Subtotalna petrozektomija pri kohlearni implantaciji

Subtotal petrosectomy in cochlear implantation

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Izvleček

Glavna indikacija za subtotalno petrozektomijo (SP) pri kohlearni implantaciji je kronično vnetje srednjega ušesa z ali brez holesteatoma. Ob kroničnem otitisu sta pomembni indikaciji še malformacije notranjega ušesa z možnostjo likvoreje in anatomske nepravilnosti. Cilj posega je eliminacija vnetja iz operativne votline in varna vstavitev elektrode v notranje uho. Poseg smo v zadnjih 13 letih opravili pri 15 bolnikih s povprečno dobo sledenja 61 mesecev. Pri vseh je šlo za polno vstavitev elektrode in pri vseh je bila operativna votlina zapolnjena z abdominalnim maščevjem. Revizijo operativne votline smo opravili pri treh bolnikih, ohranili napravo in vsi bolniki še vedno lahko uporabljajo kohlearni implant.

Abstract

The main indication for subtotal petrosectomy (SP) in cochlear implant surgery is chronic otitis media with or without cholesteatoma. In addition to chronic otitis, other indications for surgery include inner ear malformations with the possibility of cerebrospinal fluid leakage and anatomical abnormalities. The main goal of the surgical technique is to eliminate the inflammation in the mastoid cavity and insert an electrode into the inner ear. Over the past thirteen years, the procedure has been performed in 15 patients with an average follow-up of 61 months. In all patients, complete insertion of the electrode was achieved, and the cavity was filled with abdominal fat.

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Subtotalna petrozektomija je varen poseg, ki zahteva sledenje bolnikov vsaj deset let po operaciji. Za uspeh operacije je ključna natančna kirurška tehnika, s katero odstranimo bolezen, sluznico in epitel iz srednjega ušesa, popolno zaprtje zunanjega sluhovoda in prekritje implanta. Revision surgery was required in three patients with preservation of the device. All patients are still using the cochlear implant. Subtotal petrosectomy is a safe procedure. However, follow-up is required for at least ten years after surgery. Meticulous surgery with removal of all disease, middle ear mucosa, and epithelium, the complete sealing of the external ear canal, and covering of the implant to prevent extrusion are critical for a successful surgical result.

INTRODUCTION

Subtotal petrosectomy was first described by Rambo (1) and later modified and popularized by Fisch and Mattox (2,3). The main steps of the procedure are blind sac closure of the external auditory canal, exenteration of the middle ear and mastoid (including the perisigmoid, perilabyrinthine, perifacial, and hypotympanic cells), removal of the middle ear epithelium and mucosa, closure of the Eustachian tube, and obliteration of the cavity with abdominal fat. Bendet and Issing first described the role of SP in cochlear implantation in 1998 (4). They proposed the technique for cochlear implantation in ears affected by chronic otitis media. After surgery, the surgical cavity is isolated from the external environment, which reduces the risk of postoperative infection, CSF leakage, and meningitis.

The skin incision is enlarged by about 2 cm in a posterosuperior direction to create a pocket for the cochlear implant receiver. The second layer of closure is also essential as it reduces the risk of epithelial ingrowth into the surgical cavity. It is also very important to drill the anterior and inferior walls of the ear canal to avoid leaving skin fragments in the ear canal. It is also important to remove the bone above the facial nerve and the mucous membrane of the middle ear and Eustachian tube (Figure 1).

During surgery, exposure of the round window and promontory is improved. Due to the wide angle of approach to the round window area obtained by removing the posterior ear canal wall, insertion of the electrode is much easier (Figure 2).

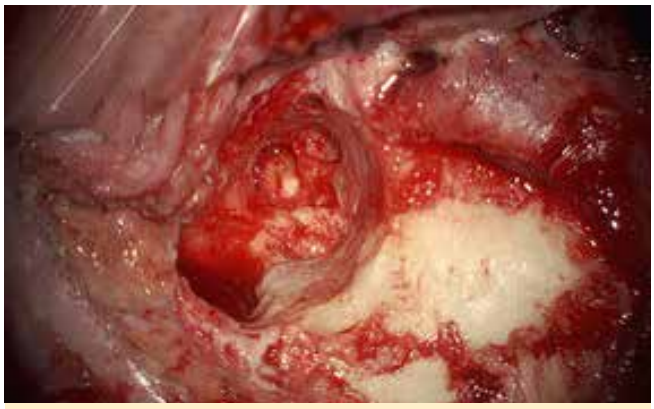

Figure 1. *Subtotal petrosectomy in a patient with a previous canal-wall-down mastoidectomy. All mastoid cells were drilled away, and the middle ear mucosa and tympanic membrane were removed. Before that, the ear canal was closed in two layers.*

