

Cochlear implant. Histopathological guide to indications and contraindications: A post mortem study on temporal bones

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Abstract. – We have studied the temporal bones of 4 deceased donors, individuals one with cochlear saccular degeneration, another with Mondini displasia, another with an ossification of the basal turn of the cochlea and the round window, *post meningitis* and the fourth who was implanted 10 years before. The indications and contraindications for cochlear implant placement are discussed.

Key Words:

Cochlear implant, Histology, Temporal bone, Congenital anomalies, Hearing loss, Surgery.

Introduction

Although the first attempt to electrically stimulate the auditory system occurred nearly two centuries ago, the development of a cochlear prostheses to restore hearing to patients with sensorineural hearing loss has happened only recently¹⁻⁸.

Some basic requirements are always observed:

- bilateral profound-to-total sensorineural hearing loss (three-frequency average 500-1000-2000 Hz)
- pure tone audiometric threshold in the better ear equal to or greater than 95 dB
- unable to benefit or insufficient benefits from conventional hearing aids
- good psychological and physical health
- motivation and consistency in attending a rehabilitation program

In *children*, these requirements must also be fulfilled by the parents or guardians.

The following *audiological tests* are performed in *adults*:

- unaided and aided warble tone
- speech detection thresholds
- speech discrimination test
- environmental sound tests

Performance in the weaker ear with appropriate, powerful hearing aids is compared to that of the patient with a cochlear implant (see selection criteria). Recruitment and discomfort are also taken into account⁶⁻⁸.

Children must fulfill the same criteria as adults. There are also more specific requirements:

- tympanometry rules out otitis media with effusion
- behavioral-audiometry or play-audiometry is used

The child must have used an appropriate hearing aid for at least 6 months, with inadequate results¹².

Potential candidate for a cochlear implant:

- unable to obtain aided speech detection threshold of 70 dB SPL and hearing level of approx. 53 dB HL or better
- poor performance on the discrimination test with conventional amplification, with scores of less than 10% on the W-22 word list

Electrical stimulation test at either the promontory or the round window membrane is not critical in candidate selection. It is often useful, however, to reassure the patient that hearing can be restored in the other ear¹³.

Materials and Methods

We have studied the histopathological changes in the temporal bones of 4 deceased individuals, one with cochlear-saccular degeneration, another with Mondini dysplasia, another with an ossification of the basal turn of the cochlea and the fourth patient who was implanted 10 years before.

These patients were donors and agreed during their life to donate post mortem their temporal bones to the House Ear Institute Los Angeles, CA, USA as a contribution to a better knowledge of temporal bone diseases.

We have removed the temporal bones in our usual way¹⁴.

Results and Discussion

There are general criteria for implantation. We have researched in our study on temporal bone, the anatomic indications and contraindications for cochlear implant placement.

Physical and radiological evaluation

Any active infection of the external and/or middle ear or eardrum perforations must be treated before inserting a cochlear implant.

High resolution computed tomography may demonstrate:

- agenesis of the cochlea: absolute contraindication
- reduction of IAC diameter (1-2 mm) is synonym of acoustic nerve aplasia: absolute contraindication¹⁵.
- fibrous and/or osseous occlusion of the cochlea: relative contraindication.

The outcome may be poorer than normal because of partial insertion of the electrode array¹⁶. The use of both Gd-enhanced T1-weighted MR images and additional gradient-echo images (0.7 mm thick) enables a certain definition of the extent of cochlear fibrosis. The high signal intralabyrinthine fluid is replaced by the low signal fibrous tissue¹⁷.

In our temporal bones we have found a cochlear hypoplasia (Mondini's deformity) that we feel is not a contraindication to im-



Figure 1. Mondini dysplasia. Interscalar septa are missing between the apical and middle turns (arrows). $\times 15$.

plantation. In fact the *interscalar septa* are missing between the apical and middle turns but the operation is feasible¹⁸ (Figure 1).

Another individual had a cochlear-saccular degeneration (Sheibe deformity) which proved to be an absolute contraindication to the implant (Figure 2). In the Figure 2 is visible that the organ of Corti is represented by a clump of cells and that there are no dendrites in the osseous *spiral lamina*¹⁹.

