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Original Article

Surgical Results and Complications of Cochlear Implantation in Far–Advanced Otosclerosis

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OBJECTIVE: To report surgical results and complications of cochlear implantation in patients with far-advanced otosclerosis (FAO).

MATERIALS and METHODS: This was a retrospective chart review of surgical results in terms of electrode insertion as well as peri- and postoperative complications. Ten cochlear implantations (CIs) were performed in eight patients with FAO. A prior stapedotomy had been performed in all cases.

RESULTS: Full electrode insertion was achieved in nine of the 10 operations (90%) and partial insertion in one operation. An unintended opening of the vestibule during drilling was the only perioperative complication. Postoperative complications occurred as two cases of vertigo (one prolonged). No chorda tympani syndrome and no cases of facial nerve stimulation were noted.

CONCLUSION: Although based on a limited number of cases, we conclude that full electrode insertion can be achieved in almost all cases and that major complications are infrequent in CI in patients with FAO. Postoperative vertigo appears to be the most commonly occurring complication.

KEYWORDS: Hearing loss, vertigo, surgery, postoperative complications

INTRODUCTION

Otosclerosis is a localized, complex temporal bone remodeling abnormality in which osteospongiosis causes progressive replacement of the normal perilabyrinthine bone with an otosclerotic bone (Figure 1). Depending on the site and extension of the lesion, the disease causes either a conductive, sensorineural, or combined hearing loss [1-3].

Far-advanced otosclerosis (FAO) is defined as a sensorineural hearing loss presenting air-conduction thresholds exceeding 85 dB, whereas very FAO describes a condition with undetectable air and bone conduction thresholds [4-6].

Stapedotomy or/and a conventional hearing aid remains the first line of treatment of FAO and has proven to be effective in 60%-80% of FAO patients [6]. In cases where this treatment is inadequate, cochlear implantation (CI) is considered the best available option [3, 6-8]. Although based on a small case series, it has been reported that CI in FAO may be associated with a variety of challenges both during and after surgery [7, 9-11]. Thus, to contribute to the literature, this study presents the surgical results of CI using successful electrode insertion in FAO at our tertiary referral center. In addition, the peri- and postoperative complications are reported.

MATERIALS and METHODS

A retrospective review was performed of the medical records of all patients with FAO who underwent CIs at our tertiary referral center, which is the only CI center in the region, covering 2.6 million inhabitants and handling the follow-up and complications of all individuals with CI in the region. This study was conducted in accordance with the Helsinki Declaration. Informed consent and ethics committee approval were not applicable, as the study was based on only a retrospective patient file review.

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During the period 1982-2014, 777 patients had received one or two cochlear implants. Of these, eight patients had been diagnosed with FAO and 10 CIs had been performed in these individuals.

Data on age, gender, prior treatment, age at implantation, surgical result (electrode insertion), intraoperative incidents, and postoperative complications, as well as postoperative imaging for electrode placement were retrieved from individual patient files.

Postoperative complications were grouped into "major" and "minor" according to the criteria proposed by Hansen et al. [7].

Major complications include a significant medical problem (e.g., meningitis), the need for additional major surgery in general anesthesia (e.g., cholesteatoma or explantation/re-implantation of the device), or any degree of permanent disability (e.g., permanent facial nerve paresis or disabling vertigo >6 months).

Minor complications are defined as events that can lead to extended hospitalization or treatment on an outpatient clinic basis, i.e., complications that are resolved spontaneously or managed by a simple minor surgical procedure, typically including transient vertigo, local infection treated by antibiotics, or aspiration of a hematoma.

