

CASE REPORT

Vibrant soundbridge implantation prior to auricular reconstruction with unilateral microtia-atresia

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Abstract

We presented the first successful application of VSB implantation prior to auriculoplasty, which can provide hearing improvement in safe conditions and open new strategies for earlier hearing rehabilitation in unilateral microtia-atresia children.

KEYWORDS

atresia, microtia, middle ear implant, Vibrant soundbridge

1 | INTRODUCTION

Herein, we present a new surgical approach for vibrant soundbridge implantation in advance of the plastic reconstruction of the auricle in patients with unilateral microtia-atresia and highlight the importance of cooperation between otologists and plastic surgeons in the performance of this technique.

Congenital aural atresia (CAA) is diagnosed in 1 in 10 000-20 000 newborns.¹ Among these cases, unilateral CAA (UCAA) is much more frequently observed than bilateral CAA.² Additionally, the middle ear and ossicles are affected to varying degrees in patients with CAA, leading to conductive hearing loss.² Although patients with UCAA typically understand speech well in everyday listening situations

in quiet, the growing interest in binaural hearing has led to an increased demand for hearing rehabilitation in patients with unilateral aural atresia.³ Previously, middle ear and auditory canal reconstructive surgery to restore conductive hearing in patients with CAA were performed; however, that is, generally considered one of the most difficult types of otologic surgery due to the restenosis as the most frequent postoperative complication, and functional results are often unsatisfactory, leading to the need for an air conduction hearing aid.^{3,4} The alternative option is to consider a bone conduction (BC) hearing device or middle ear implant (the Vibrant Soundbridge [VSB], MED-EL Corporation, Austria).⁵ For patients with UCAA, the VSB can treat the impaired ear without affecting the contralateral ear, unlike the BC device.⁴ The VSB, firstly

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implanted in children in 2009,⁶ is composed of two parts: 1) the implantable vibrating ossicular prosthesis (VORP) and floating mass transducer (FMT) and 2) the externally worn audio processor. It is able to bypass middle ear malformations and provide active auditory support directly to the cochlea. The VSB can be easily attached to a variety of middle ear structures, and it is well suited for implantation in the malformed middle ears of children with CAA.⁶ Recently, it has been increasingly used to improve hearing without surgical complications in patients with UCAA.⁶

CAA is often associated with microtia or other forms of craniofacial dysplasia. Therefore, children with atresia and microtia may face multiple surgeries to correct the malformation, indicating that they and their parents require the proper intervention of otologists and facial plastic surgeons.⁷ Most children with microtia require plastic reconstruction for cosmetic and functional benefits (ie, to facilitate wearing glasses or a mask).⁷ Auriculoplasty using a rib graft is preferable to the use of a prosthesis in terms of skin infection and implant extrusion.⁸ Correction of the microtia should be performed in patients older than 10 years as treatment at a younger age has unfavorable outcomes in terms of both the reconstructed ear and the donor-site thorax.⁹

For the early intervention in children with unilateral microtia-atresia, Frenzel et al reported “simultaneous” VSB implantation with plastic reconstruction of the auricle without any negative effects in terms of the healing process or the cosmetic outcome of the repaired auricle.⁶ However, in cases in which patients and their parents desire earlier hearing rehabilitation, the development of a new surgical approach is required. Here, we demonstrate a case of UCAA receiving VSB implantation prior to auricular reconstruction and highlight the importance of cooperation between otologists and plastic surgeons in the performance of the surgical technique presented herein.

2 | CASE REPORT

The patient was a 9-year-old boy with congenital CAA and lobule-type microtia of the right ear (Figure 1A). No

associated symptoms were observed. He visited Shinshu University Hospital, Department of Otolaryngology and asked us to treat his conductive hearing loss as early as possible. We offered a trial of a bone conduction hearing aid, but he did not want to wear it due to its appearance. Preoperative audiometry showed mean air conduction pure-tone thresholds of 70 dB HL at 0.5, 1, and 2 kHz, with an air-bone gap of 50 to 90 dB (Figure 3A). Plastic reconstruction of the auricle was scheduled to be undertaken at age 11. Therefore, we suggested to him and his parents that he undergo VSB prior to the atresioplasty. We, otolaryngologists, consulted the plastic surgeons about the surgical planning so as not to interfere with the costal cartilage grafting associated with the auriculoplasty. This study was approved by the Ethics Committee of Shinshu University School of Medicine (jRCTs032190002).