A third individual had an ossification of the basal turn of the cochlea and the round window area *post meningitis* (Figure 3). In many cases meningitis ossificate just the round window area and is not a contraindication to cochlear implant, but in this case the complete ossification of the basal turn of the cochlea represent

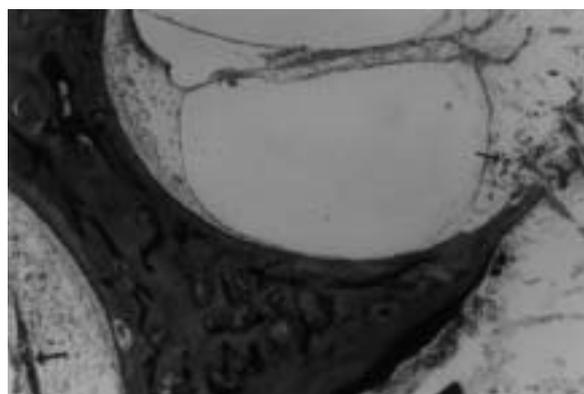


Figure 2. Cochlear saccular degeneration (Sheibe deformity). The organ of Corti is represented by a clump of cells. There are no dendrites in the osseous spiral lamina. The saccular macula has degenerated (large arrow). Some ganglion cells remain (small arrow). $\times 56$.

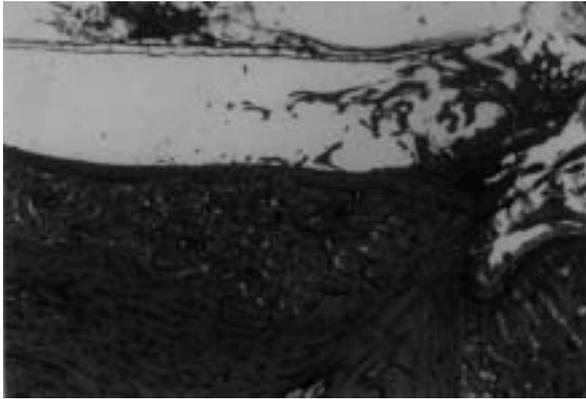


Figure 3. Ossification of the basal turn of the cochlea and the round window area postmeningitis. $\times 30$.

an absolute contraindication; the electrode could not be inserted along the cochlea²⁰⁻²².

A fourth individual had a previous implant. It is visible that the implant has not provoked any significant alteration (Figure 4).

Conclusion

- 1) Cochlear implants are not experimental
- 2) Cochlear implants are not hearing aids
- 3) Appropriate candidates have profound bilateral sensorineural hearing loss and do not benefit from conventional amplification

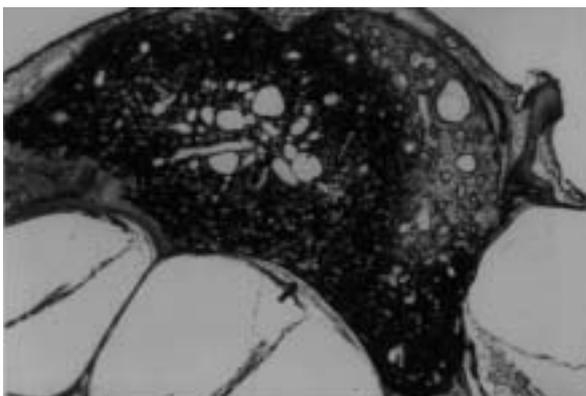


Figure 4. Fibrosis (1) and ossification (2) occurring in the basal turn of the round window area in a cochlear implant patient. The path of the electrode is visible at (3). The organ of Corti and basilar membrane have disappeared adjacent to the electrode path (4). The osseous spiral lamina is still present (5). $\times 46$.

- 4) Surgical and postoperative complications have been minimal²³⁻²⁵.
- 5) Implants increase auditory abilities and, as a result, improve speech production skills
- 6) Postlingually deafened adults with a short duration of deafness are excellent candidates for a cochlear implant²⁶.
- 7) Although postlingually deafened children in aural rehabilitation programs demonstrate the fastest and greatest development of auditory skills as a group, congenitally and prelingually deafened children show substantial benefit from a cochlear implant²⁷⁻³⁰.
- 8) Complete physical and radiological evaluation must be ruled out before any attempt of surgery. Complete agenesis of the cochlea and an abnormal acoustic nerve, the result of either congenital malformation, trauma or surgery, are contraindications for cochlear implant placement.

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