

## Original Article

# Long-Term Outcomes from Blind Sac Closure of the External Auditory Canal: Our Institutional Experience in Different Pathologies

Mordechai Kraus , Fatemeh Hassannia , Michael J Bergin , Khalid Al Zaabi ,  
John Alexander Rutka 

Department of Otolaryngology Head and Neck Surgery, University Health Network, Toronto, Ontario, Canada

ORCID iDs of the authors: M.K. 0000-0001-5349-7143; F.H. 0000-0003-2358-9738; M.J.B. 0000-0002-5132-9063; K.A.Z. 0000-0002-5230-9355; J.A.R. 0000-0002-4318-8467.

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**OBJECTIVES:** This study reports long-term results of blind sac closure of the external auditory canal performed for various pathologies, compares the complication rates and the need for revision surgery.

**MATERIALS and METHODS:** This study is a retrospective review. Ninety-six cases of blind sac closure performed for various pathologies were included in this study. The primary pathologies included extensive mucosal disease in an open mastoid cavity, cholesteatoma, skull base lesion, cerebrospinal fluid leak, and osteoradionecrosis of the temporal bone. Preoperative history, postoperative complications, and the need for revision surgery were evaluated.

**RESULTS:** The most common indication for blind sac closure in our series involved skull base lesions (62.5%). The mean follow-up period was 46 months (4 months – 20 years). The total complication rate related to blind sac closure was 10.4%. The median time between surgery and long-term complications was 5.5 years. Patients with chronic mucosal disease had the highest rate of complications.

**CONCLUSION:** Blind sac closure of external meatus can be effectively performed for different pathologies. Long-term follow-up with patients is necessary. Patients with chronic mucosal disease have the highest complication rates.

**KEYWORDS:** Blind sac closure, mastoid obliteration, external auditory canal, eustachian tube closure

## INTRODUCTION

Obliteration of the middle ear cleft with blind sac closure (BSC) of the external auditory canal and subtotal petrosectomy (STP) were first introduced by Rambo <sup>[1]</sup> in 1958 and further refined by Ugo Fish et al. <sup>[2]</sup> in 1965. This procedure effectively manages the chronically discharging ear with profound hearing loss or large conductive loss that is not amenable to surgical correction <sup>[3]</sup>. After BSC, the cavity is typically filled with abdominal fat or muscle. The goals of the procedure are to obtain a safe and dry ear, optimize postoperative care, and increase long-term satisfaction of the patient.

However in circumstances where cholesteatoma matrix is left behind, especially on the dura, a remnant of epithelium may eventually form recurrent cholesteatoma. Follow-up recommendations to assess recurrence in an obliterated cavity include magnetic resonance imaging (MRI), fat suppression, and diffusion weighted imaging (DWI). Other complications include postoperative infection or dehiscence at the BSC site.

This technique has been used for other indications such as cerebrospinal fluid (CSF) leakage (spontaneous or following other skull base surgery), improving access for complicated cases of vestibular schwannoma, glomus or other middle ear tumors, and others.

Although there is a lot of literature about BSC of the external auditory canal, complication comparisons between chronic otitis media and other pathologies have not been emphasized enough, and the follow-up period in previous studies has been relatively short.

**Corresponding Address:** Fatemeh Hassannia E-mail: fatimahassannia@yahoo.com

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The aim of this retrospective study is to demonstrate our long-term results and to discuss and compare the postoperative complications among different primary indications for which BSC was performed at a tertiary referral center.

## MATERIALS AND METHODS

This study is a retrospective chart review of all the patients who underwent BSC of the external auditory canal at a tertiary referral center between 1992 and 2019. The study employed a waiver of informed consent and was approved by the UHN Research Ethics Board (19-5764). The electronic charts were analyzed for indications, history, surgical details, and postoperative complications.

The complications were categorized as short-term (<3 months) and long-term (>3 months) based on their onset. Serviceable hearing was defined as a pure tone average of less than 50 dB and speech discrimination score of more than 50%. Patients with incomplete records were excluded. All surgeries were performed by the senior author.

