Cochlear implantation for single-sided deafness and asymmetric hearing loss

BY RICHARD M IRVING, RAGHU NANDHAN SAMPATH KUMAR

Continuing our sub-theme of cochlear implantation candidacy, **Richard Irving** and **Raghu Kumar** review the principles and benefits of cochlear implantation in individuals who have an asymmetric hearing loss. It is well known that cochlear implantation improves auditory capacity, and in this group of patients, there is an increasing body of evidence demonstrating tinnitus suppression and improved quality of life after cochlear implantation.

Rapid advances in cochlear implantation (CI) over the past decade has mirrored an expanding spectrum for candidacy worldwide. This includes a group of individuals with asymmetrical hearing loss (AHL) who have varying degrees of difference in their hearing capacity between the two ears. One extreme of AHL is single-sided deafness (SSD) where one ear has normal hearing, while the other is profoundly deaf. At the other end of this spectrum are individuals who have one profoundly deaf ear and struggle to use hearing aids in their better ear which is severely deafened and lies at the borderline of maximal conventional amplification. Currently these groups are not included in mainstream candidacy criteria for offering CI in many centres around the world. This article briefly reviews the benefits of CI in such individuals.

Single sided deafness (SSD)

SSD can result from a variety of etiologies including inner ear malformations, meningitis, temporal bone trauma, ear surgery and CPA tumours. Individuals suffering from SSD describe a pronounced 'head-shadow effect' which requires the individual to constantly adjust their head position in an attempt to hear on the affected side. This effect is more pronounced for high frequency sounds and affected individuals experience particular difficulty in speech processing and sound localisation. In SSD higher order binaural sound processing is also lost resulting in impairment of summation and squelch, producing additional difficulties for speech discrimination in noise [1]. Some affected individuals are so profoundly disabled that their SSD leads to social isolation and depression.

The traditional approach to auditory rehabilitation in SSD involves routing the sound signal to the good side with either CROS aids or bone conduction implants. These do not restore a binaural signal but can overcome some of the associated disability by placing a sound sensor on the deaf side. Cochlear implants have the potential to restore some binaural hearing, not possible with other technologies, but require the brain to integrate electric and acoustic stimuli.

CI in SSD provides binaural-bimodal hearing, which is acoustic in the normal ear and CI-aided electrical stimuli on the side of SSD [1]. Recent literature has produced evidence to support tangible benefits of CI in SSD including improved spatial orientation, squelch, temporal summation and music appreciation. Arndt et al. reported an improvement in speech perception in noise when CI is compared to CROS except when the noise was directed head on, when there was no significant difference [2]. Vlastarakos in a review of 27 studies evaluating the outcome of CI in SSD noted improvements in sound localisation

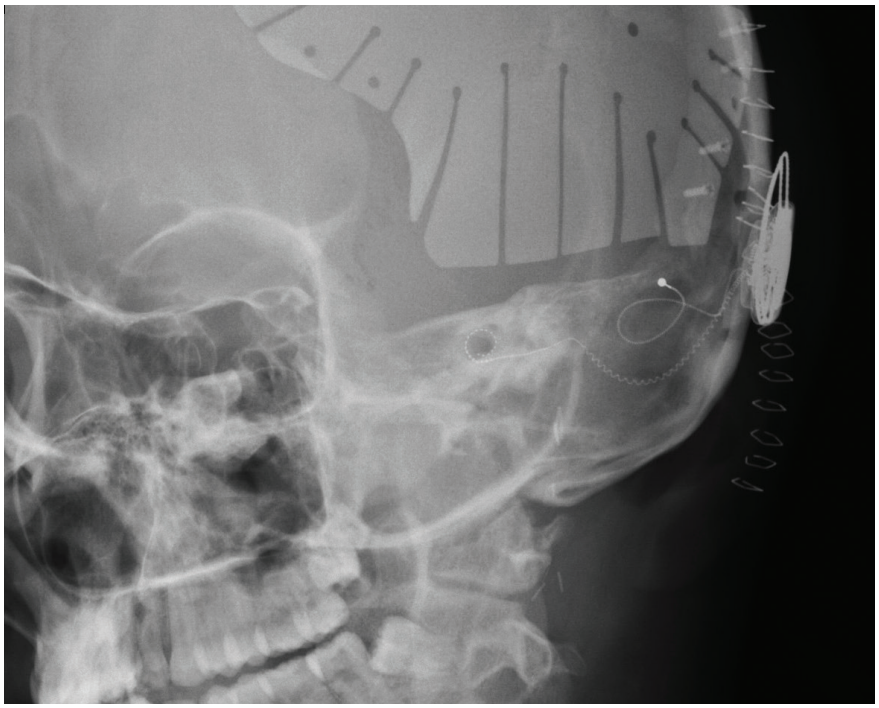

Figure I. Postoperative plain X-ray of a case of SSD secondary to trauma. Hearing in the left ear was lost as a result of a gunshot injury, contralateral hearing was normal. The patient underwent emergency decompressive craniectomy and then three months later simultaneous cranioplasy and cochlear implantation. The image shows a full insertion of the electrode and the CI body placed low, below the cranioplasty plate.

and speech discrimination [3]. Studies have also reported favourable results for tinnitus suppression with cochlear implants in SSD [4].

Asymmetric hearing loss (AHL)

AHL candidates are profoundly deaf in one ear and have hearing loss in their better ear ranging between 30dBHL to 90dBHL across speech frequencies. These individuals describe considerable disability as a result of their hearing loss despite optimal use of amplification aids. They however lie outside the recommended criteria of 90dB at 2 and 4 KHz, despite their BKB scores in noise often falling below 50% [1].

Individuals with severe high frequency hearing loss may not gain significant benefit from conventional hearing amplification. The possible reason for this lack of benefit is the presence of cochlear dead regions, which are more common with thresholds above 70 dB HL. Also, the high levels required to render high-frequency speech audible may in fact degrade the acoustic signals in these individuals. Individuals with AHL experience significant difficulty in everyday communication, particularly in noisy backgrounds, where low-frequency amplification alone is not sufficient to allow high levels of speech understanding [6].

Adults with AHL who are struggling with acoustic aids but are outside CI criteria often resort to lip reading or sign language and are required to wait until their hearing deteriorates before being accepted for a CI [6]. Young children with asymmetrical hearing loss may qualify for a CI under existing guidelines if they fail to make progress with their speech and language development [3].

After receiving CI in their poorer ear, AHL candidates perceive sounds through bimodal binaural hearing using both CI and hearing aid together. This method of bi-modal (electrical + acoustic) binaural stimulation provides better sound localisation and speech discrimination in noise improving their communication skills and quality of life [2].

Unlike in the SSD group, the benefits in AHL have been observed largely due to the CI input which predominated when compared with the hearing aid [5]. It is however often a challenge especially in children to programme the implant synchronously to match the contralateral hearing aid use. There are issues with defining optimal habilitation techniques and predicting outcomes for such candidates, since they need to get accustomed to receiving the bimodal combined psychophysical signals in their auditory cortex [7].

Conclusion

An evidence base is emerging to support the use of CI in individuals with SSD and AHL. Reported benefits include improvement in auditory capacity, tinnitus suppression and improved quality of life. The future goal is to determine the degree of benefit and cost effectiveness of CI in SSD and AHL, further to define the population who are likely to derive significant benefit from CI, and push to have this acknowledged within a more flexible approach to candidacy.

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