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Main Articles

Cochlear implantation in chronic otitis media

A. Incesulu, M.D., S. Kocaturk, M.D., M. Vural, M.Sc.

Abstract

Patients with chronic otitis media (COM) may have profound sensorineural hearing loss either due to the disease process or secondary to a surgical procedure. Some patients who are candidates for cochlear implantation may have COM coincidentally. The patients in this group need special attention when cochlear implantation is applied. The aim of this study is to evaluate the potential risks and complications in patients with COM.

Cochlear implantation was performed in six patients with COM or an infected radical cavity and profound hearing loss. Five of them underwent a two-stage operation, and one had a single-stage operation. Cochlear implantation was performed in all patients without complications. The follow-up period was uneventful.

Although such patients have some potential risks, when certain surgical rules are followed very strictly cochlear implantation can be successfully performed in patients with COM.

Key words: Cochlear Implantation; Otitis Media

Introduction

Chronic otitis media is a common otological problem in our country, as it is in other developing countries. Although the exact incidence of sensorineural hearing loss (SNHL) in COM patients is unknown, patients may have profound sensorineural hearing loss due to COM or a surgical procedure. Sensorineural hearing loss can occur as a secondary effect from serous or suppurative labyrinthitis, labyrinthine fistula, or cholesteatoma invading the labyrinth.[1] Interestingly, in some cases there may not be an obvious reason. Suppurative labyrinthitis is manifested by partial or complete permanent loss of hearing and vestibular function. Consequently, patients with COM and sensorineural hearing loss may be considered candidates for cochlear implantation. Moreover, some candidates for cochlear implantation may have COM coincidentally. All these groups present potential problems when cochlear implantation is considered. If suppurative labyrinthitis results in fibrosis and new bone formation (labyrinthitis ossificans), cochlear implantation becomes more complicated. Furthermore, insertion of the foreign body into an infected cavity could increase the risk of intracranial spread of infection via the cochleostomy, and of extrusion of the device. In addition to these problems, post-operative follow-up should be meticulous.

Patients and methods

Between April 1999 and June 2003 a total of 128 patients received cochlear implants in the cochlear implant centre at the SSK Ankara Hospital, 2nd ENT Clinic, Ankara, Turkey. Of these, six were found to have operated or unoperated COM. All of them were postlingual adult patients and had bilateral disease. The age of the patients at cochlear implantation ranged from 35 to 55, with a mean of 42.50 ± 12.43 years. Patients' demographic data are presented in Table I.

Preoperative evaluation included otolaryngologic examination, high-resolution computerized tomography (CT) for all patients, and magnetic resonance imaging (MRI) in selected patients. Pure-tone audiometry with and without hearing aids was performed preoperatively. Pure-tone audiometry at frequencies from 250 to 4000 Hz and speech audiometry were carried out in the first, sixth and 12th months after the first programming in all patients. Patients' otologic profiles are summarized in Table II. Patient 1 had active chronic otitis media without cholesteatoma. An intact canal wall tympanoplasty

From the 2nd ENT Clinic, SSK Ankara Hospital, Ankara, Turkey.
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TABLE I
PATIENTS' DEMOGRAPHIC DATA

Patient No.	Gender	Age	OofD (yrs)	DofD (yrs)	Side	Insertion depth
1	M	55	48	7	L	Full
2	F	42	34	8	L	Full
3	F	59	9	50	R	Full
4	F	36	28	8	R	Full
5	M	37	29	8	L	Full
6	F	26	18	8	R	Full

OofD, onset of deafness, DofD, duration of deafness

was performed without complications. During the operation new bone formation was encountered on the promontory and oval window niche. At the second stage, a year later, a cochlear implant was inserted using the previous posterior tympanotomy opening without difficulty. The cochleostomy opening was sealed with muscle tissue. So far the patient has done well, and he is now able to use a telephone with family members. By the end of the 12th month the patient had scored 92 per cent in three-syllable and 60 per cent in monosyllable word tests without lip-reading.

Patient 2 had had a tympanoplasty 15 years previously. She presented with an intact tympanic membrane with an effusion. A ventilating tube was inserted at the first stage of operation. After three months, cochlear implantation was performed without complications. At the end of the operation the ventilating tube was removed and fat graft was used to treat the tympanic membrane opening. The postoperative course was uneventful and she scored 80 per cent in three-syllable word test without lip-reading in open set conditions.

