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Subtotal Petrosectomy, Cavity Obliteration, and Blind Sac Closure of the External Auditory Canal: Retrospective Analysis of a Series Including 44 Cases

Original Investigation

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Abstract

Objective: This study aims to share our experiences with subtotal petrosectomy, cavity obliteration, and blind sac closure of the external auditory canal.

Methods: A total of 44 patients who underwent subtotal petrosectomy and cavity obliteration between January 2009 and April 2013 were analyzed retrospectively. Indications of operation, surgical findings, and complications were recorded.

Results: Twenty-three male and 21 female patients with a mean age of 42±18 (8-73) years were included in the study. The mean postoperative follow-up period was 22±11 (9-52) months. Seven patients underwent primary cavity obliteration (6 with supralabirentin cholesteatoma and 1 with facial nerve schwannoma; all had total sensorineural hearing loss on the operated side). Obliteration was performed as a secondary procedure in 19 patients who had uncontrolled otorrhea and unserviceable hearing. During the procedure, the implantation processes of a Carina device in 2 patients, active middle ear implant (Vibrant Soundbridge- VSB) in 4 patients, and cochlear implant in 8 patients who had dry mastoidectomy cavities were performed. Removal of the hearing devices was carried out simultaneously with the procedure in 4 patients who had been administered an auditory implant previously. The complications of cerebrospinal otorrhea and mastoid cavity infection developed in 1 patient on the 7th postoperative day. This had been drained under general anesthesia, and recovery was obtained without any problems. Three patients had skin necrosis localized in the external auditory canal, which was repaired under local anesthesia.

Conclusion: Subtotal petrosectomy and cavity obliteration procedure can be a good alternative to prevent recurrent infections and cavity problems in patients who have safe cavities with unserviceable hearing. Additionally, it is gaining more popularity in chronic otitis media patients to secure the implant electrode and to prevent cavity infection if they need to be rehabilitated with cochlear or active middle ear implants.

Key Words: Subtotal petrosectomy, cavity obliteration, chronic otitis media, cochlear implantation, active middle ear implants

Introduction

The procedure of subtotal petrosectomy, cavity obliteration, and blind sac closure of the external auditory canal is an important otologic surgical intervention that can be performed, especially for the patients with little cochlear reserve (1). This operation was first described by the American otologist Rambo in 1958 and has been modified by many authors up to now (2). In this procedure, after all cells are opened and the epithelium and mucosa are cleaned, the external auditory canal is sutured as a "cul de sac" (blind sac), and the current mastoid cavity is completely isolated from the outer environment. During the first years of this operation, the main indication of the operation was to provide ears that do not have any problems by recovering the mastoid cavities with uncontrolled otorrhea, which impairs the quality of life seriously. The fact that this method overlooked the hearing function made the scope of implementation limited to only the ears with unserviceable hearing. However, hearing loss in these patients is rehabilitated with various approaches, particularly with cochlear implantation.

Similarly, the applications of an implanted hearing aid and active middle ear plant can offer correction of conductive and mixed-type hearing losses (3, 4). These advantages have repopularized the procedure of "blind sac closure," especially in patients with cavity problems or with unavoidable ear infection despite multiple operations. The procedure of blind sac closure helps to not only control infection but also protect the cochlear or middle ear implant electrode by cutting off the relationship of the mastoid cavity with the outer environment (5). This has expanded the indications of the surgery and encouraged otologists to perform this operation more comfortably and more frequently. As in all otologic interventions, this surgical intervention also contains general and specific complications intraoperatively and postoperatively (5). In our study, we aimed to share our experiences in subtotal petrosectomy and cavity obliteration surgery that we performed in our clinic and our opinions in light of recently published articles on this topic.

Methods

Ethics committee approval for this study was received from the ethics committee of Bozyaka Teaching and Research Hospital (2014-94). The files of 44 patients who underwent subtotal petrosectomy operation between January 2009 and

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April 2013 were analyzed. Indications of the operation, surgical findings, and complications were recorded. The patients who had been followed up for 6 months or more were included. Statistical Package for Social Sciences (SPSS) 21.0 was used for statistical analysis of the data. The data were presented as mean±standard deviation.