The eight patients included five men (62.5%) and three (37.5%) women. Two patients were operated bilaterally (sequentially), yielding 10 implanted ears. The patients had either FAO or very FAO. All patients had a long history of progressive hearing loss and were postlingually deafened. All patients except one presented preoperative speech reception thresholds (SRT) above 85 dB. The discrimination scores ranged between 0%-85%, with a mean (±standard deviation [SD]) of 11.8±21.2%. All eight patients were previously stapedotomized, with five cases (62.5%) of bilateral stapedectomy. The patients were elected for CI surgery since all patients had a nonserviceable hearing despite stapedectomy. Four patients experienced vertigo prior to surgery. A preoperative computed tomography (CT) to evaluate the otic capsule and osseous abnormalities was performed in all cases (Figure 1). The mean age (±SD) at CI was 70.9±9.0 years.

In all cases, CI had been performed by the standard procedure and approach, through a retroauricular incision, mastoidectomy, posterior tympanotomy, and cochleostomy, using Nucleus® devices in nine implantations (one 24 Contour, four Freedom Contour, two Freedom Contour Advance, and two 512) and an Advanced Bionics® (Mid scale) device in one case.

Data Analysis

GraphPad Prism 7.0 for Mac OS X, GraphPad Software, San Diego California USA, was applied for data analyses.

RESULTS

Electrode Insertion

Full electrode insertion was achieved in nine ears (90%). In one case, only partial electrode insertion was possible, as 12 of 22 electrodes could be inserted. Ten extracochlear electrodes were confirmed by postoperative X-ray and CT (Figure 2).

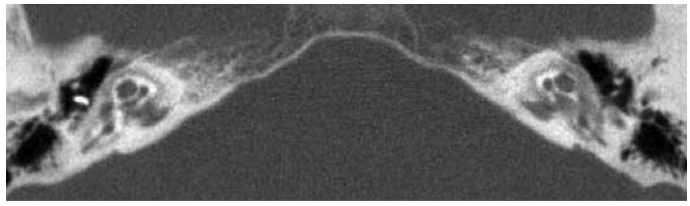

Figure 1. CT scan of bilateral FAO showing characteristic halo sign due to pericochlear hypo-ossification. Anatomical architecture around the cochlea remains. A stapes prosthesis (right) from previous surgery can be seen
FAO: far-advanced otosclerosis; CT: computed tomography

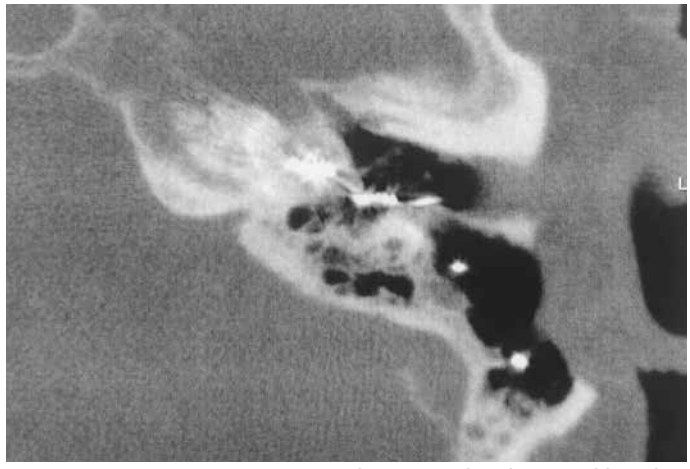

Figure 2. A postoperative CT scan revealing 10 misplaced extracochlear electrodes. The cochlear array is inserted in the basal part of cochlea
CT: computed tomography

Complications Overall

Three complications occurred in two implantations (30% of implantations, 25% of patients): one perioperative and two postoperative.

Perioperative Complications

During the cochleostomy procedure and drilling of the otosclerotic bone around the round and oval window niche, an unintentional opening of the vestibule occurred in one case (classified as a minor complication). The defect toward the vestibule was repaired with fascia and bone paté.

Facial nerve stimulation (FNS) did not occur in any case during perioperative (or postoperative) implant electrode testing.

Postoperative Complications

The patient with a vestibule lesion during surgery (see above) experienced postoperative vertigo for several months, regressing with time, but lasting >6 months (thus classified as a major complication).