Patients 3, 4 and 5 presented with previous infected mastoid cavities. In the first operation, the following steps were carried out. A standard mastoidectomy incision was created just posterior to the postauricular crease, and when the mastoidectomy cavity was reached the whole mucosal lining was removed. In one case a pearl of cholesteatoma was found. Radical mastoidectomy was performed and the fascial ridge was lowered to allow optimal access to the round window niche. During the mastoidectomy the infralabyrinthine and peritubal cell tract were removed carefully, as well as other cell tracts. The eustachian tube opening was closed with pieces of muscle and bone pate. The mastoid cavity was obliterated with an autologous free abdominal fat graft. Following this, the external auditory canal was closed as a blind sac. In patients 3 and 4, six to 12 months later a second-look operation and cochlear implantation were performed. After extended postauricular skin incision, the flap of skin and subcutaneous tissue were elevated. An inferiorly based flap of periosteum and fascia was formed and dissected. The fat graft was found to be encapsulated with fibrous tissue and was elevated from the promontory without difficulty. In patient 3, who had meningitis due to COM at the age of nine, new bone growth around the round window niche was encountered. Because of this, identification of the round window niche was more difficult than normal. Using other anatomical landmarks, cochleostomy and implantation were performed. The cochleostomy opening was sealed with muscle tissue and bone pate. The follow-up period was uneventful. The patient had had a long duration of deafness (50 years). After programming, her lip-reading ability improved and she was able to communicate with people both well known and strangers. However, her discrimination score was relatively low (44 per cent in three-syllable word test) and she had great difficulty in a noisy environment.

The next patient had a short duration of deafness. She reported that the result had exceeded her expectation in the first three months after the programming. Her discrimination score was 88 per cent in the three-syllable word test without lip-reading. She enjoyed listening to familiar songs.

An infection and fat necrosis occurred in a patient with otitis media due to measles after the first obliteration with fat graft (patient 5). Moreover, he had an allergy to the topical medication. Six months later another obliteration attempt was tried using abdominal fat. Three months after this operation, although the external auditory canal closure looked perfect, there was inadequate sealing in the mastoid cavity and middle ear on the CT scan (Figure 1). As

TABLE II
PATIENTS' OTOLOGIC PROFILES

Patient no.	Preoperative otological findings	Procedure in the first stage
1	COM without cholesteatoma	ICWT
2	Chronic EOM	VT insertion
3	Infected radical cavity	Revision mastoidectomy + obliteration + blind sac closure of external auditory canal
4	Infected radical cavity	Revision mastoidectomy + obliteration + blind sac closure of external auditory canal
5	Infected radical cavity	Revision mastoidectomy + obliteration + blind sac closure of external auditory canal in two operations
6	Inactive COM	–

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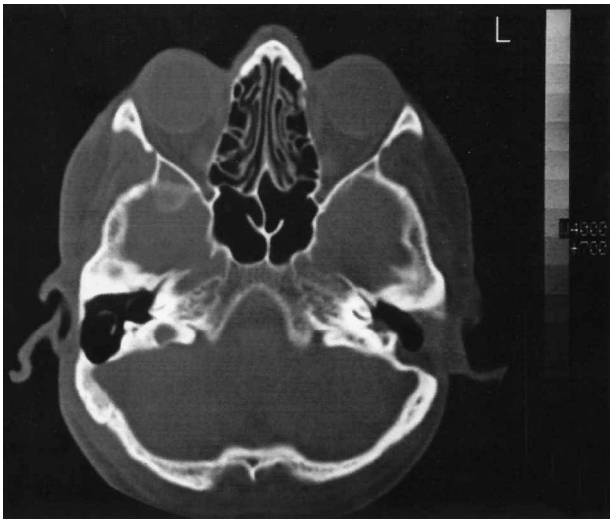

FIG. 1
Inadequate sealing in the mastoid cavity and middle ear on the left side after the first attempt at cavity obliteration.

the patient had some problems communicating with his wife owing to his hearing loss, and there were no signs of infection on the CT scan, cochlear implantation and re-obliteration were planned in the same operation. After the extended postauricular incision a randomized temporal muscle flap was prepared. Elevation of the residual fat graft revealed an infection-free mastoid cavity and middle ear. Cochlear implantation was performed without difficulty and the cavity was obliterated with residual fat tissue and a pedicled temporal muscle flap. His post-operative Stenver's view can be seen in Figure 2. The post-operative period and nine-month follow-up period were uneventful. After three months from the first programming, his discrimination scores were 100 per cent in three-syllable and 72 per cent in monosyllable word tests. His relationship with his wife had improved.