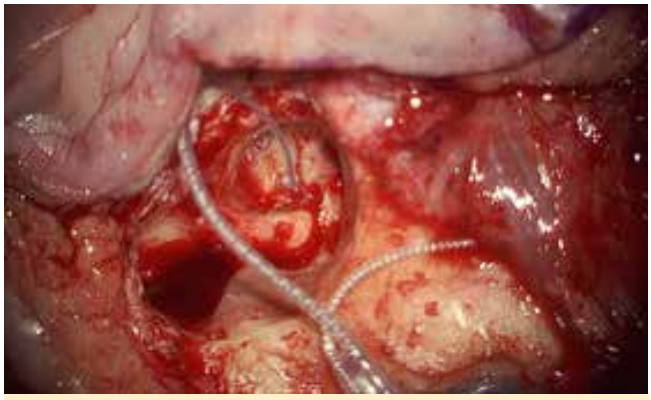

Figure 2. *The electrode of the cochlear implant was inserted through the round window into the scala tympani, and the receiver was positioned in the well behind the cavity.*

The hypothesis is that subtotal petrosectomy is a safe procedure that can provide the patient with long-term hearing. Because of the possibility of infection in the surgical cavity, we believe this is a critical outcome measure that could jeopardize the outcome.

MATERIAL AND METHODS

This retrospective study included patients with cochlear implantation and SP who had undergone surgery between 2011 and 2023 at the Department of Otolaryngology, Head and Neck Surgery, UKC Maribor. In these patients, the etiology of deafness, indication for SP, complications after SP, and intraoperative findings during revision surgery were analyzed. All patients underwent preoperative high-resolution CT and MR. Follow-up was defined as the time from surgery to the last office visit. During follow-up, we looked for signs of inflammation in the surgical field. We performed the first CT scan one year after surgery and then yearly for the next three years. All procedures performed in the study were in accordance with the ethical standards of the institution.

RESULTS

Between 2011 and 2023, we performed 15 SPs for cochlear implantation. In all patients, the implantation was unilateral and in one stage. At the time of surgery, the patients were between 22 and 80 years old. We operated on four females and 11 males. In 53% of the patients, a mastoidectomy was performed, which is the most common indication for SP. Two patients had perforation of the tympanic membrane, and two had been treated with radiotherapy for malignant disease in previous years. Three patients had an unfavorable anatomy: one had an inner ear malformation with CSF leakage, the second had an ossified basal turn of the cochlea with the electrode inserted in the middle turn, and the third had a narrow and angled external auditory canal.

The mastoid was closed with abdominal fat in all patients (Figure 3). Complete insertion of the electrode was achieved in all patients, including the patient in whom the electrode was inserted through the middle

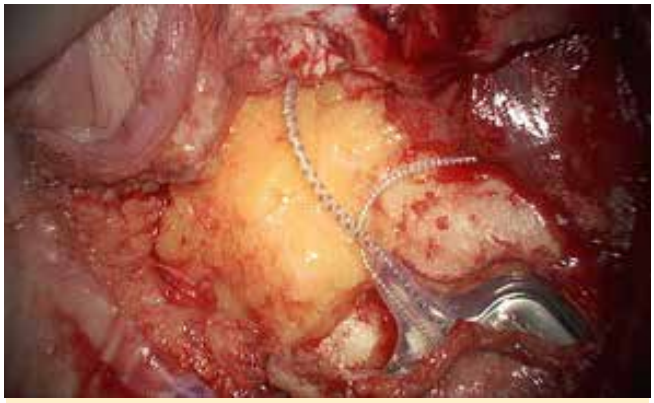

Figure 3. *A fat graft from the abdomen was placed in the mastoid cavity. The receiver of the implant was partly covered with the fascial layer.*

