Cochlear Implantation in Patients with Chronic Otitis: Indications for Subtotal Petrosectomy and Obliteration of the Middle Ear

ABSTRACT—Normally, active chronic suppurative otitis media is regarded as a contraindication for cochlear implantation. In case of a radical cavity after surgical treatment for cholesteatoma, the electrode covered by the epithelial lining of the mastoid will likely become exposed or extruded. Under these circumstances we suggest the subtotal petrosectomy, obliteration of the middle ear cleft with abdominal fat, and the blindsac closure of the external ear canal before cochlear implantation.

Fourteen patients with chronic otitis media were successfully implanted with an intracochlear multichannel cochlear implant. After an average follow-up of 28 months a temporary facial palsy in one patient and an insufficient closure of a retroauricular fistula over the mastoid cavity in two cases were observed as postoperative complications. One patient with a tumefactive inflammatory pseudotumor developed a massive inflammation in the implanted ear 2 months after surgery which could not be controlled by conservative treatment. The implant had to be removed and after administration of cyclophosphamide she could be successfully reimplanted 7 months later.

Implantation of a foreign body in a potentially infected space which communicates with the endocranium means a surgical challenge which can be managed by obliteration of the middle ear. In case of massive inflammation we prefer a two-stage procedure.

To date, the rehabilitation of deaf patients with a multichannel cochlear implant has been established as a worldwide accepted method. In case of normal temporal bone anatomy the surgical procedure is standardized and offers few problems. Due to restrictive preoperative patient selection, the incidence of postoperative complications is rather low and is usually flap related.¹⁻⁵ The percentage of so-called "major complications" which

require surgical revision is estimated as low as 7.4%.³ To reduce the surgical risk a sufficient amount of experience in regard to the special type of implant is required. The flap design should be thoroughly planned, the posterior tympanotomy carefully performed and the electrode array gently inserted after an adequate cochleostomy. The importance of a reliable device fixation is emphasized in order to prevent migration.^{3,6}

Figure 1. CT scan of temporal bone with bilateral mastoid cavities after removal of cholesteatoma. Note the thin lining in the posterior part of both cavities which do not provide sufficient protection for an electrode array.

Figure 2. Spontaneous extrusion of the intra-cochlear electrode array in a radical cavity with a thin epithelial lining. The electrode array had been covered by a cartilaginous graft and fixed with ionomeric cement which can be seen as the white foreign body at the bottom of the cavity.

There are many reasons for deafness and in spite of modern diagnostic tools and the cause of the hearing loss cannot be revealed in every case. Beside trauma of the temporal bone, meningitis plays an important role, especially in children. Chronic otitis media may cause deafness by itself or it may be induced as a sequelae of cholesteatoma surgery.

Treatment of choice in case of chronic middle ear discharge is tympanoplasty. A durable closure of the defect in the tympanic membrane can be achieved if there is adequate Eustachian tube function. In these cases a cochlear implantation can be performed without any problems. The anatomical situation of cochlear implant surgery in case of mastoid cavity after removing a cholesteatoma is demonstrated in Figure 1 and includes the following aspects:

- implantation of a foreign body in an area with chronic inflammation
- spread of inflammation along the electrode array into the scala tympani with following labyrinthitis and meningitis
- risk of recurrent cholesteatoma
- extrusion of the electrode array in the mastoid cavity/outer ear canal (Fig. 2)

Usually an active inflammation of the middle ear and a persistent defect of the tympanic membrane are regarded as contraindications for cochlear implantation.⁷

To avoid problems of electrode extrusion through the thin skin of a radical cavity (Fig. 2) in three patients, we changed our surgical procedure including subtotal

petrosectomy, obliteration, and closure of the outer ear canal according to the technique of Fisch.⁸

MATERIAL AND METHODS

To date, over 1100 patients were provided with a multichannel cochlear implant at the department of otorhinolaryngology of the Medical University Hannover. In 14 deaf patients with coincident bilateral chronic middle ear disease an obliteration of the middle ear cleft with a permanent closure of the external ear canal was performed to eliminate chronic ear discharge. The surgical technique will be described in detail later on. Seven male and seven female patients with an average age of 48 (2.5–66) years were implanted. The average number of middle ear operations due to chronic otitis media ran up to 5.5; one woman underwent ear surgery 26 times on both ears. Cholesteatoma was diagnosed in 9 patients, a traumatic cholesteatoma after temporal bone fracture in one case, one otitis after measles, and two patients showed evidence of a so-called tumefactive lesion of the temporal bone. Thirteen patients showed bilateral mastoid cavities after cholesteatoma surgery. A 30 month-old child suffered from a congenital deafness in both ears with a Mondini-dysplasia as shown by CT scan. The vestibulocochlear nerve could be morphologically demonstrated on MRI. All patients were evaluated for cochlear implant candidacy by a standardized proce-

cedure including imaging, medical, audiological, and psychological tests.