Surgical Intervention

All of the surgical interventions were performed under general anesthesia by a single surgeon. In the revision cases, the previous postauricular incision line was extended forward from the upper and lower points, while a wide-based postauricular incision was used for the primary cases. The flap was elevated up to the mastoid bone cortex. Subtotal petrosectomy was performed for eradication of the pathology in the existent cavity in the revision cases and eradication of the pathology in the temporal bone in the primary cases. In the presence of a cavity, the squamous epithelium was carefully stripped so that no residue remained, and the opening of the Eustachian tube was obliterated with bone. Then, the skin covering the external auditory canal was elevated all around the bone and cartilage. It was sutured from its free edges by using the horizontal matrix suture technique with 4.0 Vicryl, and a blind sac was formed (Figure 1). Cavity obliteration was performed after taking abdominal fat tissue from the left lower quadrant. A penrose drain was inserted into the cavity, incision sites were sutured, and the operation was ended with dressing. In the case of planned hearing rehabilitation for the same session, active middle ear implantation or cochlear implantation was performed before obliteration of the cavity with fat. If removal of the existing cochlear implant or active middle ear implant had been planned, the removal process was carried out first, and subsequently, the procedure of subtotal petrosectomy and blind sac closure of the external auditory canal was performed.

Figure 1. Blind sac closure of the external auditory canal

Results

Between January 2009 and April 2013, subtotal petrosectomy was performed for 44 patients (23 males and 21 females) with a mean age of 42±18 (8-73) years (Table 1). The mean follow-up period was 22±11 (9-52) months. In 7 of 44 patients, subtotal petrosectomy was applied as the primary intervention. Six of these 7 patients had supralabirentin cholesteatoma. Four of them had total sensorineural hearing loss on their operated ears, and 2 had severe mixed-type hearing loss. In one patient for whom the procedure was applied as the primary intervention, facial nerve schwannoma originating from the geniculate ganglion was present. Severe mixed-type hearing loss was also detected in this patient.

Subtotal petrosectomy was performed as a secondary procedure in 19 patients who had been operated on due to chronic otitis media with cholesteatoma. In 6 of these patients, total sensorineural hearing loss was found in their operated ears. Thirteen had severe mixed-type or conductive hearing loss. The most common complaint of the patients as the reason for admission to the hospital was "uncontrolled otorrhea," which impairs the quality of life seriously. Hearing rehabilitation was provided by applying cochlear implantation after the procedure in 2 patients, a Vibrant in 3 patients, and a bone anchored hearing aid (BAHA) in 1 patient.

For 14 patients, a hearing aid (CARINA, Vibrant Soundbridge) that could be implanted simultaneously with subtotal petrosectomy and cochlear implantation was applied. These patients were the ones with cavity and hearing loss who had undergone mastoidectomy due to chronic otitis media previously, and obliteration procedure was performed in order to protect the implanted electrodes against cavity problems. Of these patients, a CARINA device was implanted in 2, a Vibrant Soundbridge (VSB) was implanted in 4, and cochlear implantation was performed in 8 patients. Six patients who had CARINA and VSB applied had moderate and severe mixed-type hearing loss. Eight patients with cochlear implantation had severe and/or very advanced sensorineural hearing loss.

In the remaining 4 patients, the procedure of subtotal petrosectomy and cavity obliteration was combined with the removal of a hearing prosthesis because of uncontrolled infection (of these, cochlear implant was removed in 3 patients, and an active electromagnetic middle ear implant was removed in 1 patient). The procedure was performed bilaterally in a single session in 1

Table 1. Surgical interventions and features of patients

Patient No	Age (year)	Duration of Follow-up	Gender	Indication	Auditory Rehabilitation	Complication	Revision
1	63	10	F	Extensive Cholesteatoma			-
2	45	12	M		VSB		+
3	31	10	F	Otorrhea			+
4	48	9	F		CI		+
5	38	13	M	Extensive Cholesteatoma			-
6	36	15	M		VSB		+
7	63	12	M	Otorrhea			+
8	53	10	F	VSB removed			+
9	58	12	M		VSB		+
10	37	18	M	Otorrhea			+
11	62	17	F	Otorrhea		Necrosis of EAC	+
12	27	15	F		CI		+
13	32	15	M	Otorrhea			+
14	54	14	F		CARINA		+
15	20	12	F	Otorrhea			+
16	14	11	M		VSB		+
17	36	11	M	Otorrhea		Necrosis of EAC	+
18	31	11	M	Otorrhea			+
19	11	9	M		CI		+
20	61	26	F	Extensive Cholesteatoma			-
21	64	24	F	CI removed			+
22	35	22	F		CARINA		+
23	47	24	M	Otorrhea			+
24	58	21	M	Right Facial Schwannoma		Formation of abscess in the otorrhea and cavity on the 7th post-op day	-
25	42	21	M	Otorrhea			+
26	60	21	F	Otorrhea			+
27	10	20	M		CI		+
28	67	19	F	Otorrhea			+
29	51	18	M		CI		+
30	55	30	F	Otorrhea			+
31	48	30	M	CI removed			+
32	44	28	F	Extensive Cholesteatoma			-
33	8	28	F		CI		+
34	9	26	F		CI		+
35	16	36	M	Otorrhea			+
36	45	33	F	Otorrhea		DKY nekrozu	+
37	40	38	M	Otorrhea			+
38	33	32	M		CI		+
39	15	50	F	Otorrhea			+
40	73	44	M	Extensive Cholesteatoma			-
41	65	43	M	CI removed			+
42	33	42	F	Otorrhea			+
43	46	38	F	Otorrhea			+
44	64	52	M	Extensive Cholesteatoma			-

VSB: Vibrant Soundbridge; EAC: external auditory canal; CI: cochlear implant

of 42 patients. While the cochlear implant was installed in the right ear of this patient, the cochlear implant in the left side was removed in the same session, and cavity obliteration was performed for both ears.