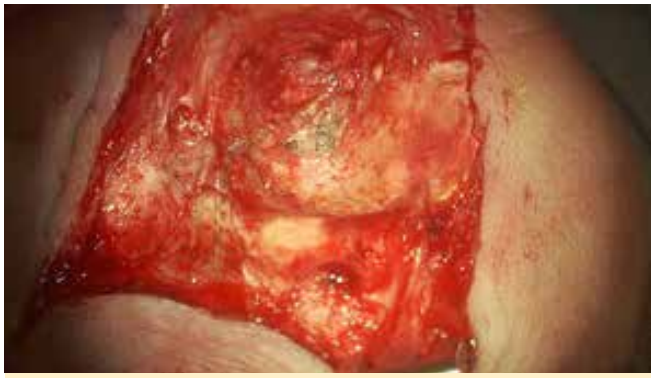

Figure 4. *Revision operation of the SP and cochlear implantation. The majority of the fat graft was removed, and the electrode was surrounded with connective tissue. A recurrence of the cholesteatoma can be seen in the medial part of the operating cavity.*

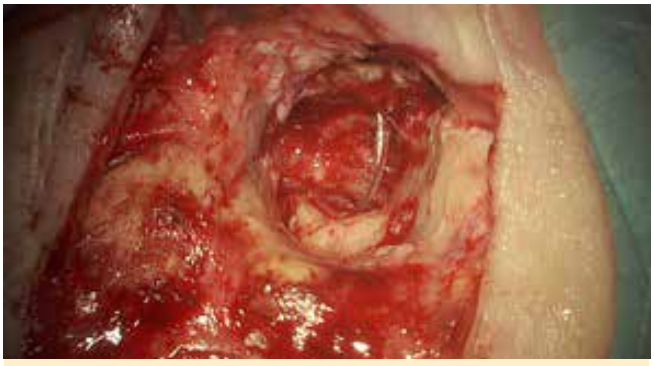

Figure 5. *The same patient as in Figure 4 after the removal of the cholesteatoma. The electrode was preserved and is still in place.*

turn of the cochlea. The implant was activated in all patients within 30 days of surgery.

The average follow-up for this group of patients was 61 months. Three patients developed inflammation between 20 and 26 months. They were all operated on, and the electrode was left in the cavity. One patient had to be re-operated on after Covid19 infection. She was sneezing and coughing for a long time. During the revision, we found the material used to obliterate the Eustachian tube in the mastoid cavity, which allowed the infection to spread from the nasopharynx. In the second patient, a cholesteatoma was found in the surgical cavity. Because of the cholesteatoma, she had undergone surgery years before and had a canal wall down mastoidectomy prior to cochlear implantation (Figures 4 and 5). In the third patient, communication was found between the obliterated ear canal and the surgical cavity. It is likely that an epithelial remnant remained in the former ear canal.

In all patients, we were able to eradicate the inflammation and keep the electrode in place without reimplantation. All three continue to use the cochlear implant.

There were no short-term complications related to wound healing or donor site problems in the series of patients presented.

DISCUSSION

The indications for cochlear implantation have changed in recent years. In the early days of cochlear implantation, chronic middle ear disease was a limiting factor for surgery. Especially in patients with a previous mastoidectomy, there was a high risk of inflammation in the surgical field and extrusion of the electrode. To eliminate this risk, surgeries were proposed in which a protective layer of tissue was placed around the electrode. Since then, SP has become more widely used, and the number of surgeons performing the procedure has increased. The only contraindication to SP is the preservation of residual hearing and subsequent electroacoustic stimulation, which is not possible due to the closed ear canal.

In the review article, which included 27 studies with 379 SPs, the main indications were chronic otitis in 55%, pre-formed canal-wall-down mastoidectomy in 35%, cholesteatoma in 19%, ossification of the cochlea in 7%, inner ear malformations in 4%, temporal bone fractures in 4%, and unfavorable anatomy in 4% (5). Other indications were rare. Our indications were largely consistent with the results of the above study. The only indication not mentioned was osteoradionecrosis, which we found in two patients. We operated on patients who were treated with radiotherapy more than ten years ago and were considered to be free of disease. In the first patient, we performed a classic cochlear implantation using the transmastoid approach. Unfortunately, a few weeks after the surgery, we observed a dehiscence in the lateral ear canal wall, which continued to grow. The radiotherapy had likely affected the bone of the ear canal, which was thinned by the transmastoid approach, and it had begun to necrotize. Such a condition could jeopardize the whole operation. Therefore, we decided to go for SP, which healed without problems.

