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CASE REPORT

Cochlear implantation in deaf patients with eosinophilic otitis media using subtotal petrosectomy and mastoid obliteration

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Abstract We investigated the usefulness and safety of our cochlear implantation method for two deaf patients with eosinophilic otitis media. The surgical approach was a subtotal petrosectomy to remove the theater of eosinophilic infiltration and to prevent leaching of foreign substances and entry of stimuli that are the cause of eosinophilic inflammations. The operative cavity was obliterated with abdominal fat. There were no complications or recurrent inflammation following surgery in the cases of both patients. It was confirmed by CT scan that the eustachian tube was closed and the operative cavity remained obliterated with abdominal fat. Following the procedure, the hearing threshold results of the two patients were 30 and 34 dB. Cochlear implantation procedures in this report for deaf patients resulting from eosinophilic otitis media may be effective and safe. Using steroids before surgery may be the better option. To further confirm the efficacy and safety of our surgical concept, we need to administer this treatment concept for a large number of cases in a future study.

Introduction

In 2011, diagnostic criteria for eosinophilic otitis media (EOM) were established by the EOM study group [1]. The major criterion of EOM is otitis media with effusion or chronic otitis media with eosinophil-dominant effusion. The minor criteria are as follows: highly viscous middle ear effusion (MEE); resistance to conventional treatment for otitis media; association with bronchial asthma; and association with nasal polyposis. Definitive cases are defined as positive for the major criterion plus two or more of the minor criteria (Table 1). The conservative therapy for eosinophilic otitis media is intratympanic, topical steroid administration. It is also possible to give systemic steroid administration. In recent years, molecularly targeted drugs (anti-IgE antibodies) of omalizumab have been reported to be effective against eosinophilic otitis media [2]. These conservative therapies are used both to stop topical eosinophilic inflammations and to prevent the progression of sensorineural hearing loss. In a few cases, despite appropriate, conservative therapy, sensorineural hearing loss continued to develop, and in the worst cases, the patients became deaf [3]. For cases in which conversational understanding was difficult, despite the use of hearing aids, receiving a cochlear implantation procedure was considered as one treatment option. While there are some reports of cochlear implant procedures for deaf, eosinophilic otitis media patients [4], such reports are very few. Furthermore, the concepts for this surgical procedure vary from report to report. Recently, we have performed cochlear implantation procedures for two cases of deafness resulting from eosinophilic otitis media. The surgical approach was a subtotal petrosectomy [5] to remove mucosa from the tympanic cavity, and the mastoid cavity as completely as possible. Then, the external auditory canal was closed using blind sac closure. Furthermore, the eustachian tube was also closed, and the operative cavity was obliterated with abdominal fat. We would like to report on these results and consider this surgical concept.

Case 1

The patient is a 64-year-old male. From the age of 42, he contracted and was treated for asthma. Chronic otitis media with eosinophil-dominant effusion and glue-like middle ear

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Table 1 Diagnostic criteria of eosinophilic otitis media (EOM)

Major: otitis media with effusion or chronic otitis media with eosinophil-dominant effusion
Minor
1. Highly viscous middle ear effusion
2. Resistance to conventional treatment for otitis media
3. Association with bronchial asthma
4. Association with nasal polyposis
Definitive case: positive for major + two or more minor criteria
Exclusion criteria: Churg–Strauss syndrome, hypereosinophilic syndrome

fluid together with bronchial asthma were observed, and a diagnosis of eosinophilic otitis media was made by the otolaryngology department at a nearby hospital. Steroids were injected into the tympanic cavity. As the condition worsened, the patient received systemic steroid administration as a conservative therapy. In August 2013, his hearing impairment became more severe. Even with the use of hearing aids, the patient had difficulty understanding conversation, so he was introduced to our department. Pure tone average was not on the scale in the left ear and 82.5 dB in the right ear. (Fig. 1a). There were perforations in both tympanic membranes, and the mucosa in the tympanic cavities was edematous (Fig. 1b, c). The results of a CT scan indicated bilaterally well-developed mastoid air cells, but they showed little pneumatisation. (Fig. 1d). A cochlear implant procedure with subtotal petrosectomy was performed in the left ear. All 22 electrodes could be emplaced. The device used was CI24RE(CA) (Cochlear Ltd., Australia). During the implantation, there was hardly any resistance. The neural response telemetry (NRT) following surgery indicated that the response from all electrodes was good. Blood loss was 170 mL. There was no recurrent inflammation 21 months following surgery. It was confirmed by CT scan that the eustachian tube was closed and the operative cavity remained obliterated with abdominal fat (Fig. 1e). Twenty one months following the procedure, the hearing threshold result was 30 dB (Fig. 1f).

