Cochlear implantation in patient with Charcot-Marie-Tooth disease

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Abstract

Two patients with auditory neuropathy spectrum disorder (ANSD) considered to be associated with Charcot-Marie-Tooth (CMT) are reported. In case 1, a 23-year-old man presented with progressive bilateral sensorineural hearing loss (SNHL) from 10 years of age and was diagnosed with ANSD. He was later diagnosed with CMT by neurological testing. In case 2, a 16-year-old girl, the younger sister of the patient in case 1, presented with progressive SNHL with similar auditory findings since 6 years of age as those of her brother. Both cases underwent bilateral cochlear implantation. In case 1, the maximum discrimination score improved to 45% 24 months after the first side of cochlear implantation from 5% before the surgery. In case 2, the score was 5% 10 months after cochlear implant (CI) surgery from 0% before the surgery. CI treatment for CMT patients has been considered difficult because of both failure in synchronization of nerve conduction due to demyelination and axonal failure of the auditory nerve. Though slower progress compared to the average subset of patients receiving CI was seen, significant improvement was gradually observed in the present patients after bilateral cochlear implantations. CI is thus a viable option for rehabilitation of SNHL in CMT patients.

Key word

Charcot-Marie-Tooth Disease, Auditory neuropathy, Cochlear Implants

Text

Introduction

Charcot-Marie-Tooth (CMT) is a hereditary neuropathy encompassing a group of diseases characterized by chronic motor and sensory neuropathy. CMT usually develops before the first and

second decades of life. The main complaint is slow progressive chronic motor and sensory neuropathy, and the symptoms include difficulty walking and distal muscle weakness of the lower limbs. CMT is sometimes accompanied by profound hearing loss and considered one of the causes of auditory neuropathy spectrum disorder (ANSD).[1] Cochlear implant (CI) treatment has been considered difficult in cases of auditory nerve failure and in CMT patients because of both failure in synchronization of nerve conduction due to demyelination and axonal failure of the auditory nerve. There are only a few previous reports of CI in patients with CMT. [2] The cases of two patients with ANSD considered to be associated with CMT who received CI treatment are presented.

Case Presentation

Case 1

A 23-year-old man who had progressive bilateral hearing loss from 10 years of age was referred for progressive bilateral sensorineural hearing loss (SNHL). The same progressive hearing loss was recognized in the brother and sister on the family history. They had purchased hearing aids before, but did not use them because there was no effect. At the first visit to our hospital, at the age of 19 years, the pure tone audiogram (PTA) showed profound SNHL, and the maximum discrimination score was 5% in quiet in both ears. Distortion product otoacoustic emissions (DPOAE) showed bilateral normal responses, although the auditory brainstem response (ABR) and auditory steady-state response (ASSR) showed no responses. The patient was diagnosed with ANSD; his family history showed similar hearing loss in his younger brother and sister. No special findings were found on diagnostic imaging using computed tomography (CT) and magnetic resonance imaging (MRI). The genetic test for congenital hearing loss about the presence of 154 mutations in 19 genes reported as a cause of hearing loss [3] was negative.

The progress of his hearing since age 12 years is shown (Fig. 1). From 12 years of age, a high hearing threshold was observed in the middle frequency around 1 kHz, and a high hearing threshold

in the high frequency was observed as he got older. On the other hand, hearing in the low frequencies, such as 125 Hz and 250 Hz, was relatively maintained.

Left-sided cochlear implantation was performed using an implant (Flex 28 Concerto®, MED-EL Medical Electronics, Austria) based on the diagnosis of ANSD. The electrodes were fully inserted without resistance. Intraoperative device testing showed normal impedance levels throughout the array; however, electrically evoked compound action potentials (ECAPs) were absent on all electrodes. The maximum discrimination score improved from 0% preoperatively to 30% (70 dB) in quiet 15 months after cochlear implantation.