No operative complications associated with the surgical intervention were observed in the patients. However, cerebrospinal otorrhea and mastoid cavity infection developed in 1 patient on the 7th postoperative day. The patient was started on antibiotic therapy, and drainage was performed under general anesthesia, and recovery was obtained without any problem. Skin necrosis localized in the external auditory canal occurred in 3 patients, and it was repaired under local anesthesia.

Discussion

In the literature, it is seen that chronic otitis media patients with little cochlear reserve and otorrhea that can not be controlled by conventional methods are mainly exposed to subtotal petrosectomy and cavity obliteration (6). Similarly, our study included cases having chronic otitis media with uncontrollable otorrhea and severe hearing loss (sensorineural, mixed, or conductive-type). This procedure primarily aims to obtain an obliterated mastoid cavity clarified from the existent pathology, which does not have otorrhea and any relationship with the outer environment. Quite often, this pathology is the squamous epithelium that occupies "the middle ear, mastoid cavity, or broader temporal bone regions." Most of the cases in our series were active or recurrent cholesteatoma cases. Only 1 of 44 cases had facial nerve schwannoma originating from the geniculate ganglion and extending into the middle fossa and having destroyed the bone chain.

Another patient group that undergoes this procedure contains patients with radical mastoidectomy cavity and/or chronic otitis media, for whom cochlear implantation has been planned. In our series, 8 of the patients already had a radical cavity or ongoing chronic otitis media. For this patient group, the main purpose of cavity obliteration and the advantage that is aimed to be gained are to minimize the risk for infection, to prevent possible escape of the cerebrospinal fluid, and to decrease the risk for recurrent meningitis (7). The aim of the procedure of subtotal petrosectomy and cavity obliteration and cochlear or active middle ear implantation was also the same in our clinic. By providing isolation of the electrode from the mastoid cavity and thus from the outer environment after cochlear implantation, the risk for contamination and infection of the labyrinth and central nervous system is reduced. In our series, cochlear implants that had been implemented without a "cul de sac" in 3 patients and an active middle ear implant in 1 patient were removed because of mastoid cavity problems, and cavity obliteration was performed for these patients. This application is not limited to only cochlear implants. It can also be implemented for patients who have cavity problems and who have undergone active middle ear implants (8, 9). Blind sac closure procedure inevitably results in the elimination of middle ear functions. Therefore, in spite of being a quite effective method for infection control, it has not been used for patients having little cochlear reserve, in order to avoid hindering the implementation of hearing aids for many years. However, the development of bone-implantable hearing devices that will stimulate the cochlea directly or active middle ear implants has expanded the indication of this procedure. In our study, a secondary implant of a hearing aid into the bone and primary or secondary active middle ear implant into the round window were applied.

Although the procedure of subtotal petrosectomy and cavity obliteration has been modified by many otologists from the early years up to now, the main principles have remained the same (10, 11). Some complications associated with the procedure are especially emphasized. The most important complications include infected oil used in the obliteration, skin necrosis that can occur in the external auditory canal, and formation of cholesteatoma by the squamous epithelium confined to the cavity. In the follow-up of postoperative cavity infection, observations during daily dressings and vital signs have importance. In our study, cerebrospinal fluid fistula that presented with rash, increased temperature, and sensitization on the surgical site and occurrence of infection were observed only in 1 patient on the 7th postoperative day. This case was drained under general anesthesia, and recovery was provided through parenteral antibiotic therapy uneventfully. Some authors suggest that abdominal fat tissue should be washed with "rifampicin" before being placed into the cavity in order to minimize the risk for infection in the cavity (7). Three complications associated with skin necrosis of the external auditory canal were observed in our series of 44 cases. Each of these 3 cases was revised under local anesthesia. In the literature, it is recommended (especially in revision cases where the skin of the external auditory canal should be sutured as "stratified" (skin and subsurface skin separately) without stretching when possible (7, 11). In our cases, during suture of the external auditory canal, we prefer to decollate the anterior wall skin of the external auditory canal as completely as possible and to suture using a horizontal matrix technique with Vicryl without stretching. It is important for the elimination of the infection in the temporal bone that all cells of the temporal bone are opened and that eradication of existing disease is provided. However, in spite of all precautions, "echo-planar" magnetic resonance imaging (MRI) is used when the presence of infection in the cavity is suspected. The control of the squamous epithelium that is confined to the cavity and leads to the formation of cholesteatoma is the most significant point that should be considered during the follow-up period after cavity obliteration. Different opinions have been presented on the necessity and means of radiological imaging during this stage. For instance, in the literature, although there have been some authors who support the use of MRI for observing the development of cholesteatoma, some have used and also suggested bone window computed tomography (CT) (Figure 2, 3) (7). For this aim, we recommend clinical and radiological follow-up examination every 6 months for the first year and once a year for the