Case 2

The patient is a 71-year-old male. From February 2011, hearing impairment developed in both ears. He was examined in our department in March 2011. There were perforations in both tympanic membranes, and highly viscous middle ear effusion was observed (Fig. 2b, c). The present of abundant eosinophil were determined using the eosin stain test, and the patient was suffering from the complex condition of highly viscous middle ear effusion and bronchial asthma, so eosinophilic otitis media was diagnosed. Pure tone average was 102.5 dB in the right ear, and pure tone average was 105 dB in the left ear (Fig. 2a). A CT scan indicated bilateral mastoid air cell representing good development, but little pneumatisation was shown (Fig. 2d). The steroid used was 60 mg of Predonine gradually decreasing the dosage to zero, finishing the administration the day before the operation. The cochlear implant procedure with subtotal petrosectomy was performed on the right ear. Twenty two electrodes were emplaced. The device used was CI24RE (CA) (Cochlear Ltd., Australia). During the implantation, there was hardly any resistance. The neural response telemetry (NRT) following surgery indicated that the response from all electrodes was good. Blood loss was 50 mL. Following the operation, there was no recurrent inflammation. It was confirmed by CT scan that the eustachian tube was closed and the operative cavity remained obliterated with abdominal fat (Fig. 2e). Eight months following the procedure, the hearing threshold result was 34 dB (Fig. 2f).

Discussion

The cause of deafness in patients suffering from eosinophilic otitis media is conjectured to be damage to the cochlea [6, 7]. Thus, in theory, it is possible to restore the sense of hearing through a cochlear implantation. However, because of the pattern of increasingly worsening eosinophilic otitis media occurring in the mucosa of the middle ear and mastoid cavity, the risk of postoperative complications increases as compared with the cases of standard cochlear implants. The incidence of complications occurring in the cases of cochlear implants performed in patients with otitis media is 1.7–4.1 % [8]. Thus, it is essential to establish an operative procedure that allows for the avoidance of these complications and results in a safe cochlear implantation. We have performed operations for cases of deafness caused by eosinophilic otitis media. Our surgical procedure for cochlear implant performed in the cases of deafness caused by eosinophilic otitis media is a subtotal petrosectomy. The concepts of the surgery consist of the following two points: (1) removal of mucosa from the middle ear and the mastoid cavity as completely as possible to remove the theater of eosinophilic infiltration;