A few months after surgery, he developed gait abnormalities and was referred to the neurology department. He had demyelinating neuropathy in neurological testing and was diagnosed with CMT; however, genetic tests for CMT were negative. Right-sided cochlear implantation was done in the same manner as on the left side 18 months after the first implantation (Flex 28 Synchrony®, MED-EL Medical Electronics, Austria). Intraoperative device testing yielded the same results as those observed after the first operation. The maximum discrimination score improved to 45% (60 dB) in quiet 6 months after cochlear implantation of both sides. Before the operation he was difficult to communicate only by sound, and after the operation he can make a conversation in daily life.

Case 2

A 16-year-old girl, the younger sister of the patient in case 1, was referred for progressive SNHL with similar auditory findings since 6 years of age as those of her brother. PTA showed profound hearing loss, DPOAE showed normal response, ABR and ASSR showed no responses, and no special findings were found on CT and MRI. However, she presented with no clear evidence of motor and sensory neuropathy, unlike her brother (case 1). Bilateral simultaneous cochlear implantation of implants (CI522®, Cochlear Ltd., Australia) was performed based on the diagnosis of ANSD. Intraoperative device testing showed normal impedance levels throughout the array,

while ECAPs were absent on all electrodes, as observed in the case of her brother. The hearing threshold on CI was an average of 30 dB, and the maximum discrimination score improved to 5% (50 dB) in quiet 10 months after cochlear implantation of both sides. (Fig. 2) Before the operation in the conversation she used writing and lip reading, and after the operation she did not have enough ability to have a conversation only by sound.

Discussion

CMT may show ANSD because of both failure in synchronization of nerve conduction due to demyelination and axonal failure of the auditory nerve. CMT can be inherited as an autosomal dominant, autosomal recessive, or X-linked disorder, and at least 40 genes and loci are involved. CMT hereditary neuropathy, especially CMT1 and CMT2 types, are common among patients with chronic neuropathy who undergo neurological examinations. [1] CMT1 type is mainly caused by a demyelinating neuropathy, CMT2 type by axonal failure, and the causative genes include PMP22, MPZ, GJB1, and MFN2 genes. The frequency of subtypes is essentially unclear. Comprehensive genetic testing is being conducted as research, but the causative genes of more than 60% of cases are still unclear. [4] In case 1, the causative gene could not be identified. A definitive diagnosis of CMT in case 1 was confirmed after the operation of case 2. Since case 2 had the same hearing loss and postoperative course as case 1, ANSD in case 2 was considered to be associated with CMT.

In case 1, the natural course of hearing loss due to CMT was observed before CI surgery. Though his hearing loss in the middle and high frequencies proceeded gradually, the low frequency was relatively maintained. Previous research showed normal or near-normal hearing for low sound frequencies on the audiogram exam, even though the hearing abilities with CMT were highly variable, similar to the course of these cases. [5]

Because CI treatment has been considered difficult in cases of auditory nerve failure, there have been few previous reports of CI in patients with CMT. With slower progression in these cases compared to other cases receiving CI, improvement was gradually observed. Previous studies

reported slow improvement, similar to the present cases, [2] and CI was considered to reconstitute synchronous neural activity by way of supraphysiological electrical stimulation and an increase in speech discrimination, but there were no obvious reasons.

The present cases showed that cochlear implantation was a valid option for rehabilitation of SNHL in CMT patients. However, there are no previous reports of long-term hearing outcomes with CI in CMT patients since the patients were all over 50 years old. Long-term hearing protection was expected in these cases, so it was necessary to follow it carefully. Previous studies have shown that retrocochlear hearing loss such as NF2 deteriorates gradually after CI surgery. [6] Further research is needed because there are no reports of comprehensive long-term changes in audiograms with CMT, which may vary due to various genetic mutations.

Conclusion

Two patients with ANSD associated with CMT from the same family having hearing loss who received CI treatment were presented. For CMT patients, CI is a treatment that should be considered because it improves hearing although progression is slow compared to other patients receiving CI.

Disclosure Statement

The authors have no conflict of interest.