Another patient experienced severe vertigo immediately after surgery, and irritation nystagmus toward the operated ear was observed. The day after surgery, the vertigo increased in intensity and was accompanied by vomiting and ipsilateral otalgia. The nystagmus was now directed toward the contralateral ear. During the following 3 weeks, the vertigo regressed and the nystagmus disappeared (thus classified as a minor complication). Three years later, the patient was implanted contralaterally without vertigo complaints.

No patient experienced facial nerve paresis after surgery and no FNS occurred at processor switch-on or thereafter. No chorda tympani syndrome was reported.

DISCUSSION

Even though our center has an uptake area of 2.6 million inhabitants and is the largest CI center in the country, the case series was small compared to other CI centers worldwide. Thus, FAO is a relatively rare indication for CI, and the limited number of patients emphasizes the value of adding experiences between centers.

Electrode insertion difficulty in FAO is well known and can be caused by cochlear ossification or pericochlear hypodense foci leading to incorrect placement or incomplete insertion of the electrode array [9, 12] (Figure 2). In our case series, one implantation (10%) resulted in partial insertion (10%), with 10 electrodes located outside the cochlea. A thorough examination of the occurring anatomy and pathology on the preoperative CT, optionally magnetic resonance imaging, should be routinely performed to optimize orientation during surgery and limit the risk of perioperative complications [9, 13].

Among our patients, two experienced three complications in relation to the 10 surgeries performed (25% of patients, 30% of implantations). One of the three complications was major, as vertigo/dizziness lasted for >6 months (10% of operations); the remaining two complications were minor (20% of operations). Of these, the minor complication of accidental opening of the vestibule during surgery was directly associated with the major complication of prolonged postoperative vertigo/dizziness.

Vertigo is a common complication of CI [7, 11, 14]. Consistent with otosclerosis as a recognized cause of vestibular complaints, four patients experienced vertigo prior to the surgery [14, 15]. However, two patients had postoperative vertigo, which was clearly related to the surgery, one of which was due an unintentional lesion of the vestibule during the operation. The operation-related vertigo subsided during the following weeks in both cases. However, one of the patients had residual dizziness (not related to surgery) for >6 months after the operation. FNS occurs when the electrode current stimulates the labyrinthine portion of the facial nerve, and this is not an unusual occurrence in patients implanted for otosclerosis [8, 9, 11, 16]. The higher incidence of FNS in otosclerosis may be caused by a dysplastic bone between the cochlea and facial nerve canal allowing the current to escape the otic capsule [17]. Previous estimates range from 0%-75% of otosclerosis patients [6, 9-11, 16-18]. FNS may depend on the implanted device as the perimodiolar array leads less current laterally [6, 17, 18]. Although the complete absence of FNS among our patients is noticeable, an explanation could be the precurved feature that characterizes all the implanted devices.

Chorda tympani syndrome is characterized by gustatory changes, in some cases associated with unilateral sweating of the submental region [19]. No chorda tympani syndrome cases were encountered in the present case series. This was also somewhat unexpected, since it is reportedly a frequent condition [7]. However, the presently reported complication rate should take the inherent limitations of a retrospective case file study into account, as some less serious complications, such as the chorda tympani syndrome, may be underreported.

CONCLUSION

Although based on a limited number of cases, we conclude that full electrode insertion can be achieved in almost all cases and that major complications are infrequent in CI in patients with FAO. Postoperative vertigo appears to be the most commonly occurring complication.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013).

Informed Consent: Informed consent is not necessary due to the retrospective nature of this study.

Peer-review: Externally peer-reviewed.

Author contributions: Concept - N.W., M.B., P.C.T.; Design - N.W., M.B., P.C.T.; Supervision - S.F., P.C.T.; Resource - P.C.T.; Materials - P.C.T.; Data Collection and/or Processing - N.W., M.B., S.F., P.C.T.; Analysis and/or Interpretation - N.W., M.B., P.C.T.; Literature Search - N.W., M.B., P.C.T.; Writing - N.W., M.B., S.F.,P.C.T.; Critical Reviews - S.F., P.C.T.

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