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Research Article

Meanings of the Tympanic Mucosa Recovered By Tubotympanoplasty (A Long T-Shaped Solid Silicon Plate in Eustachian Tubal Orifice)

Abstract

We used a surgical procedure suggested by Murata et al. and inserted a T-silicon plate from the tympanic cavity into the opening of the eustachian tube in 2 cases of chronic otitis media. The goal of this surgery was to promote the regeneration and the epithelization of residual mucosa of the eustachian tube. In our results, epitheliums of regenerated tympanic mucosa were histologically examined. Two patients with eustachian tube stenosis demonstrated increased ventilatory function of the eustachian tube and showed epithelium of regenerated mucosa extended toward the mesotympanic and the pretympenic space surrounding the opening of the eustachian tube. Electron microscopic examination of regenerated mucosa of the anterior tympanic cavity, obtained after tubotympanoplasty revealed stratified ciliated epithelium. From above results, our technique suggested to improve the ventilatory function of the eustachian tube, and to promote formation of epithelium of regenerated tympanic mucosa.

Introduction

Ventilatory dysfunction of the eustachian tube has been said to be one of the causes of acquired cholesteatoma otitis. Clinically, however, normal ventilatory function of the eustachian tube is preserved in some patients with acquired cholesteatoma otitis. Sade' [1], described the concept of gas exchange occurring inside the middle ear cavity including the mastoid air cells. Gas exchange is a passive process that moves air into and out of the cavity; that is, in the body, gases move between the closed cavity and the surrounding blood vessels in the mucosa of middle ear in proportion to the gradient of partial pressure, thus equalizing the pressure between the closed cavity and the blood [2]. This gas-exchanging function as well as the ventilatory function of the eustachian tube is necessary for normal functioning of the ear.

In this study, we performed tubotympanoplasty using a T-silicon tube in patients with advanced cholesteatoma otitis who had undergone unavoidable radical mastoidectomy and removal of the mucous membrane of the middle ear. We used a surgical procedure suggested by Murata [3] and inserted a T-silicon plate from the tympanic cavity into the opening of the eustachian tube. The goal of this surgery was to promote the regeneration and the epithelization of residual mucosa of the eustachian tube and the extension of it toward the opening

of the eustachian tube. We then performed the reconstructed ossicular chains as a secondary operation in these patients. The ventilatory function of the eustachian tube and the range of extension of epithelium of regenerated tympanic mucosa, which are related to development of the pneumatization system, were evaluated after surgery. Epithelium of regenerated tympanic mucosa was histologically examined.

Subjects and Methods

Subjects

Two patients with choleseatoma otitis undergoing radical mastoidectomy and tubotympanoplasty.

Methods

We used a surgical procedure suggested by Murata [3] and performed tubotympanoplasty. Radical mastoidectomy was performed at the first operation. A T-silicon tube (thickness, 0.2-0.5 mm; length, 2cm) that we had made was inserted from the tympanic cavity into the opening of the eustachian tube. Then, as illustrated in Figure 1a, hyperplasia of granulation tissue occurred in the tympanic cavity. The epithelium of the external auditory meatus grew, and extended beyond the granulation tissue, which seemed to function as a footing, and as a result the T-silicon tube was covered with it.

Granulation tissue in the tympanic cavity became fibrotic, and epithelium of the residual mucosa of the eustachian tube regenerated and extended toward the anterior tympanic cavity surrounding the opening of the eustachian tube (Figure 1b).

The secondary operation was subsequently performed. Regenerated epithelium of the external auditory meatus was ablated and then its mucosal epithelium was dissected. The T-silicon plate was finally removed. The dissected mucosal epithelium was turned over and attached to the tympanic wall. Then, the sound-conducting mechanism was restored using residual regenerated epithelium of the external auditory meatus and the temporalis fascia (Figure 1c). We then examined the ventilatory function of the eustachian tube in all patients, by tubal catheterization both before the first operation and after the secondary operation.

At the time of the second surgery, we evaluated the range of extension of regenerated tympanic mucosa and performed electron microscopy to view the tympanic mucosa.

Results

Ventilatory function of the eustachian tube

The results of tubal catheterization were compared before the first operation and after the planned next operation. Two patients with eustachian tube stenosis demonstrated increased ventilatory function of the eustachian tube.

Range of extension of regenerated tympanic mucosa

Epithelium of regenerated mucosa extended toward the pretyimpanum and the mesotympanum from surrounding the opening of the eustachian tube in 2 patients.

Electron microscopic observation of regenerated tympanic mucosa (Figure 2)

Electron microscopic examination of regenerated mucosa of the anterior tympanic cavity (Figure 2a), obtained after tubotympanoplasty revealed pseudostratified ciliated epithelium.

This was observed in the mucosa of the eustachian tube as well. Electron microscopic examination of the epithelium of surgically-induced wounds on the mastoid cavity (Figure 2b) demonstrated subepithelial granulation tissue. A layer of squamous cells was also observed and was completely different from the epithelium of the regenerated mucosa of the reconstructed tympanic cavity.

Discussion

Acquired cholesteatoma otitis has been shown to develop when retraction occurs in the tympanic membrane because of eustachian tube dysfunction. Thus, normal ventilatory function of the eustachian tube has been said to be required for successful tympanoplasty.

