Published in final edited form as:

Eur Arch Otorhinolaryngol. 2014 March ; 271(3): 455–458. doi:10.1007/s00405-013-2431-2.

Facial nerve canal dehiscence in chronic otitis media without cholesteatoma

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Abstract

The information on incidence of the facial nerve canal dehiscence in chronic otitis media is important for surgeons. The purpose of this study is to disclose the histopathologic findings of facial nerve canal dehiscence in human temporal bones with chronic otitis media. We divided the human temporal bones into two groups (age 4 years, and under 4 years of age). We evaluated the incidence and the area of the facial nerve canal dehiscence in chronic otitis media under light microscopy. Age-matched normal control temporal bones were also examined. In the age group of 4 years, 68.9 % of temporal bones with chronic otitis media and 71.9 % of controls had the facial nerve canal dehiscence. There was no significant difference between them ($P = 0.61$). The area of the dehiscence in temporal bones with chronic otitis media was not statistically different from controls ($P = 0.53$). In the age group under 4 years, 88.2 % of temporal bones with chronic otitis

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Conflict of interest The authors declare that they have no conflicts of interest, and have no financial relationship to other organizations.

media and 76.5 % of controls had the dehiscence. No significant difference was found between them ($P = 0.66$). The area of the dehiscence in temporal bones with chronic otitis media was not statistically different from controls in the age group under 4 years ($P = 0.43$). In chronic otitis media, the incidence of facial nerve canal dehiscence was high and was not statistically different from controls. These results suggest that there is no association between chronic otitis media and the presence of facial nerve canal dehiscence.

Keywords

Facial nerve; Temporal bone; Otitis media; Facial nerve palsy; Facial nerve canal; Fallopian canal

Introduction

The facial nerve is vulnerable during ear surgery when there is a dehiscence of the facial nerve canal. Otologic surgeons need a lot of information about facial nerve canal dehiscence to avoid injury of the nerve. In most of the previous reports, facial nerve canal dehiscence was investigated from the histopathological or surgical standpoint [1]. Generally, the incidence of facial nerve canal dehiscence in surgical reports [2–7] is lower than that in histopathological reports [8–11]. In the surgical reports, the patients with pathological conditions such as otosclerosis or chronic otitis media were evaluated, while histopathological examinations used normal temporal bones.

In young children, inflammation of the middle ear cavity can affect the development of the canal since the development of the canal continues after birth and is completed by the age of 4 years [12, 13].

To the best of our knowledge, there is no histopathological report on facial nerve canal dehiscence in chronic otitis media, and no study has examined the influence of chronic otitis media on the canal during development. The purpose of this human temporal bone study was to evaluate the incidence and the area of facial nerve canal dehiscence in chronic otitis media.

Materials and methods

This study was approved by the Institutional Review Board of University of Minnesota (0206M26181). Human temporal bones from the collection of the Otopathology Laboratory of the Department of Otolaryngology of the University of Minnesota were reviewed for this study. Temporal bones had previously been removed at autopsy, fixed in formalin solution, decalcified, embedded in celloidin, and serially sectioned in the horizontal plane at a thickness of 20 μm . Every tenth section was stained with hematoxylin and eosin and mounted on a glass slide for light-microscopic observation.

We divided the subjects into two groups: the group of age 4 years and older, and the group of under 4 years of age. The group of age 4 or older included 132 temporal bones from 96 chronic otitis media cases (64 male and 32 female; ranging in age from 4 to 93 years; mean age $\pm$ standard deviation (SD), 50.2 ± 24.1 years old). For normal controls, 121 age-matched temporal bones from 82 subjects (49 male and 33 female; ranging in age from 5 to 96 years; mean age $\pm$ SD, 52.1 ± 25.6) were examined.

The group of age 4 or under included 17 temporal bones with chronic otitis media from 12 cases (9 male and 3 female; ranging in age from 7 months to 3 years; mean age $\pm$ SD, 1.59 ± 1.24). For normal controls, 17 age-matched temporal bones from 13 cases (7 male and 6

female; ranging in age from 6 months to 3 years; mean age $\pm$ SD, 1.63 ± 0.95) were examined.

Temporal bones with histopathologic anomaly, otologic disease, systemic bone disease, or erosion or infiltration by tumor were excluded. Temporal bones with cholesteatoma or a history of ear surgery were also excluded. We also eliminated temporal bones in which the structures being examined were not clearly visible.

Facial nerve canal dehiscence was defined as a bony defect of the facial canal [8]. The diagnosis of chronic otitis media was made under light microscopy based on the presence of irreversible histopathological changes such as granulation tissue, cholesterol granuloma, or fibrocystic structures in the middle ear cleft.

We investigated the horizontal and vertical segments in which the canal faced to the middle ear cavity, and examined the incidence of all the dehiscences and classified a large dehiscence as being more than 1 mm^2 in size [4]. We evaluated the area of the dehiscence, which was estimated based on the facial nerve canal dehiscence width in each cross section, section thickness, and the total number of facial nerve canal dehiscence sections. The width of the facial nerve canal dehiscence was measured at its shortest distance in each cross section. When there were several dehiscences in one temporal bone, we summed each area.

The images were acquired with a digital camera connected to a personal computer. The calibrated images were obtained at a magnification of $20\times$ and serial sections were measured using image analysis software, Image-Pro Plus (Media Cybernetics, Silver Springs, MD; Version 3.0). Results were presented as mean $\pm$ SD. Statistical evaluation was performed with Fisher's exact test, Chi-square test, and Mann-Whitney U test. The level of significance was set at $P < 0.05$.

