability to chew gum due to a limitation (such as osteoarthritis of the temporomandibular joint).

The follow-up sessions were at 2, 6, and 12 weeks. At each visit, the patients were examined by microscopy by an otologist, and they underwent an audiometric assessment. A package of gum was given along with a new logbook if middle-ear fluid was still confirmed. However, if the fluid was found to have resolved at the subsequent follow-up appointment, the patients were told to cease using the gum. On the other hand, if the middle-ear fluid persisted until the final follow-up at 12 weeks, a myringotomy was performed.

### *Data analysis*

The statistical analyses were performed using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA) and Stata, version 15 (StataCorp LLC., College Station, TX, USA). The demographic data were analyzed with descriptive statistics; the categorical data were expressed as number (%), whereas the continuous data were presented as mean ( $\pm$  standard deviation). The Kaplan–Meier method was used to examine the time to improvement during follow-up, while Cox regression was employed to analyze the correlated time-to-event data. After a univariable analysis was performed, the selection of variables for a multivariable analysis was based on a univariable p-value of  $< 0.1$ . Results were shown as adjusted hazard ratio (HR), 95% CI, and p-value. P-values of  $< 0.05$  were considered statistically significant.

## Results

### *Demographic data and patients' characteristics*

The 30 patients were comprised of 22 females (73.33%) and 8 males (26.67%). Their mean age was  $55.0 \pm 20.19$  years, ranging between 12–77 years. The average duration of the symptoms to the first treatment was 30

days. Seventeen patients had unilateral OME (56.67%) while the remaining thirteen had bilateral OME (43.33%). The physical examinations revealed a normal nasal cavity and nasopharynx in 18 patients (60%), nasal congestion in another 4 (13.33%), and nasal discharge in 8 (26.67%). The contour of the tympanic membrane was normal in 22 ears (51.16%), but 21 ears (48.84%) had tympanic membrane retraction. Right-sided OME was identified in 24 ears (55.81%) and left-sided OME in 19 ears (44.19%). There were 26 ears (60.47%) full of fluid and 17 (39.53%) with air in the middle ear. Twenty-two ears (51.16%) contained clear fluid whereas 21 ears (48.84%) had amber-colored fluid. The demographic data are presented in **Table 1** .

#### *Time to improvement of OME*

At the 2-week follow-up, 11 ears were free of OME. At the 6-week follow-up, 9 more ears were found to be OME-free. At the 12-week follow-up, a further 3 ears were free of OME, giving a total of 23 ears (53.49%) OME-free over the 12-week period. Myringotomy was performed after xylitol gum chewing in 13 ears (30.23%) or 10 patients (33.33%) The data are presented in **Table 2** .

#### *Audiometry*

Three out of the 30 patients had missing data, and all three had unilateral OME. Consequently, the statistical evaluation was based on 40 audiometric results.

The mean difference between the pure tone average at the first and last visits was  $10.30 \pm 13.20$  (p-value  $< 0.001$ ).

When we performed a statistical analysis of the average air-bone gap, 3 audiometric results had zero air-bone gap at the beginning. The remaining 37 audiometry results were therefore used for the evaluation, which revealed a significant statistical difference (p-value = 0.042; **Table 3** ).

#### *Factors associated with time to improvement*

Factors known to affect OME in adults were statistically analyzed. They were patient age; the duration of symptoms; a history of OME; a history of myringotomy; the characteristics of the middle-ear fluid, such as its color; air in the middle ear; and the average air-bone gap. Three factors were found to be related to time to improvement: a patient age between 40 and 60 years, a duration of symptoms of  $< 2$  weeks, and a history of OME (Table 4).

#### *Age*

We classified age into 3 groups. One out of the six (16.67%) patients who were aged  $< 40$  years recovered from OME. A further six out of the seven (85.71%) patients aged 40–60 years recovered, while another nine out of the seventeen (52.94%) aged  $> 60$  years recovered (Table 5).

#### *Duration of symptoms*

We classified the duration of onset into 2 groups. Eight out of the eleven patients (72.73%) who had OME for  $[?] 2$  weeks recovered from OME, while another 8 out of the nineteen (42.11%) who had OME for  $> 2$  weeks recovered (Table 5).

#### *History of OME*

Only 9 patients had previously had OME. Three out of those nine (33.33%) recovered from OME, whereas thirteen out of the twenty-one (61.90%) without a history of OME did so (Table 5).

#### *History of myringotomy*

There were 25 patients without a history of myringotomy. Of those, fifteen (60%) recovered from OME (Table 5).

#### *Air in middle ear*

Patients with air in the middle ear (for example, air-fluid level or air bubbles) had a 1.42-times greater OME resolution (95% CI 0.62, 3.24) than those with a middle ear fully filled with fluid, but without statistical significance (p-value = 0.833).

#### *Color of middle-ear fluid*

Patients with a clear middle-ear fluid had a 1.07-times greater OME resolution (95% CI 0.42, 2.75) than those with an amber-colored fluid; however, this was without statistical significance (p-value = 0.883).