Surgical Technique

The skin incision starts preauricular and goes posterior and superior. A monolayer flap is elevated including the temporalis muscle and the mastoid plane including the tip is exposed. The skin flap has a broad base with good blood supply from the occipital artery which seems to be important since most patients already underwent ear surgery by a retroauricular approach. A subtotal petrosectomy according to Fisch⁸ (this is a radical mastoidectomy) is performed to remove the mucosa and the skin layer completely from the ear canal and the middle ear. The external ear canal is transected, the skin elevated and the meatus closed in three layers if possible. The tympanic orifice of the Eustachian tube is obliterated with a free myofascial graft in combination with fibrin glue and bone wax after removal of the mucosa. After performing the cochleostomy in a regular manner the electrode array is inserted into the scala tympani and fixed with ionomeric cement near the cochleostomy. The mastoid cavity and the drilled out middle ear are filled with abdominal fat (Fig. 3). The operation is finished by a multilayer closure of the incision as shown by Lenarz.⁹

RESULTS

All 14 patients could be successfully implanted with a cochlear implant. In 8 patients a Nucleus Mini 22 was used; a Nucleus double array (1+10+11) and a Nu-

Figure 3. Intraoperative situation after subtotal petrosectomy and obliteration of the middle ear with abdominal fat on the left side. In this case a Clarion[®] device had been implanted and fixed with a crossed Vicryl[®] suture.

cleus 20+2 of the Cochlear Corporation were used twice; and in three patients an Advanced Bionics Clarion device was implanted. In all patients the active electrodes could be placed in the cochlea. The middle ear obliteration and implantation was performed as a one-stage procedure in 10 cases. Due to active inflammation in four patients, the ear was closed in a first procedure and the device implanted approximately 6 months later. In those cases intraoperative orientation was more difficult as a consequence of missing anatomical landmarks, but an open scala tympani could be identified via a cochleostomy in all patients. We did not observe an obvious regeneration of middle ear mucosa in the second surgery.

In spite of the complicated surgical procedure all implanted devices are working well and all patients show benefit from their implantation.

Due to extremely thin retroauricular skin, a retroauricular fistula developed with partial necrosis of the free fat graft in two patients. This complication was managed by a nuchal based transpositional flap and new fat implantation. One patient whose facial nerve was exposed during cholesteatoma surgery developed a mild transient facial palsy for two weeks. One female patient had clinical and histological features of a tumefactive lesion on both ears which led to 26 ear operations. Due to massive inflammation in both mastoid cavities we decided to obliterate both ears in the aforementioned manner as the patient developed bilateral deafness. After this procedure, local conditions were excellent and the patient did not feel otalgia any longer. Therefore a rehabilitation with a cochlear implant was planned after an uneventful period of six months. First, the immediate postoperative period passed without any problems and the patient showed good progress with her implant. Unfortunately, two months after implantation an intensive inflammation occurred which could not be managed by conservative treatment. In this situation we decided to remove the implant but let the intracochlear portion of the electrode array stay in place. After administration of an immunosuppressive treatment with cyclophosphamide the local conditions settled and 1 year after explantation the patient was successfully reimplanted using a Nucleus 22 M again. After a period of 20 months we did not observe any severe problems on the implanted side (Fig. 4). For further information this special case see Schönermark.¹⁸

The above mentioned child had a congenital deafness on both ears due to Mondini-dysplasia shown by CT scan. She had a history of two episodes of pneumococcal meningitis. A defect was found intraoperatively in the stapes footplate with a liquor filled cystic sac in the middle ear. We decided to obliterate the middle ear cleft after successful insertion of the electrode array due to massive liquorrhoea after opening the sac. Three weeks later contralateral tympanoscopy demonstrated a similar

Figure 4. Postoperative CT scan showing the intra-cochlear portion of the electrode array in the basal turn of the right cochlea in a patient with bilateral fibroinflammatory lesion of the temporal bone. Note the obliterated middle ear space on both sides.

dysplasia of the stapes footplate. The defect was covered by a connective tissue graft according to stapedotomy.¹⁰

After an average follow-up of 28 months no further complications could be observed, especially no recurrences of cholesteatoma developed. The surgical results are summarized in Table 1.