Cochlear implantation in chronic middle ear disease remains a challenge. In addition to successful electrode insertion, it is necessary to eliminate the infection and create a sterile field. The procedure can also be performed in two stages: creating the cavity and eliminating the infection. In the second stage, when the field is sterile, the electrode can be inserted (4, 6, 7). On the other hand, staging the procedure delays implantation, which is undesirable for patients. In the case of cholesteatoma, patients have to wait 6–12 months for cochlear implantation and may still have residual cholesteatoma after this time, which further delays the procedure (8). Our patients were operated on in one stage. Even if they were operated on in two stages, we could not prevent all possible complications. Complications in our group of patients occurred relatively late—almost two years. However, if there is any doubt about the complete eradication and removal of the cholesteatoma, the procedure should be staged. There was no significant difference in complication rates between the one-stage and two-stage procedures. The pooled complication rate from the review article with 379 SPs was 12.4%, and the pooled cholesteatoma recurrence rate was 9.3%. These findings correlate with our results where we had one cholesteatoma recurrence in the chronic otitis group of 10 patients

Table 1: Clinical data, follow-up, and complications in patients with SP at cochlear implantation (RT: radiotherapy; CWD: canal-wall-down mastoidectomy)

Case	Age	Gender	Etiology of hearing loss	Time from operation (months)	Indication for SP	Inflammation in the cavity (months)
1	45	F	Cholesteatoma	158	CWD	26
2	71	M	Cholesteatoam	139	CWD	-
3	60	F	Chronic otits	101	Tympanic membrane perforation	-
4	67	M	Chronic otitis	99	CWD	-
5	66	M	RT(nasopharyngeal carcinoma)	85	Osteoradionecrosis	-
6	54	F	Cholesteatoma	64	CWD	20
7	35	M	Genetic	59	Anatomy	-
8	64	M	Meningitis	54	Ossified basal turn of the cochlea	22
9	38	M	Inner ear malformation	52	CSF leak	-
10	67	M	Chronic otitis	34	Anatomy	-
11	66	M	Chronic otitis	26	CWD	-
12	80	F	Chronic otitis	16	CWD	-
13	22	M	RT (medulloblastoma)	14	Osteoradionecrosis Tympanic membrane perforation	-
14	38	M	Chronic otitis	6	CWD	-
15	74	M	Chronic otitis	4	CWD	-

and three revisions in 15 patients.

The most common immediate complications in SP are wound infection, wound dehiscence, and abdominal wall hematoma from fat removal. In our group of patients, we did not observe any problems in the immediate postoperative period. This is probably due to our more extended experience with SPs, which we perform to close defects in lateral skull base surgery. After SP, facial nerve palsy, recurrent or residual cholesteatoma, and postoperative dizziness have also been described (5).

SP can be performed in children and there are no differences in complication rates compared to adult patients. The temporalis musculofascial flap has been used more frequently in children than in the adult population. We have performed two SPs for cochlear implantation. However, they were not included because the patients were lost to follow-up. The indications in both cases were unfavorable anatomy: a hypoplastic mastoid with an anterior sigmoid sinus where the transmastoid approach was not possible.

After SP in deaf patients with canal-down mastoidectomy, in addition to the cochlear implantation, patients benefit from the cleaning of the surgical cavity. The surgical cavity has to be cleaned once a year in patients with canal-down mastoidectomy, but is no longer necessary after SP. Some patients also suffer from otorrhea, which is also eliminated with successful SP. Patients can also expose the ear to water, which is not possible with canal-down mastoidectomy.

Patients with SP have a blind sack closure of the ear canal, so the condition of the middle ear and mastoid cannot be seen on otoscopy. Patients must be followed with high-resolution CT every two years for at least ten years. The first patient had surgery in 2011, and for many years, cochlear implant manufacturers produced devices that could go into the magnetic field conditionally – below 1.5 T with a protective bandage around the cochlear implant receiver. There was a high risk of magnet dislocation in the cochlear implant receiver.

It is also difficult to distinguish with MR the cholesteatoma from the fat filling the cavity. For these

reasons, we followed the patients using CT scans. Soft tissue expansion or new bony erosion is suspicious for cholesteatoma recurrence (9,10). Second-look surgery can be an important tool to detect recurrent cholesteatoma from eroding the temporal bone and potentially causing device failure (11).

The functional outcome of cochlear implantation is difficult to assess because it depends on many factors, including the recipient's age at implantation, duration of hearing loss before implantation, residual hearing, time of daily use of the cochlear implant, speech ability before implantation, and anatomical conditions within the cochlea. For these reasons, comparing results with other recipients is also difficult.

In order to avoid complications, the technique must be perfectly mastered and should be part of the technical expertise of every surgeon performing cochlear implantation.

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