Results

The group of age 4 years and older

Of 132 temporal bones with chronic otitis media, there were 91 temporal bones with facial nerve canal dehiscence (68.9 %) (Fig. 1). Of 121 control temporal bones, 87 temporal bones had dehiscence (71.9 %). There was no significant difference between these two groups ($P = 0.61$, Chi-square test). The mean area of dehiscence was $0.72 \pm 0.73 \text{ mm}^2$ (range $0.03\text{--}3.66 \text{ mm}^2$) in temporal bones with chronic otitis media ($n = 91$). In normal control temporal bones with dehiscence ($n = 87$), the mean area of dehiscence was $0.67 \pm 0.50 \text{ mm}^2$ (range $0.03\text{--}2.14 \text{ mm}^2$). No significant difference was found between two groups ($P = 0.53$, Mann-Whitney U test).

Of 132 temporal bones having chronic otitis media of age of 4 years and older, there were 20 temporal bones with large dehiscence (15.2 %). Of 121 control temporal bones, 20 temporal bones had large dehiscence (16.5 %). There was no significant difference between these two groups ($P = 0.76$, Chi-square test).

The group of age under 4 years

Of 17 temporal bones having chronic otitis media, there were 15 temporal bones with facial nerve canal dehiscence (88.2 %) (Fig. 2). Of 17 control temporal bones, there were 13 temporal bones with facial nerve canal dehiscence (76.5 %). No significant difference was recognized between two groups ($P = 0.66$, Fisher's exact test). The mean area of the facial nerve canal dehiscence was $0.85 \pm 0.75 \text{ mm}^2$ (range $0.07\text{--}2.24 \text{ mm}^2$) in temporal bones with chronic otitis media ($n = 15$). In normal control temporal bones with dehiscence ($n = 13$), the

mean area of the dehiscence was $0.97 \pm 0.53 \text{ mm}^2$ (range 0.35–2.07 mm^2). There was no significant difference between the two groups ($P = 0.43$, Mann–Whitney U test).

Of 17 temporal bones having chronic otitis media of age under 4 years, there were 5 temporal bones with large dehiscence (29.4 %). Of 17 control temporal bones, 7 temporal bones had a large dehiscence (41.2 %). There was no significant difference between these two groups ($P = 0.72$, Fisher's exact test).

Discussion

Facial nerve canal dehiscence is thought not to be a congenital anomaly but a termination of the development, because the ossification patterns seemed symmetrical in 80 % of temporal bones [14]. The development of the facial nerve canal starts at 21 gestational weeks from apical otic ossification centers and at 26 gestational weeks from canalicular ossification centers near the stapedial muscle. The two centers fuse postpartum near the region of the oval window [8, 11]. However, it is not evident when the facial nerve canal has completely developed [14–16]. There is a report in which the authors mentioned that the development of the canal was completed by the age of 4 years from an anatomical and radiological standpoint [13]. Another report mentioned that middle ear inflammation in young children could affect the development of the canal [12]. We showed in this study that no significant difference was observed between the incidence of the facial nerve canal dehiscence in temporal bones with chronic otitis media and that in normal controls. Our findings suggest that inflammation in the middle ear may hardly influence the development of the canal in early childhood.

In clinical studies, the incidence of facial nerve canal dehiscence in chronic otitis media without cholesteatoma was 6.1–23.8 % [2–7]. In histopathological studies using normal human temporal bones, the incidence of facial nerve canal dehiscence was 25–74 % [8–11]. This discrepancy has been discussed in previous studies [2–5]. It has been stated that a dehiscence must be at least 1 mm in size to be detected during surgery [4]. In addition, the thickened epithelium or the effusion in the middle ear may result in the dehiscence being missed. On the other hand, histopathological investigation can detect the horizontal and vertical segment of the canal completely and find small dehiscence. Although we were not able to identify the duration of the chronic otitis media in each temporal bone, our histopathological findings showed that the incidence of facial nerve canal dehiscence in chronic otitis media was high and there was no statistical difference between chronic otitis media and normal controls. Even in large dehiscence, no significant difference was found.

Peripheral facial paralysis is a complication of chronic otitis media with and without cholesteatoma. Although the mechanism of paralysis as a result of chronic otitis media is not fully understood, facial nerve canal dehiscence could be an underlying factor in the development of facial palsy. Harker and Pignatari observed that there was a facial nerve canal dehiscence at the most common site in four out of five cases with chronic otitis media without cholesteatoma who developed peripheral facial paralysis [17]. Our findings clearly show that the facial nerve canal dehiscence in chronic otitis media exists at a high rate, and that inflammation in chronic otitis media does not increase the incidence of facial nerve canal dehiscence.

Conclusion

The incidence of facial nerve canal dehiscence in chronic otitis media is high, but is not statistically different compared to normal controls. Surgeons may give much attention to facial nerve canal dehiscence to prevent surgical complications.

Acknowledgments

Funding Source: NIH NIDCD U24DC011968, The International Hearing Foundation, 5 M Lions International, and the Starkey Foundation. The authors also thank Ms. Monika Schachern and Carolyn Sutherland for their assistance in this study.

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Fig. 1. Facial nerve canal dehiscence (*arrows*) in chronic otitis media of 84 year-old male, left ear. Thickened epithelium and effusion in middle ear was found. *S* stapes. *TM* tympanic membrane. (hematoxylin–eosin staining; temporal bone number, HB 636)

Fig. 2. Facial nerve canal dehiscence (*arrows*) in chronic otitis media of 1 year-old boy, right ear. Mucosa and submucosa in middle ear are thickened and effusion in middle ear was found. *S* stapes. (hematoxylin–eosin staining; temporal bone number, HB 245)