DISCUSSION

The promising experience in rehabilitating deaf patients with a cochlear implant during the last 10 years has established this technique as a worldwide accepted method. Due to restrictive patient selection postopera-

tive complications are rare. Active chronic inflammation of the ear is regarded as a relative contraindication against cochlear implantation because of the risk of inflammatory spread to the implant with development of a labyrinthitis and meningitis.⁷ It could be shown experimentally that sealing of the cochleostomy with a fascial graft reduces the incidence of labyrinthitis in case of pneumococcal induced otitis media.¹¹ A similar problem confronts the surgeon in patients with bilateral mastoid cavities. There is a real risk of recurrent cholesteatoma and the thin epithelial lining of the cavity does not provide sufficient protection of the electrode array which could be extruded as observed in one of our patients. The same experiences were reported by Webb et al.⁶ in an implanted patient with cavities after scarlet fever. A possibility of managing the problem of chronic suppurative otitis media in case of malfunction of the eustachian tube or mastoid cavities is the closure of the external ear canal and the middle ear which was proposed by Rambo (cited by 12).

Fisch⁸ systematically developed the concept of what he calls subtotal petrosectomy. The rationale of this procedure consists of a multilayer blindsac closure of the external ear canal and a thorough removal of all middle ear mucosa as the substrate of chronic inflammation by a radical mastoidectomy. Further indications for this surgical approach other than persistent chronic otitis are considered to be massive liquorrhea due to temporal bone fracture and cholesteatoma.⁸ Donnelly et al.,¹³ Gray,¹⁴ and Parnes⁷ indicate a similar therapeutical

Table 1. Surgical Results

No.	Age	Otological Disease	CWD/CAU	One Stage/Two Stage	Complications	Implant
1	2,5	Mondini-Dysplasia	CWU	one stage	—	Nucleus
2	18	arachnoid cyst				
3	30	Bilateral active cholesteatoma	CWD	one stage	—	Nucleus
4	39	Bilateral temporal bone fracture with active cholesteatoma	CWU	one stage	—	Clarion
5	47	Tumefactive inflammatory pseudotumor	CWD	two stage	wound healing disorders	Nucleus
6	49	Chronic suppurative otitis media	CWU	two stage	—	Nucleus
7	50	Bilateral active cholesteatoma	CWD	two stage	seroma	Nucleus
8	53	Tumefactive inflammatory pseudotumor	CWD	two stage	—	Nucleus
9	55	Bilateral active cholesteatoma	CWD	one stage	retroauricular fistula	Clarion
10	60	Bilateral active cholesteatoma	CWD	one stage	—	Nucleus
11	60	Bilateral stable radical cavities	CWD	one stage	retroauricular fistula	Nucleus
12	62	Bilateral stable radical cavities	CWD	one stage	—	Clarion
		First Cochlear Implant 1992				
		Explantation due to recurrence				
		1993 and revision surgery with subtotal petrosectomy and reimplantation 1993				
13	63	Chronic otitis media after scarlet fever	CWD	one stage	—	Nucleus
14	66	Cholesteatoma	CWD	one stage	—	Nucleus

approach in these situations while Scrivener¹⁵ recommends an augmentation of the epithelial lining of the mastoid cavity with a fascia lata graft prior to implantation. In our opinion this technique and the subcutaneous implantation of cartilage do not seem reliable enough and the problem of recurrent inflammation of the cavity is not sufficiently solved.

Because of the number of flap related major complications, a diligent planning of the skin flap seems to be a crucial point in this special situation in our opinion. The fact should be taken into account that most of the patients had undergone previous ear surgery by a retroauricular approach. Therefore the basis of the C-shaped incision may not be reliable and should be avoided in these situations according to our experience.⁶

In the first years of cochlear implant surgery, a Dacron tie was placed in the posterior bony external canal wall for electrode fixation. Aside from electrode extrusion, a development of cholesteatoma could be observed.⁶ A similar pathophysiological mechanism might induce cholesteatoma in case of narrow anatomical conditions and insufficient ventilation of the middle ear. In this situation the electrode could touch the intact tympanic membrane and cholesteatoma might occur. Therefore we would recommend an elective middle ear obliteration in those situations. Cases of inner ear dysplasia with massive liquorrhea (gusher-phenomenon) can lead to life-threatening meningitis which was observed in two cases.² However, our technique is not necessary in all cases of dysplasia which can normally be handled without major problems.

A very special diagnostic and therapeutic problem is the so-called fibroinflammatory pseudotumor which has been described in only 21 cases since 1975.¹⁶ This entity is defined as histologically benign, locally destructive lesions composed of fibrovascular tissue admixed with chronic inflammatory cells.¹⁷ A coincidence with other fibrosclerosing disorders such as retroperitoneal fibrosis, orbital pseudotumor and Riedel's thyroiditis is observed.¹⁶ Although surgical excision is supposed to be the treatment of choice, no proven judgment of its prognosis can be made regarding to the rarity of this disease.^{17,18} Our experiences demonstrate the possibility of cochlear implantation even in problematic situations such as mastoid cavities and persistent chronic ear disease by a distinct surgical procedure. In consider-

ation of the observed postoperative complications we would recommend a two-stage procedure in case of existing inflammatory alterations in the cavity.

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