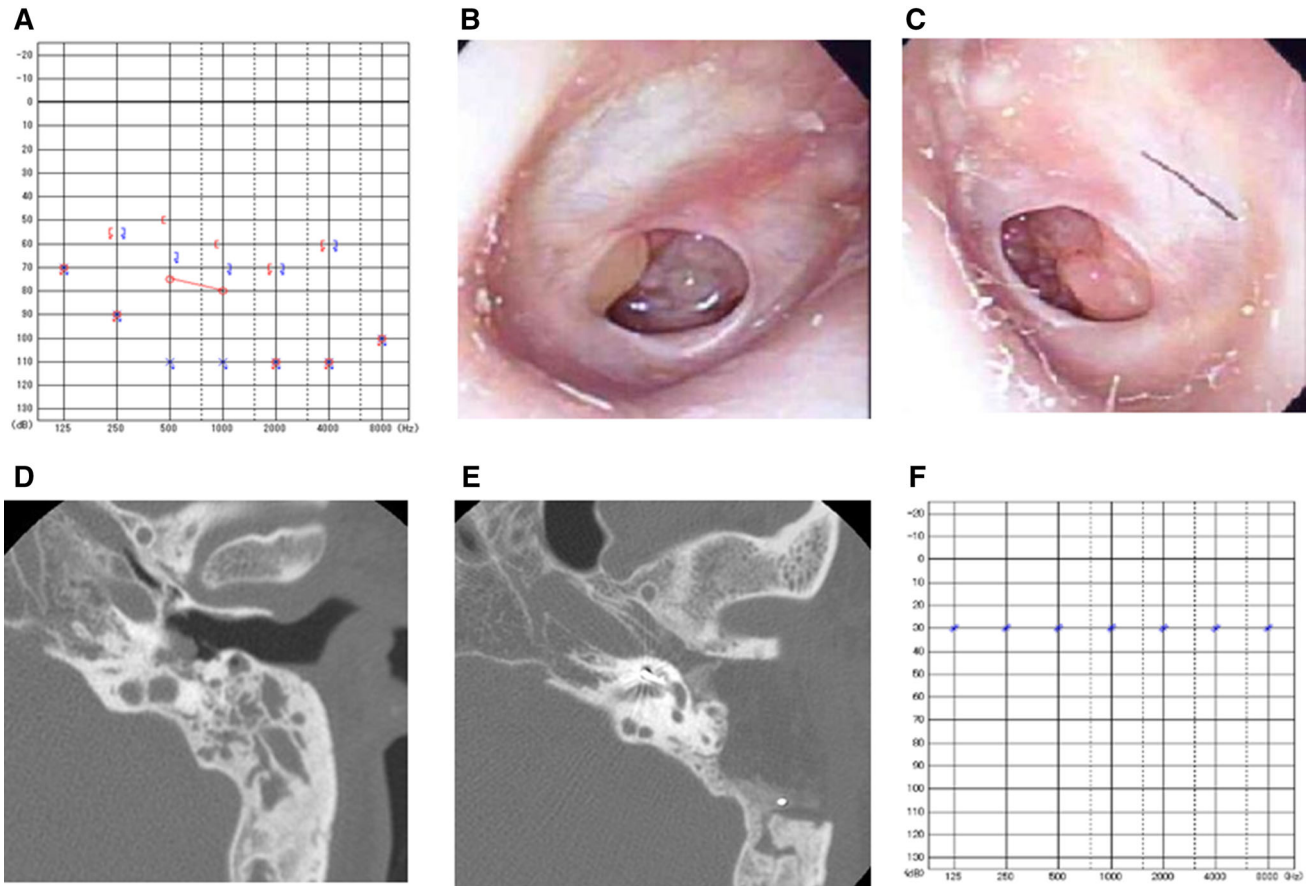

Fig. 1 Clinical findings of Case 1. **a** Pure tone audiogram before surgery, **b** endoscopic future of right eardrum, **c** left eardrum, **d** CT scan before surgery, **e** CT imaging after surgery, and **f** hearing threshold result after surgery

and (2) closure of the eustachian tube and the external auditory canal to prevent leaching of foreign substances and entry of stimuli that are the cause of eosinophilic inflammations. It is suggested that eosinophilic infiltration in the tissue can be caused by some antigenic materials as a result of the proliferation and activation of helper T-cells, followed by the secretion of eosinophil chemoattractants. Furthermore, the eustachian tube can be an entrance route into the middle ear for antigenic materials, such as bacteria, viruses, and fungi [9]. Thus, we believe that if prevention of the "leaching of foreign substances and entry of stimuli" is successfully realized by closing the eustachian tube and the external auditory canal, then the local, inflammatory, symptomatic processes will not reoccur. However, the removal of all the mucosa from the operating field may not be surgically possible, and since the number of patients in the current study is small, we cannot conclude the efficacy and safety of our surgical concept. We need to administer this treatment concept for a large number of cases in the future study.

There is some division of opinion as to whether it is better to carry out the procedure in stages or to complete the entire procedure with one, comprehensive operation. Szymanski et al. suggest the treatment algorithm. They advocate a staged operation for suppurative and continuously draining otitis media, previous tympanomastoid surgeries with "unstable" disease, extended cholesteatoma and previously irradiated temporal bone because of the risk of biofilm formation on the implant [10]. Postelmans et al. also recommend a staged procedure in the case of an active infection or in the case of an unstable cavity [11]. On the other hand, Free et al. [12] and Bernardeschi et al. [13]. have confirmed that even for cases of complicating otitis media and special cases, performing subtotal petrosectomy, blind sac closure of the external auditory canal, closure of the eustachian tube, and obliteration of the operative cavity with abdominal fat all as one, comprehensive procedure for cochlear implantation is safe and renders good results. On this occasion, we have also verified the safety of this single-stage procedure for two cases of eosinophilic otitis media. Since the number of patients was small, comparison with staged procedures cannot yet be made, but we feel that it is no problem to perform the procedure in one, comprehensive operation in terms of the risk of infection, because eosinophilic otitis media is not an infectious disease.