Preoperatively, a film pattern was copied from the contralateral ear (Figure 1B). With the film attached to his face, the ear position was determined by comparison with the contralateral ear from the frontal view and in a sitting position (Figure 1C). The use of glasses with a scale enabled us to design the ideal ear position (Figure 1D). Surgery was performed under general anesthesia with facial nerve monitoring. First, an arc-shaped incision line was marked 2 cm away from the proposed ear (Figure 2A). We incised the skin to the level of the periosteum and made a single-layer flap. Mastoidectomy to the point where the atretic plate was visible was performed. The atretic plate was then gently drilled. We found that the incus and malleus were fused into a malformed complex, which was strongly adhesive to surrounding structures (Figure 2B). After removing the complex, the tympanic facial nerve and stapes were identified (Figure 2C). In accordance with the manufacturer's protocols, the implant (VORP 503) was placed in the prepared bone bed and fixed to the cortical bone with screws (Figure 2E). A Vibroplasty-Clip-Coupler was attached to the FMT, and the Coupler-FMT assembly placed onto the head of the stapes superstructure (Figure 2D) and secured with fascia. The skin flap was sutured with a drain (Figure 2F), which was removed 2 days after the surgery.

Eight weeks postsurgery, the initial activation of the audio processor was performed. He has been able to comfortably

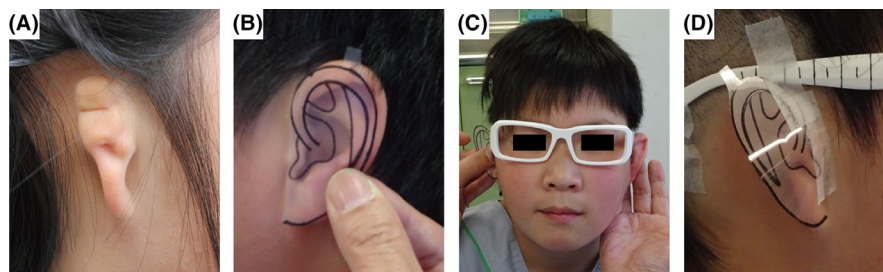


FIGURE 1 Preoperative preparation. A, Preoperative appearance of lobule-type microtia. B, Copying a film pattern from the contralateral normal ear. With the film attached to the patient's face, the proper position of the ear to be created was determined by comparison with the opposite ear from the frontal (C) and side (D) view using glasses

postoperative evaluations. His score on the Japanese monosyllable test at 0, −5, and −10 dB SNR was improved remarkably (Figure 3F). The results of sound localization testing are described in Figure 3B, D and show the time course of the deviation (d) score. The d scores showed improvement in this case from 18.75 to 7.92. He will receive the auriculoplasty with costal cartilage grafting at age 11.

3 | DISCUSSION

The use of a VSB in patients with unilateral hearing loss is known to improve the ability to understand speech in noise and sound localization.^{6,10} We have consistently observed that VSB implantation results in significantly greater hearing ability without impairing auditory function in the case of UCAA. Also, there is general consensus that congenital and early childhood hearing loss should be treated as soon as possible.⁴ Taken together, the above findings indicate that it is ideal to address conductive hearing loss in children with UCAA via VSB, which means intervention prior to the plastic reconstruction of the ear, which is generally performed at the age of 10 or older.

However, since the temporal bone, middle ear structures, and facial nerve are often affected to varying extents in UCAA children, preoperative evaluation via CT scans is needed.¹¹ In this case, the stapes as well as adequate middle ear and mastoid pneumatization were identified, allowing us to place the FMT on the stapes superstructure. Even if the malformation was markedly more severe, a BC device or a cartilage conduction hearing aid,¹² which are approved in Japan, might have been an alternative solution for the restoration of auditory function.

Plastic reconstruction of the auricle follows a standard procedure with autologous rib cartilage in two operative steps based on the technique of Nagata.¹³ Although some modifications have been reported,^{9,14,15} these operations predominantly include (a) costal cartilage harvest and implantation of the sculpted framework in a subcutaneous pocket and (b) elevation of the auricle with skin grafting. When performing VSB implantation in advance of the auriculoplasty, otologists must ask plastic surgeons to design the proposed ear preoperatively. Additionally, both the skin undermined around the proposed ear for creation of the ear and the temporoparietal and mastoid fascia potentially utilized in the second step must be preserved during VSB implantation. Therefore, we selected a retroauricular incision through “all” layers at about 20 mm from the outline of the prospective ear and elevated a single-layer flap, leaving the tissues including the skin and subcutaneous fascia used in the auriculoplasty intact. Hence, our surgical procedure will not interfere with future plastic reconstruction.

4 | CONCLUSION

In summary, we presented the first successful application of VSB implantation prior to auricular reconstruction and demonstrated that this intervention can provide substantial hearing improvement in safe conditions and open new strategies for earlier hearing rehabilitation in UCAA children. To achieve a successful outcome, cooperation between otologists and plastic surgeons is essential.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

HY: prepared the original draft and performed the described surgical procedure. MT and SI: reviewed the paper. JS, IT, and FN: performed the described surgical procedure and reviewed the paper. TY and SU: supervised the project and reviewed the draft.

ETHICAL APPROVAL

This study was approved by the Ethics Committee of Shinshu University School of Medicine (jRCTs032190002).

DATA AVAILABILITY STATEMENT

Data sharing was not applicable to this paper as no datasets were generated or analyzed.

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