## Surgical Technique

All procedures were performed under general anesthesia with intra-operative facial nerve monitoring. Following a post-auricular incision, an anteriorly based periosteal flap was raised. The external auditory canal skin was transected at the osseous-chondral junction of the external canal and the skin was raised off the underlying cartilage to produce a 1 cm sleeve of external canal skin. The external ear canal was everted with Fisch technique and closed off in a blind sac fashion with 2-0 polysorb simple interrupted stitches. The periosteum was sutured in a trapdoor fashion over the canal skin sac as a second seal. A subtotal petrosectomy or modified radical mastoidectomy was performed. Any remaining external auditory canal skin, tympanic membrane, and annulus were removed, as were the malleus and incus (if present). The bony external canal was further drilled to ensure no remnant of squamous tissue was buried within the wound. The eustachian tube was obliterated using pieces of periosteum and/or cartilage. The cavity was then filled with abdominal fat harvested from left lower abdomen and sealed with Tisseel (Baxter Corporation, Mississauga ON Canada). Harvested fat was allowed to soak in antibiotic solution prior to obliteration.

## Statistical Analysis

All data were entered in a computer and analyzed using the Statistical Package for Social Sciences (SPSS) statistics software package

version 21.0 (IBM Corp., Armonk, NY, USA). Chi-squared test was used in assessing the significance of data difference. The level of significance was  $p < 0.05$ .

## RESULTS

Between 1992 and 2019, BSC of the external auditory canal with obliteration of the mastoid cavity was performed in 96 patients (54 women and 42 men) with a mean age of 49.9 (18-75) years. Fifty procedures were performed on the right ear and 46 on the left one. Fifty-three patients (55%) had a severe to profound hearing loss; only two patients had mild preoperative hearing loss. Forty-two (44%) patients had previous otologic surgery.

Mastoid obliteration with BSC of the external auditory canal was performed in patients with four different primary pathologies; chronic inflammatory middle ear and mastoid disease (with or without cholesteatoma); skull base lesions; CSF leakage; and osteoradionecrosis of the temporal bone (Table 1). Skull base lesions were the most common indication for BSC in our series (62.5%).

Among 12 patients with chronic mastoid disease, 11 (92%) had undergone one or more surgeries prior to the BSC. Ten (83%) patients of this group had no serviceable hearing. The mean follow-up period was 46 months (4 months-20 years).

Overall, ten patients (10.4%) in our series had complications related to BSC. There were four patients with short-term and six with long-term complications (Table 2). The median time between surgery and the long-term complications was 5.5 years (6 months-14 years). Table

**Table 1.** Number of blind sac closure cases in different pathologies

Primary pathology	Number (%)
Chronic inflammatory disease	12 (12.5%)
Extensive mucosal disease	10
Cholesteatoma	2
Skull base lesions	60 (62.5%)
Vestibular schwannoma	31
Glomus tumor	12
Other schwannoma	6
Sac adenocarcinoma	4
Petrous apex cholesteatoma	3
Others	4
CSF leakage repair	19 (20%)
Following skull base surgery	13
Post tympanomastoidectomy	2
Idiopathic	2
Mondini	1
Metastatic carcinoma	1
Osteoradionecrosis	5 (5%)
Total	96 (100%)

CSF: cerebrospinal fluid

## MAIN POINTS

- Blind sac closure (BSC) of the external auditory canal/mastoid obliteration is performed for different primary pathologies including persistent chronic otitis media, following skull base tumor resection, CSF leakage and osteoradionecrosis of temporal bone to provide a safe and dry ear in certain circumstances.
- Patients with chronic mucosal disease have a higher post-operative complication rate over the longterm.
- Complications can occur as late as 14 years after BSC.
- Long-term postoperative MRI surveillance with fat suppression and DWI sequences should be conducted in all patients following BSC if clinically concerned.

3 shows cases with complications, which are discussed further below. Revision surgery was required for 7 (7%) patients.

Both short- and long-term complication rates in our series were significantly higher in patients with chronic inflammatory disease (Table 4). This difference was statistically significant for long-term complications between chronic mastoid disease and skull base tumor groups (Chi-squared test, p=0.01).

**DISCUSSION**

Mastoid obliteration and BSC of the external auditory canal are being increasingly performed for various pathologies. As hearing rehabilitation has improved in recent years with contralateral routing of sound (CROS) aids, implantable hearing aids, bone anchored hearing aids, and cochlear implantation, this technique has become more common. These devices address conductive hearing loss resulting from obliteration of the external auditory canal and help to restore binaural hearing.