However, clinically, some patients with chronic otitis media or acquired cholesteatoma otitis have been found to maintain normal ventilatory function of the eustachian tube. In an

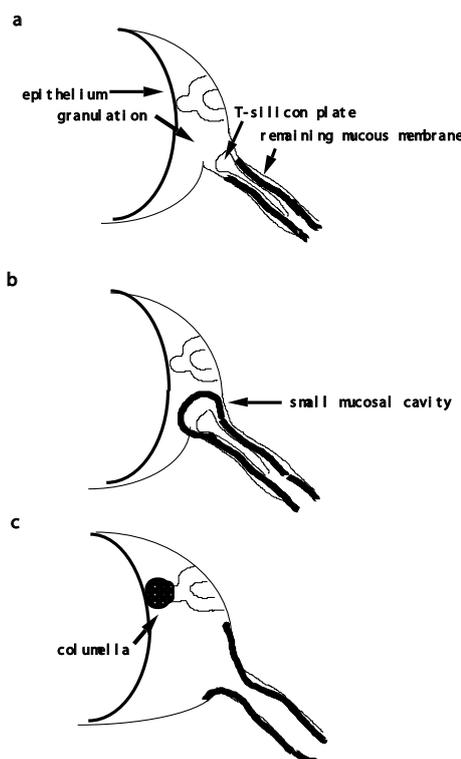


Figure 1: Planned staged tubo-tympanoplasty.

a: Silicone plate placed in the eustachian tube and the pretyimpanum at radical mastoidectomy (first stage surgery). Hyperplasia of granulation tissue occurred in the tympanic cavity. The epithelium of the external auditory meatus grew, and extended beyond the granulation tissue, which seemed to function as a footing, and as a result the T-silicon tube was covered with it.

b: These granulations in tympanic cavity changed fibrosis. This fibrosis volume decreased. The normalized mucosa extended from the remaining tubal mucosa. A small mucosal cavity could develop in half a year or later following the first surgery.

c: At the second stage surgery, regenerated epithelium of the external auditory meatus was ablated and then its mucosal epithelium was dissected. The T-silicon tube was finally removed. Then, the sound-conducting mechanism was restored using residual regenerated epithelium of the external auditory meatus and the temporalis fascia.

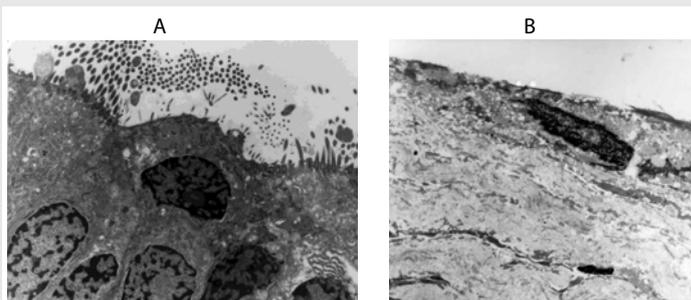


Figure 2: a: Regenerated mucosa of the anterior tympanic cavity obtained after tubotympanoplasty revealed pseudostratified ciliated epithelium like as the mucosa of the eustachian tube (E.M)

b: The epithelium of surgically-induced wounds in the mastoid cavity demonstrated subepithelial granulation tissue. A layer of squamous cells was also observed, and was completely different from the epithelium of the regenerated mucosa of the anterior tympanic cavity (a).

animal study conducted by Takahashi [4]. One of 14 cats with induced ventilatory dysfunction developed exudative otitis media; and 5 of 14 cats had zero pressure in transient positive pressure in the middle ear. Sade' [1], reported the concept of gas exchange occurring inside the body.



Because of this passive movement of gases between the closed cavity and the blood in proportion to the gradient of partial pressure, the body can maintain zero pressure in a closed cavity [2].

Along with the ventilatory function of the eustachian tube, the gas-exchanging function of the mucosa of the middle ear plays an important role in preventing adhesion and the occurrence of retraction of the tympanic membrane. For this reason, it is important to preserve as much normal mucosa of the middle ear as possible at the time of operation, in order to maintain gas-exchange function. Results of the study conducted by Takahashi [4], showed that gas-exchange function could be recovered even if the normal mucosa of the middle ear was partially preserved.

In this study, we used a surgical procedure suggested by Murata [3] and performed tubotympanoplasty using a T-silicon plate in patients with advanced cholesteatoma otitis.

Prior to this operation, radical mastoidectomy, in which the mucous membrane of the middle ear was completely removed, had to be performed. As a result of tubotympanoplasty using the T-silicon plate, the ventilatory function of the eustachian tube improved in many patients.

In all patients epithelium of residual mucosa of the eustachian tube regenerated and extended toward the anterior tympanic cavity surrounding the opening of the eustachian tube.

It also extended toward the mesotympanic and the epitympanic space in some patients. Electron microscopic examination of the epithelium of regenerated mucosa

of the anterior tympanic cavity revealed the presence of stratified ciliated epithelium in the tympanic cavity. This was also observed in mucosal epithelium of the eustachian tube, suggesting that the anterior tympanic cavity had been prepared for gas exchange function. No relationship between the range of extension of epithelium of regenerated mucosa and the interval between the first and second operations was demonstrated in this study. Thus, further investigation of cell growth rate of epithelium of regenerated mucosa and each growth factor receptor is needed in such patients.

Above all, tympanoplasty in patients with advanced otitis media who had poor ventilatory function and had undergone removal of the mucosa of the middle ear in the first operation was shown to improve the ventilatory function of the eustachian tube, and to promote formation of epithelium of regenerated mucosa, thus providing a location for exchange of gases. In this way, the pneumatic system develops in the tympanic cavity and recesses of the tympanic membrane and adhesions occur less frequently when secondary tympanoplasty is performed.

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