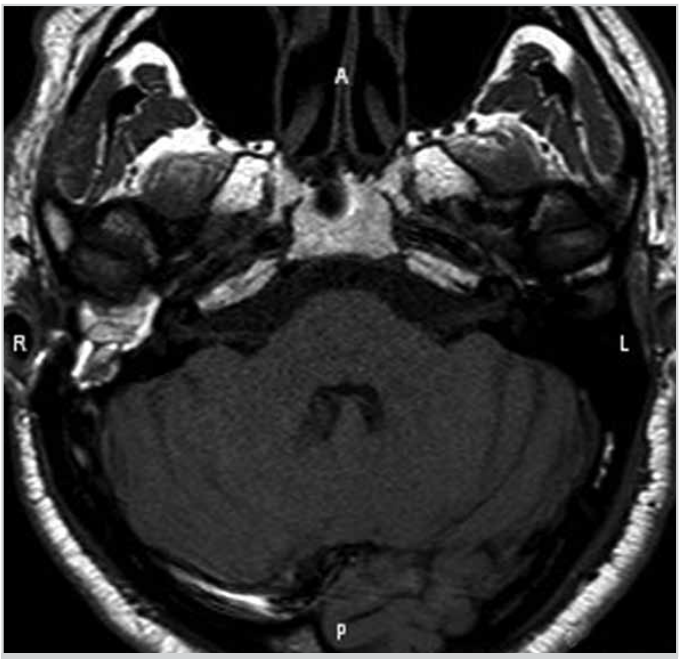

Figure 2. Postoperative MRI (T1-weighted) image of a patient who underwent cavity obliteration (hyperechogenic brightness associated with fat tissue draws attention)
MRI: Magnetic Resonance Imaging

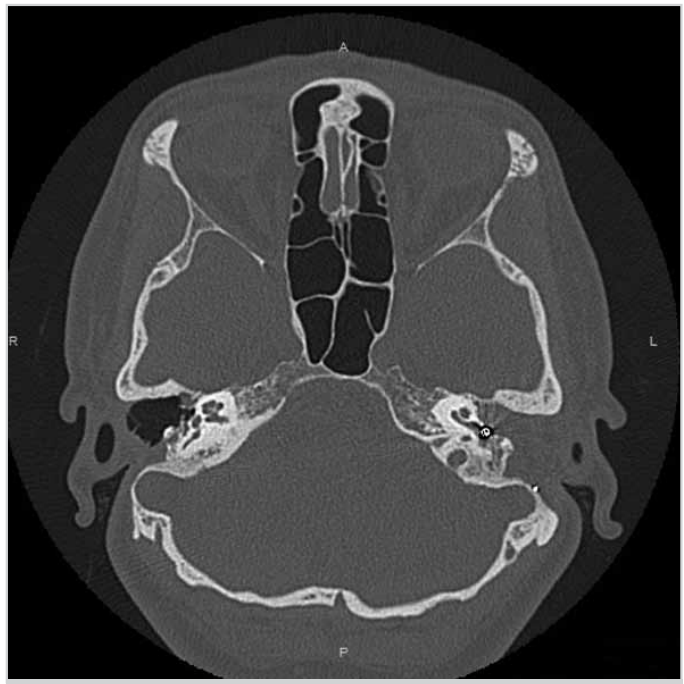

Figure 3. Postoperative CT image of a patient who had a VSB applied on the round window and cavity obliteration
VSB: Vibrant Soundbridge; CT: Computed Tomography

following period. However, there are some authors suggesting radiological imaging in the 1st, 3rd, 5th, and 10th postoperative years (7). In our cases, the occurrence of cholesteatoma has not been observed up to now. For cases that have undergone middle ear implantation or cochlear implantation, MRI is not a healthy monitoring method due to artifacts. Therefore, it is important that the procedure of subtotal petrosectomy be performed by experienced surgeons.

Conclusion

As a result, it can be suggested that subtotal petrosectomy and blind sac closure technique can be used for infection control and patient comfort in patients with little cochlear reserve and that they can be applied widely in chronic otitis cases that will undergo active middle ear or cochlear implantation.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Bozyaka Teaching and Research Hospital (2014-94).

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