BSC of the external auditory canal has been performed for different primary pathologies at our center between 1992 and 2019. Our first patient group had chronic otitis media with persistent otorrhea (due to either cholesteatoma or extensive mucosal disease), and 92% of these cases had undergone one or more surgeries previously; all except two had non-serviceable hearing.

The second patient group was those with skull base tumors. In larger vestibular schwannomas with restricted mastoid cavity access, the

**Table 2.** Complications Number (%)

Complications		Number (%)
Short term	Abdominal hematoma	1 (1.5)
	Closure breakdown	1 (1.5)
	Wound dehiscence/discharge	2 (2)
Long term	Pre-auricular abscess	1 (1.5)
	Epidermoid cyst	1 (1.5)
	Post-aural abscess due to retained skin	4 (4)
Total		10 (10.4)

**Table 3.** Complications

Patient	Diagnosis	Complication	Time to complication	Revision surgery
1	CSF leak following VS surgery	Abdominal hematoma	Same day	Yes
2	Middle ear adenoma	Closure break down	Gradually after surgery	Yes
3	Petrous apex cholesterol granuloma	Wound dehiscence	One month	No, local care
4	Glomus jugular	Wound discharge	2 weeks	No, local care
5	Mastoid mucosal disease	Post-aural fistula/retained skin	1 year	Yes
6	Meningioma	Post-aural fistula/retained skin, recurrent meningioma	6 months	Yes
7	CSF leak following VS surgery	Post-aural fistula	9 years	Declined
8	Vestibular schwannoma	Post-aural abscess (retained skin)	6 years	Yes
9	Mastoid mucosal disease	Pre-auricular fistula	5 years	Yes
10	CSF leak following VS surgery	Epidermoid cyst	14 years	Yes

VS: Vestibular schwannoma, CSF: Cerebrospinal fluid

senior author used an extended translabyrinthine approach with BSC of the external auditory canal, removal of the posterior bony canal wall, obliteration of the eustachian tube and middle ear to improve surgical access and reduce the risk of postoperative CSF leakage. Falcioni et al. [4] reported their results from 200 consecutive cases of translabyrinthine vestibular schwannoma removal, which was extended to 22 patients with BSC of external auditory canal but did not discuss BSC complications. To our knowledge, our study is the first to evaluate the complications of blind sac surgery in patients with vestibular schwannoma with an enlarged translabyrinthine approach.

Our final two groups included patients with a CSF leak (mostly, following a skull base tumor surgery) and osteoradionecrosis of the temporal bone. Patients with osteoradionecrosis of the temporal bone had no postoperative complications in our series. Most cases involved nasopharyngeal or parotid malignancy after radiation therapy. The low complication rate in this cohort may be attributed to lack of previous otologic surgery with disruption of tissue planes; thus, complications related to wound breakdown would be less. Additionally, most of these patients initially received a conservative medical therapy, including topical antibiotic, steroid drops, and in-office debridement, prior to surgery, which may have resulted in fewer infections in this group. The small sample size in this group may also have affected the results.

One female patient had closure breakdown of the blind sac area after the surgery. A number of surgeries had been performed on that ear (not in our center) for what appeared to be a middle ear adenoma.

**Table 4.** Complications related to blind sac closure based on primary pathology

Primary pathology	Short-term complication rate	Long-term complication rate
Chronic inflammatory mastoid disease	8% (1/12)	17% (2/12)
Skull base lesions	3.5% (2/60)	3.5% (2/60)
CSF leak repair	5% (1/19)	10.5% (2/19)
Osteoradionecrosis	0%	0%

CSF: cerebrospinal fluid

Because of the extensive mucosal disease and continuous discharge, an STP with BSC of ear canal was performed. Unfortunately, after surgery, the incision broke down and she underwent revision mastoid obliteration and closure. Two patients had wound discharge postoperatively which was completely resolved with local care.

While only two patients had a preoperative diagnosis of cholesteatoma, neither of them had complications from residual disease. In contrast, one patient with mucosal disease and three patients with skull base tumor resection or CSF leak repair had late complications pertaining to epithelium retention. One of these patients declined revision surgery and is still followed clinically. Revision surgery was performed on two patients, and both had evidence of implantation cholesteatoma. For another patient, increasing discomfort occurred in the operated ear 14 years after surgery. An MRI revealed an abnormal DWI signal, indicating an epidermoid cyst or fat necrosis. On revision surgery, epidermoid cyst and cholesterol granuloma were found inside the cavity.

