Open Journal of
Clinical & Medical
Case Reports

Volume 7 (2021)
Issue 05

ISSN: 2379-1039

Unilateral cochlear implantation after 60 years of bilateral hearing deprivation

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Abstract

Cochlear implantation (CI) is a well-known efficient intervention for patients with severe-to-profound hearing loss, as it can lead to substantial improvement in auditory performance, speech perception and quality of life. Although long auditory deprivation is traditionally thought to affect negatively auditory performances with a CI, especially in elderly patients, in the last years an increasing number of studies has demonstrated the advantages of the CI even in this particular situation.

We report a case of an 80-year-old male patient implanted after 60 years of complete auditory deprivation. A retrospective chart review was conducted. Speech tests scores, collected during the 5 years following cochlear implantation, were analysed. The test results show a significant improvement in speech perception skills over 60 months of cochlear implant use, reinforced and supported by an intensive speech therapy program.

Strictly selected patients with post-lingual deafness could benefit from cochlear implantation, independently from their age, even after a long-term auditory deprivation.

Keywords

Cochlear implants; sensorineural hearing loss; long-term hearing deprivation; elderly.

Abbreviations

CI: cochlear implant; LTAD: long-term auditory deprivation; HA: hearing aid; CT: computed tomography; MRI: magnetic resonance imaging

Introduction

To date, the impact of long-term auditory deprivation (LTAD) on cochlear implant (CI) performances is not well established, as there are no large samples studies focused on this topic. LTAD in the ear-to-be-implanted has been traditionally depicted as a negative predictive factor for CI outcome [1-3], because the lack of auditory inputs could lead to loss of spiral ganglion cells and consequent retrograde neural degeneration and auditory cortex reorganization towards non-auditory stimuli [4,5]. However, good results could be obtained even with very low number of spiral ganglion cells [6,7], and auditory cortex plasticity is able to revert these changes, even when hearing restoration occurs after 40 years of sound deprivation [8].

LTAD can also speed up cognitive decline and increase the risk of dementia, by decreasing quality of communication leading to social isolation and depression. Rehabilitation of hearing loss, using both hearing aids (HAs) and CIs, may also have the potential to slow down cognitive decline associated with ageing [13-15].

Case Presentation

We present the case of a male patient with a history of deafness since the age of 20, as result of anti-tuberculosis medical therapy (Streptomycin). He attended a lip-reading course, never used HAs, and conducted a normal social and working life, even though he needed some assistance.

He never heard his wife's voice, listened to the radio or TV, or used a telephone. In the 90s he started the CI candidacy process, abandoned soon, and presented again in 2013, at the age of 80, after 60 years of complete bilateral auditory deprivation. Pure-tone thresholds showed no auditory sensation at 120 dB, and speech perception score was 0%. Computed tomography (CT) scan and magnetic resonance imaging (MRI) showed bilateral normal inner ear anatomy. Candidacy assessment was discussed by an interdisciplinary team, composed of otolaryngologist, speech-therapist, psychologist, anaesthesiologist and radiologist. In particular, the psychological evaluation aimed at establishing the real expectations and motivation of both patient and family.

The patient underwent a transtympanic promontory stimulation test, to study auditory-neuron function, as it is suggested in cases of LTAD. The test was performed under local anaesthesia of the tympanic membrane, by placing a needle electrode transtympanically on the promontory. Contact with the promontory was confirmed by monitoring the electrode impedance. The reference electrode was placed on the forehead. Particular attention was paid on stimulation levels, sound frequency, sequential and temporal discrimination. Stimulation rates tested were 50, 100 and 200 Hz. We collected the lowest intensity able to elicit an auditory perception (threshold or T-level), and the maximum acceptable level of stimulation nearing painful auditory perception (comfort or C-level). For the 50 Hz stimulation rate, C-level was of 12.4 μA and T-level of 18.9 μA; for the 100 Hz we found 17.1 μA and 26.3 μA; for the 200 Hz, 23.5 μA and 38.4 μA. Frequency, sequential and temporal discrimination were respectively of 85%, 60 msec and 80 msec.

These data highlighted a good peripheral and, notably, central auditory neural activity, especially

given patient's age and LTAD (Figure 1).

The patient underwent right-ear CI surgery (Neurelec, Digisonic SP), with a standard facial recess approach to the round window. Full electrode insertion was achieved. Intraoperative electrophysiological tests showed normal impedance for all the 20 electrodes and stapedial reflex was electrically elicited at basal, intermediate and apical turns. The intraoperative EABR (Eclipse system) was recorded, with wave II, III and V elicited with standard stimulation levels. Waves morphologies and latencies demonstrated a good auditory-neuron conduction, consistent with an adequate neural cell population and the preoperative promontory stimulation test (Figure 2).

No peri- or post-operative complications occurred. The CI was activated 1 month after intervention and a standard speech therapy rehabilitation program was started. CI outcome was examined basing on speech perception tests results at pre-implantation, 1, 6, 12 and 60 months post-activation (Figure 3). PCVRAR test (Protocollo Comune di Valutazione dei Risultati in Audiologia Riabilitativa) was used and speech tests included disyllabic words and sentences recognition test, and comprehension test (questions items). Speech tests were conducted with natural voice and a signal/noise ratio of +15 dB, with a 65 dB sound presented frontally, and noise coming from backward, at 1 metre distance. Tests with recorded voice resulted in much worse results: 30% words discrimination at 65 dB (the patient never listened to recorded voice in his 20-years-long «hearing life»).