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Figure legend

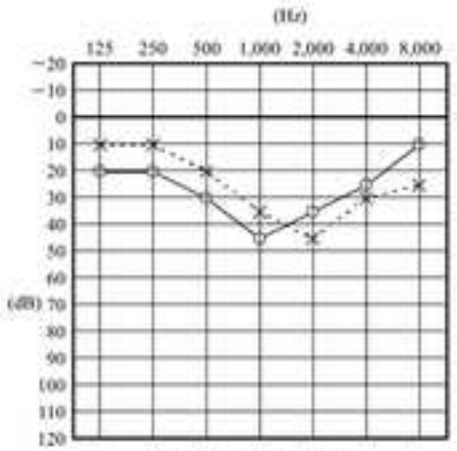
Fig. 1 Auditory history in case 1

In case 1, hearing loss progresses gradually. Middle-frequency hearing drops at 12 years of age, and high-frequency hearing loss gradually worsens. On the other hand, hearing in the low frequencies, such as 125 Hz and 250 Hz, is relatively maintained. Hearing after CIs insertion is almost unchanged before and after surgery. After operation the hearing level on both sides with CIs is shown. Hearing improvement is gradually observed in the present patients after bilateral cochlear implantations.

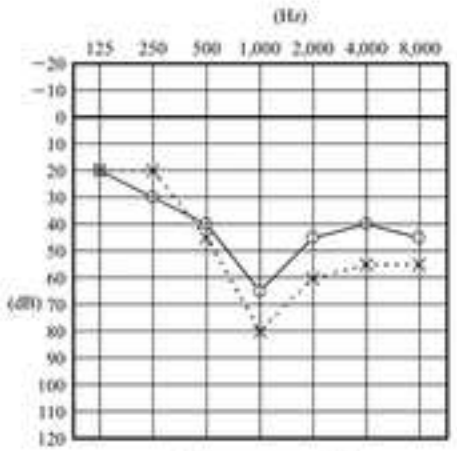
Fig. 2 Auditory history in case 2

In case 2, her hearing is almost deaf before surgery at 16 years of age, and hearing level after CI insertion is almost unchanged. After operation the bilateral hearing level with CIs is shown, which shows improvement.