#### *Average air-bone gap*

We divided the initial, average, air-bone gaps into 2 groups: gaps of  $\leq$  20 dB, and gaps of  $>$  20 dB. Those patients with an initial, average, air-bone gap of  $\leq$  20 dB had a 2.25-times greater OME resolution (95% CI 0.94, 5.53) than those with an average air-bone gap of  $>$  20 dB. Nevertheless, the difference was not statistically significant (p-value = 0.068).

The multivariable analysis (Table 6) found that only 2 variables affected OME resolution: age group, and average air-bone gap. Patients aged 40–60 years had an 11.19-times (95% CI 1.26, 99.39) better OME resolution than those aged  $<$  40 years, with statistical significance (p-value = 0.030). Similarly, patients with an average air-bone gap of  $\leq$  20 dB had a 3.80-times (95% CI 1.16, 12.41) higher OME resolution than those with an average air-bone gap of  $>$  20 dB, again with statistical significance (p-value = 0.027). In contrast, neither the duration of the symptoms nor a history of OME were found to be associated with the cure rate (p-value  $>$  0.05).

#### *Complications*

No major complications were detected. However, some patients reported minor side effects: an irritating and burning sensation in the oral cavity, the xylitol gum being too sticky, and the gum sticking to dentures.

### **Discussion**

OME usually occurs following eustachian tube dysfunction. Rather than solely relying on natural resolution, hastening the process of restoring normal tube function will lead to a better quality of life for OME patients. Several techniques have been proposed to improve the function of the eustachian tube; for example, the Toynbee and Valsalva maneuvers aim to force open the eustachian tubes.<sup>3,8,10</sup> In this study, we investigated the use of gum-chewing as a way of opening the tubes.

Gum-chewing creates jaw movement and induces more frequent swallowing. Gum-chewing is particularly beneficial for senile patients, who tend to have less eustachian tube activity due to dental problems, a poor or lost appetite, being less talkative, and a reduced swallowing frequency.<sup>11,12</sup> In an earlier experimental study measuring tensor veli palatini muscle activity before and after eustachian tube rehabilitation by using electromyography monitoring, it was found that swallowing increases the strength of the tensor veli palatini muscle.<sup>13</sup> Given that chewing gum increases the frequency of swallowing, the eustachian tube function should therefore improve.

Regarding the results, only 23 out of 43 ears (53.49%) became free of OME during the 12-week study period. Even though there is no definite, documented, resolution rate for OME in adults, this proportion is lower than the usual resolution rates in children reported in the literature (75%–90%)<sup>1</sup> In other words, the gum-chewing did not enhance the cure rate. The reason why the resolution rates for adults are lower than those for children is possibly due to the cause of the eustachian tube dysfunction. OME in children often follows an acute upper-respiratory infection, such as the common cold or acute sinusitis. The OME is temporary and easy to cure. In contrast, the causes of OME in adults tend to be more chronic, for example, allergic rhinitis, exposure to smoking, and hormonal changes, all of which affect mucociliary activity.<sup>14,15</sup> The other explanation is that there are age-related, morphological changes to the eustachian tubes. With advancing age, there are alterations in the size and shape of the eustachian tube cartilage, as well as in the positions of the levator veli palatini and tensor veli palatini muscles. Consequently, chewing gum may not always be

sufficient to solve these problems in adult or senile patients, even though the method is intended to promote the swallowing activity.<sup>16</sup>

Taking a closer look at the data, only 2 parameters—patient age and the initial average air-bone gap—affected the resolution rate and time to improvement. The patients who were 40–60 years of age demonstrated a higher OME resolution and a shorter time to improvement than the other age groups. The effect of the muscular opening function could be the reason. In another study that measured middle-ear pressure after chewing, mouth opening, and jaw movement, the muscular opening function was found to be stronger in adults than in children or senile patients.<sup>17</sup>

Initial, average, air-bone gaps of [?] 20 dB yielded a better OME resolution rate than gaps of > 20 dB. This could be explained by middle-ear fluid viscosity. Previous research has suggested that there is a correlation between middle-ear fluid viscosity and audiometry. Highly viscous or thick middle-ear fluid was found to result in a poorer air-conduction threshold and a larger air-bone gap (p-value < 0.001) than thin middle-ear effusion.<sup>18</sup> Thus, lighter viscosities tend to lead to faster resolutions of OME.

There were some limitations of this study. Firstly, only a small number of patients was investigated. Moreover, confounding factors (such as intranasal corticosteroid use, oral antibiotic use, and underlying conditions) might have affected the eustachian tube function. Furthermore, we lacked an exact protocol for the gum-chewing (the number of gums, frequency, and duration of gum-chewing). As a result, the conclusion that chewing gum is ineffective for the management of OME is still inconclusive. A further study with a randomized controlled trial utilizing a larger population is suggested.

Overall, given its minor side effects and low cost, xylitol-gum chewing could prove to be an adjunctive treatment to complement watchful waiting for the management of OME in selected patients. Its primary benefit is that it may help to hasten the natural resolution of OME.

## Conclusions

Xylitol-gum chewing did not increase the overall OME resolution rate. Nevertheless, it is still a choice for the management of OME in that it may help to accelerate the resolution time, with only minor side effects being experienced by some patients. Two factors that would need to be considered before suggesting gum-chewing are the patient's age and the size of the initial air-bone gap.

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