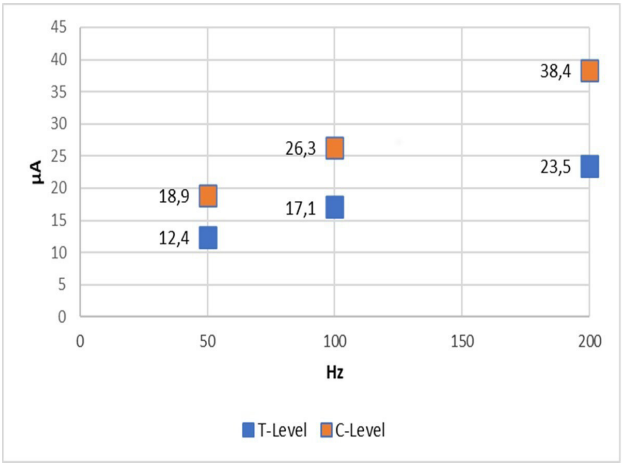

Figure 1: T - Level and C - Level scores at the frequencies of stimulation of 50, 100 and 200 Hz.

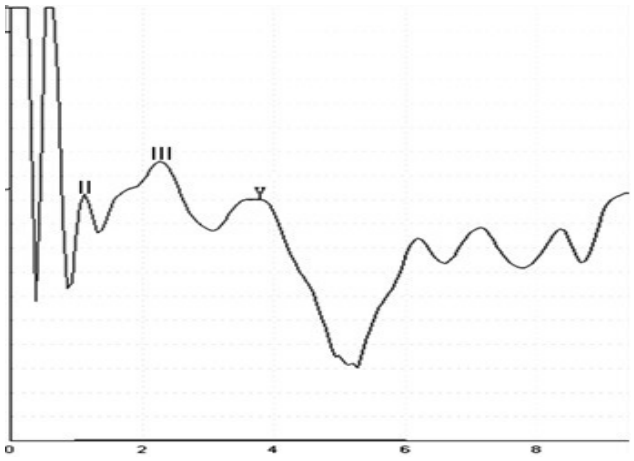

Figure 2: Intraoperative EABR.

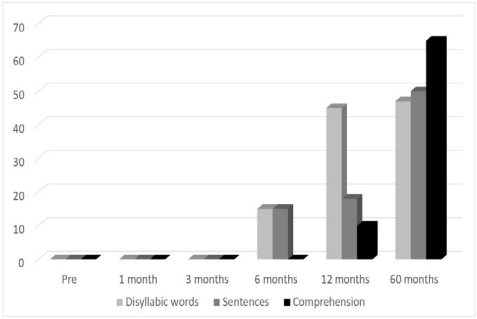

Figure 3: Graphic representation of speech tests results evolution with time.

Discussion

When patient's device was activated, stimulation levels map showed a narrow electrical dynamic range, as it happens in cases of LTAD. This finding is consistent with the previous promontory stimulation test and can be linked to auditory cortex degeneration, especially in the primary auditory area, occurring over time in absence of acoustic stimuli. In this situation, individualization of mapping and rehabilitation is of utmost importance for acoustic elaboration, sound and verbal comprehension, and can significantly influence CI outcomes. Speech understanding is tightly correlated with acoustic compression, influenced itself by CI dynamic range. In fact, as it is shown in Figure 3, the patient did not obtain any kind of auditory result until the 6th month follow-up, representing the time for the brain to re-adjust (neural plasticity) and learn how to effectively decode and elaborate the electrical input.

Disyllabic words recognition results continuously improved through the 1st year after activation; then the performances, apart from mild fluctuations depending mainly on training sessions frequency, remained stable with time. Conversely, sentences recognition and comprehension scores increased poorly and slowly during the 1st year, and then progressively improved (Figure 3). During ordinary daily life, the patient became more independent in managing his personal activities and gained even the ability to entertain simple conversations on the phone, limited to common use questions and familiar voices (mainly his wife).

These results are the effect of continual accurate fitting sessions, which he attended twice a week for the first 18 months, weekly for other 6 months, then monthly. Such a kind of schedule was needed because of the LTAD, and every prolonged interruption of the training session negatively impacted on performances. In addition, it must be considered that, being an 80-years-old patient, a hypothetical mild cognitive impairment could have already occurred, playing a role in final performances.

Conclusion

Bilateral LTAD usually negatively affects CI performances; however, it should not be always considered detrimental towards surgical indications, because a carefully selected group of these patients, even among the elderly population, can benefit from CI intervention.

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Manuscript Information: Received: March 08, 2021; Accepted: May 07, 2021; Published: May 17, 2021

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Citation: Guida M, Donati G, Negri M, Benincasa P, Falcioni M. Unilateral cochlear implantation after 60 years of bilateral hearing deprivation. Open J Clin Med Case Rep. 2021; 1747.