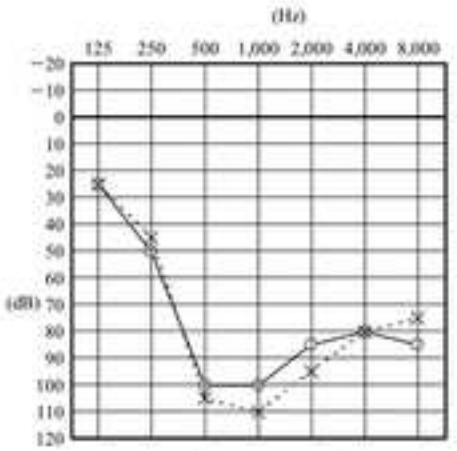
Figure1



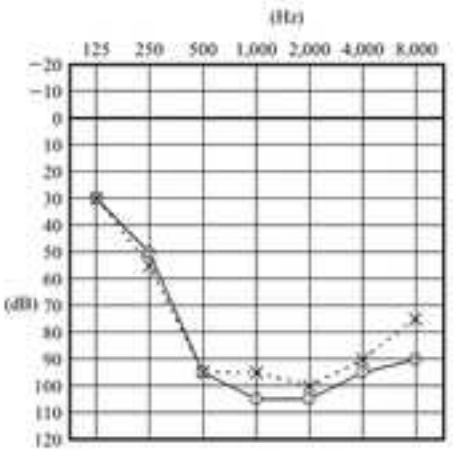
12 years old



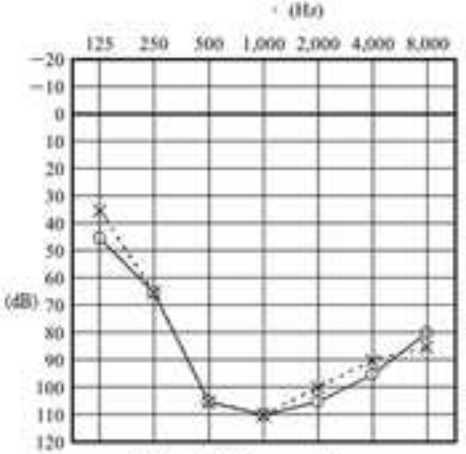
14 years old



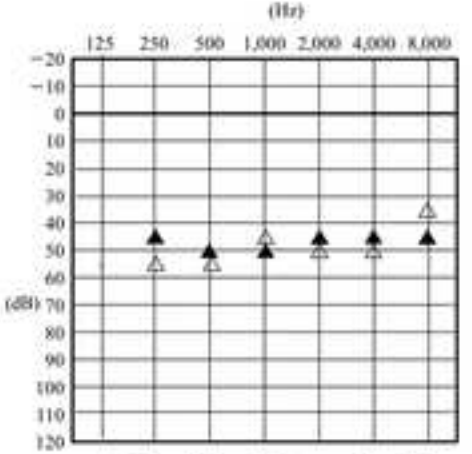
19 years old



23 years old (Pre Operation)



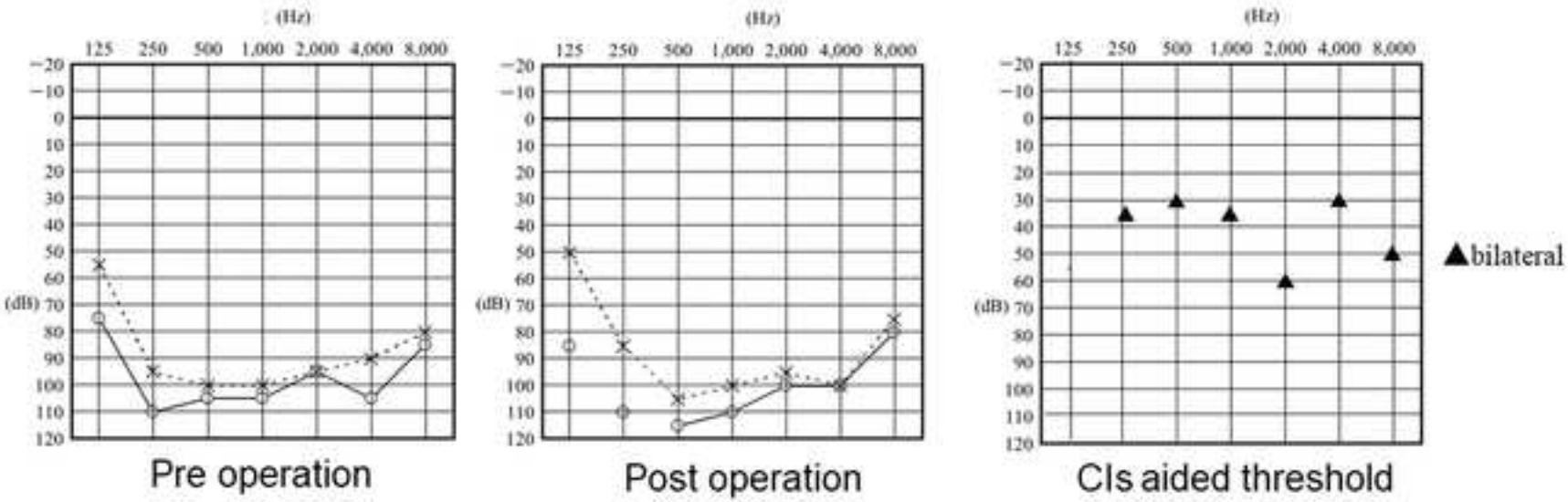
Post Operation



CIs aided threshold

▲ Right
△ Left

Figure2


(Hz)
125 250 500 1,000 2,000 4,000 8,000
−20 −10 0 10 20 30 40 50 60 (dB) 70 80 90 100 110 120
Pre operation
(Hz)
125 250 500 1,000 2,000 4,000 8,000
−20 −10 0 10 20 30 40 50 60 (dB) 70 80 90 100 110 120
Post operation
(Hz)
125 250 500 1,000 2,000 4,000 8,000
−20 −10 0 10 20 30 40 50 60 (dB) 70 80 90 100 110 120
▲bilateral
CIs aided threshold

Ethical Standards

We obtained written informed consent from each participant and each participant's guardian. A patient's anonymity was preserved.