Patient 6 had bilateral tympanosclerosis. She had had a previous unsuccessful myringoplasty in the left ear and an unsuccessful tympanoplasty in the right ear. The left ear was chosen for implantation, and in the first stage myringoplasty was performed. Six months later the graft was intact and the cochlear implantation was planned at the second stage. Although preoperative CT and MRI scans showed an open cochlea, the lumen was not found at surgery. This condition was discussed with family members and a decision was made to perform an implantation on the other side at another session. The right ear had dry perforation with tympanosclerosis. Because she was studying for a master's degree she did not wish to wait for a two-stage operation, and so as she had inactive COM we decided on a single-stage procedure. Therefore, subtotal petrosectomy, eustachian tube obliteration, external auditory canal obliteration, cochlear implantation and cavity obliteration with a free abdominal fat graft were performed without difficulty in the same stage. Her follow-up was unremarkable. She did very well and scored 92 per cent in the three-syllable word test six months later.

FIG. 2
Postoperative Stenver's view of patient 5.

The mean follow-up period was 24.16 ± 7.6 months (range 17–39) after implantation. No complications occurred.

Discussion

COM can produce cochlear damage resulting in sensorineural hearing loss. Several theories have been put forward to explain the mechanism of SNHL. Potentially ototoxic bacterial endotoxins[2] and exotoxins,[3] and local treatment agents have been reported to cause inner ear damage. Moreover, meningitis due to COM could be a reason for severe SNHL. Another is surgery for COM. SNHL may result from either iatrogenic fistulization of the labyrinth or from attempts to remove pathologic tissue from over the previous fistula. The incidence of post-operative profound SNHL has been reported to be in the 3.3–56 per cent range.[4–6] Apart from being the cause of SNHL, COM can be an incidental finding in some candidates for cochlear implantation. The management and assessment of the appropriate surgical procedure for this group of patients can be very complex and depends on the classification of COM.

COM can be found either in an active form, which is with or without cholesteatoma, or in an inactive form. Furthermore, the presence of a previous mastoid cavity, either healthy or infected, makes the surgical procedure more complicated.

If there is active infection, a two-stage operation should be performed. In the first stage, all the cells in the mastoid bone and middle ear must be opened. Blind sac closure of the external auditory canal provides isolation from the environment. The procedure is completed with closure of the eustachian tube and cavity obliteration. Several obliteration materials, such as autologous abdominal fat graft, bone pate, hydroxyapatite and tricalcium phosphate, cartilage and temporalis muscle, may be used in the cavity. Bone pate, hydroxyapatite and tricalcium phosphate may turn into solid bone; the surgeon may therefore have to drill before cochlear implantation at the second stage of the operation.[7]

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Among the various materials used for obliteration, autologous abdominal fat graft and temporalis muscle are the most common. Autologous abdominal fat is easily obtained in large amounts; moreover, it usually resists necrosis. Although there was fat necrosis in one of our patients, we still recommend using abdominal fat graft at the first-stage operation. At the second stage the fat graft was found well capsulated in all cases and could be elevated very easily. The second option for obliteration is temporalis muscle. In the case with fat necrosis a pedicled temporal muscle flap was used to cover residual fat tissue. During the 24 months follow-up period the ear was stable and trouble free.

- **Patients with chronic otitis media (COM) may have profound sensorineural hearing loss due to the disease process or secondary to a surgical procedure**
- **Some of these patients are candidates for cochlear implantation, and as such require special care**
- **The aim of this study was to evaluate the potential risks and complications of implantation in patients with COM**
- **Five of six patients underwent a two-stage operation, one had a single-stage operation; implantation was performed in all without complications, and their follow-up was uneventful**
- **When the surgical techniques are followed very strictly cochlear implantation can be successfully performed in patients with COM**

If the patient has inactive COM, repair of the dry tympanic membrane perforation is sufficient. In one of our cases with tympanosclerosis we performed tympanoplasty in the first stage and we attempted to perform cochlear implantation in this ear. However, the patient probably had an 'empty promontory' in that ear. This terminology defines an anatomical variation characterized by medial rotation or shift of the cochlear wall (conference presentation). The rotation could not be recognized with conventional two-dimensional CT scans. Three-dimensional CT scans can identify the variation and provide more accurate preoperative surgical planning. However, three-dimensional CT scans were not available in our centre, so this problem could not be predicted before surgery. As the surgeon did not wish to damage cochlear elements, extensive drilling to find the cochlear lumen was avoided. The situation was discussed with family members and it was decided to perform cochlear implantation on the other ear after studying the results of CT and MRI scans.