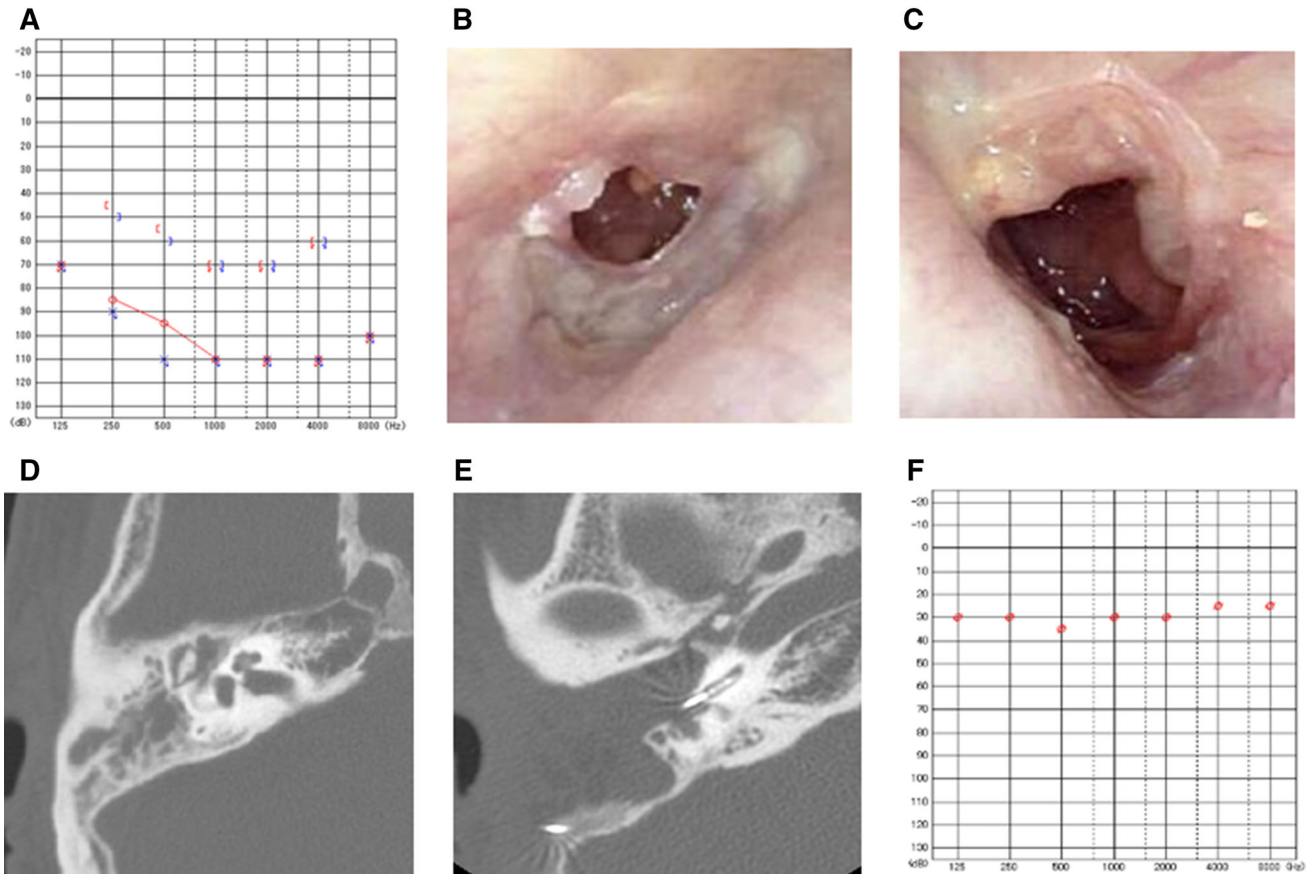

Fig. 2 Clinical findings of Case 2. **a** Pure tone audiogram before surgery, **b** endoscopic future of right eardrum, **c** left eardrum, **d** computed tomography imaging before surgery, **e** computed tomography imaging after surgery, and **f** hearing threshold result after surgery

For Case 1, steroids were not used, because it was determined that preoperative otorrhea was not significant, and the patient's condition was stable. However, during the course of this operation, it was found that the membrane's edema was severe. Thus, blood loss was great (170 mL). For Case 2, preoperative volume of mucinous otorrhea was great, and the tympanic cavity's membrane was highly edematous, so steroid pulse therapy was carried out from 7 days prior to the operation. As a result, the middle ear membrane's edema was improved during hospitalization. During the operation, the blood loss was low (50 mL), and it was observed that the edema was not severe. Given the experience of these two cases, we suppose that the use of steroids may be the better option. To further confirm the efficacy of the use of steroids, a randomized trial will need to be conducted.

Conclusions

The cochlear implantation procedures for deaf patients resulting from eosinophilic otitis media, which are discussed in this report, may be effective and safe. To further confirm the efficacy and safety of our surgical concept, we need to administer this treatment concept for a large number of cases in the future study.

Compliance with ethical standards

Conflict of interest None.

Ethical approval This study does not contain any studies with human participants performed by any of the authors.

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