Another patient originally underwent neurosurgical removal of an extensive intracranial meningioma involving the middle cranial fossa and presented with post-aural discharge and Bezold abscess. On review, the tumor was found to involve the middle ear and mastoid with significant associated hearing loss. An STP with BSC was performed, and the fistula tract was excised. Unfortunately, six months after BSC, she developed another post-aural abscess. Revision mastoidectomy with excision of recurrent meningioma and implantation cholesteatoma was performed.

The final patient presented with two bouts of mastoiditis five years after surgery. She had a pre-auricular sinus (noted preoperatively), the extent of which was unappreciated earlier. On revision surgery, a fistula was noted between this pre-auricular abnormality and the mastoid cavity, which explained the cause of infection. The pre-auricular fistula was excised and the cavity was re-obliterated with a temporalis muscle flap. There was no evidence of cholesteatoma in the cavity.

Complications of BSC of the external auditory canal in patients with chronic mastoid disease have been reviewed in the literature<sup>[5,6]</sup> and show wound infection, residual cholesteatoma, and post-aural abscess as the most common complications. In the largest published series, to date, involving 460 patients who underwent STP for various indications, Prasad et al.<sup>[3]</sup> reviewed the indications and outcomes of BSC. In contrast to our study, however, patients with transotic, transcochlear, or infratempora fossa approaches were not included and their 36-month follow-up was shorter than ours. The most common indication for STP in these patients was recurrent chronic otitis, with or without cholesteatoma. Recidivism (1.1%) and post-auricular wound fistula (1.1%) were the most common postoperative complications. In our study, patients with mucosal disease seemed to have a higher rate of complication, and we believe that a history of multiple previous surgeries and chronic mastoid infection might explain this.

Muzaffar et al.<sup>[7]</sup> identified recurrent disease in two cases of cholesteatoma and one case of glomus tumor from a series of 33 BSC patients. Retained diseased mastoid air cells, chronic inflammatory processes

within the cavity, or epithelial implantation may be the cause of this observation. Additionally, patients who have had multiple previous surgeries can further complicate the BSC surgery. In contrast, none of our cases with epithelium retention were in patients with primary cholesteatoma and were, instead, likely due to unintended epithelial implantation at the time of surgery.

Only one study dealt with complications of BSC in patients with spontaneous CSF leak<sup>[8]</sup>. In this study, 36% of the patients with spontaneous CSF leak, developed post-auricular, or abdominal site infection following mastoid obliteration and BSC. In our study, complications of BSC (both short-term and long-term) were observed in 16% of the patients with CSF leak. Cases of leak in our patients, however, were mostly following skull base tumor removal as only one patient in our series had a spontaneous CSF leak.

One patient in our study had wound closure breakdown. This was a patient with a recurrent middle ear adenoma who had had multiple surgeries prior to BSC. Difficulty in dissecting the external auditory canal and a relatively poor blood supply was the reason thought for the local failure. Although some studies recommended using muscle graft and connective tissue to reinforce the closure in revision cases<sup>[9]</sup>, Lyutenski et al.<sup>[10]</sup> failed to show any differences in the rate of revision surgery due to impaired wound healing when comparing groups of patients with and without reinforcement.

One patient had a pre-auricular abscess following BSC. This patient had a congenital pre-auricular pit, which was not fully appreciated on clinical examination and was the probable source of mastoid cavity infection and subsequent abscess. It is, therefore, important to examine patients for any pre-auricular fistula or pit before BSC.

Considering the onset of complications 14 years after surgery in one patient, it seems reasonable that to detect the development of late complications, long-term postoperative MRI surveillance with fat suppression and DWI sequences should be conducted.

## CONCLUSION

Our study is the first to compare complications of BSC after various surgical approaches and for various indications. We have also presented the longest follow-up of any published BSC series.

BSC of the external auditory canal can be effectively used in different clinical situations including skull base tumors involving restricted mastoid access; however, long-term follow-up of patients is necessary. Patients with chronic mucosal disease seem to have a higher complication rate and require a higher index of suspicion for developing long-term complications.

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**Conflict of Interest:** The authors have no conflict of interest to declare.

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