Cochlear implantation in patients with a previous mastoid cavity is a complicated procedure. The main questions in such cases are whether to stage and what obliteration materials to choose. If the patient has a dry, healthy mastoid cavity, a single-stage operation may be performed.[8,9] Subtotal petrosectomy, obliteration of the eustachian tube, blind sac closure of the external auditory canal, cochlear implant insertion, fixation of the implant and fat graft obliteration of the mastoid cavity are the surgical steps. Recently El-Kashlan *et al.* recommended meatal closure and cochlear implantation in a single-stage procedure for cases with simple dry tympanic membrane perforation and a healthy mastoid cavity. In this technique, they used external auditory canal closure with a modified Rambo technique, with resection of the medial external auditory canal skin, the tympanic membrane and the malleus and incus.[10] This could be useful for a dry mastoid cavity, but in inactive COM repair of the tympanic membrane would seem to be adequate. Whatever the technique, the most important issue is elevation of the fibroepithelial lining of the mastoid. This can be preserved or discarded, but the surgeon should be certain that no squamous epithelium is left behind. If there is, recurrent cholesteatoma will be an expected complication. In infected radical cavities, a two-stage operation is very reasonable. Opening all the mastoid air cells, obliteration of the eustachian tube, blind sac closure of the external auditory canal and obliteration of the cavity are performed in the first stage. If there is no sign of infection after three to six months cochlear implantation may be performed. Our three patients had infected radical cavities and two-stage operations were performed. In two cases there was no problem during surgery and in the follow-up period. One patient needed another attempt to obliterate the cavity, and later he did very well.

Recently, some cases of meningitis after cochlear implantation have been reported, although only some of them had clinical findings of acute otitis media.[11] Therefore, in the patient with a potentially infected cavity, safe sealing of the cochleostomy opening is really important. The incidence of labyrinthitis in the grafted cochlea was found to be significantly less than it was in the ungrafted cochlea, regardless of graft materials. In the study by Dahm *et al.*, fascia and an absorbable gelatin sponge was used as graft materials.[12] On the other hand, changes in the fascia over the cochleostomy were recently reported as a histopathologic finding (Conference presentation). The fascia became a very thin membrane infiltrated with inflammatory cells. Bacterial transport through this membrane may therefore be possible. Hamzavi *et al.* have recommended bone pate for sealing because of its high osteoblastic potential.[8] Pieces of muscle tissue, fascia graft and muscle tissue with fibrin glue are also recommended materials. In our first three cases we used muscle tissue to cover cochleostomy opening. Muscle tissue and bone pate were used for the other three cases. Although the follow-up periods were not very long, no complications were seen. In the study of Donnelly *et al.*, a patient had a recurrence of the middle ear disease and potentially life-threatening complications two years after implantation.[13] There-

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fore, clinical monitoring for this group of patients should be very close. The best and easy method of follow-up is regular otological examination. Patients with cochlear implants visit the cochlear implant service regularly and need lifetime care, so clinical monitoring has become easier. MRI would be a useful method to evaluate recurrent COM with or without cholesteatoma, but it may not be suitable for all cochlear implant users. The sensitivity of high resolution CT (HRCT) scans to distinguish between fat tissue and recurrent cholesteatoma is very low.[7] If there is high clinical suspicion of recurrence, HRCT could be used and the scan should be done in a serial mode. On the other hand, non-obliteration of the cavity could give a better chance of evaluating the cavity with HRCT. In our series, we generally preferred the two-stage technique. Therefore, regular and meticulous clinical follow-up is felt to be of the greatest importance.

Conclusion

In this study a small group of patients with COM are presented. Except in one patient we performed a two-stage operation because, especially in the presence of active COM or an infected radical cavity, it seems essential. Although there are several risks in this group of patients, when certain surgical rules are followed very strictly it is a safe procedure. Nevertheless, the follow-up should be very close. In our group, all patients except one were young and of working age, so, in spite of the higher than normal risks, cochlear implantation is an appropriate method of rehabilitation in both at a personal level and from a socioeconomic perspective.

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Address for correspondence:
Armagan Incesulu, M.D.,
Portakal Cicegi Sok. No: 3/5 06540,
Cankaya, Ankara,
Turkey.

Fax: +90 (312) 439 61 88
E-mail: armaganincesulu@yahoo.com

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