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Subtotal Petrosectomy and Mastoid Obliteration in Adult and Pediatric Cochlear Implant Recipients

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Abstract

Objective—To investigate the effect of subtotal petrosectomy and mastoid obliteration (SPMO) on the overall success of adult and pediatric cochlear implant (CI) recipients.

Study Design—Retrospective Case Series

Setting—Tertiary Care Referral Center

Patients—39 ears in 36 patients (23 adults and 13 children) received both surgeries between 1990 and 2012.

Intervention—CI candidates underwent SPMO to permit implantation and minimize the risks of infectious complications in the recipient ear. SPMO was performed prior to (69.3%), at the time of (25.6%) and after CI (5.13%). Mastoids were obliterated with fat (30.8%), muscle (66.7%), and bone pate (2.56%).

Main Outcome Measure—Feasibility, complications and success of SPMO and CI were assessed with standard statistical analysis and Fischer's Test with Two Sided P –Values.

Results—Ear disease was definitively managed and CI was successfully placed in all but one case. Complications including abscess (n=3), subcutaneous emphysema (n=1), ear canal granulation formation (n=1) and electrode extrusion (n=1) occurred in 15.4% of patients. Predisposing syndromes were present in children more often than adults (43.8% vs 13.0%, p=0.0598). Adults more often than children had previous mastoid surgery for middle ear disease (30.4% vs 0.0% p=0.0288). CIs were placed under local anesthetic and sedation (n=3) and after radiation treatment for nasopharyngeal cancer (n=2) in adult ears.

Conclusions—SPMO is an effective and safe procedure for definitively managing middle ear disease and implanting adult and pediatric CI candidates.

Keywords

Cochlear Implant; Subtotal Petrosectomy; Mastoid Obliteration; Recurrent Acute Otitis Media; Chronic Ear Disease; Otitis media; Pediatric; Adult; Canal Closure

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Introduction

Middle ear disease continues to be an obstacle to overcome for cochlear implant (CI) candidates and a risk to avoid for CI recipients. The typical age for pediatric cochlear implantation corresponds with the peak age for recurrent acute otitis media (RAOM), and profound hearing loss resulting from middle ear disease progression or surgical treatment can be an indication for cochlear implantation. Subtotal petrosectomy with mastoid obliteration (SPMO) has been shown to definitively address active and prevent future otitis media in these situations. [1-3]

Common indications for SPMO with CI include salvage of ears after failure of myringotomy tubes (MT) management in otitis media (OM) prone children; chronic otitis media (COM) including ears with chronic perforation, a radical cavity, or previous cholesteatomatous deformation; and facilitating surgical exposure for difficult cochleostomies in adults and children.[1-9] The majority of studies involving SPMO and CI however do not distinguish between the pediatric and adult ear outcomes. In order to elucidate the optimal role of SPMO in these two distinct CI age groups, a single academic institution experience is presented for analysis. (See Methods, Supplemental Digital Content)

Results

The majority of adults and almost all pediatric patients underwent SPMO and CI without adverse event (78.3% vs 93.8%, $p=0.370$). Table 1 provides the patient cohort demographics. SPMO and CI were performed in slightly more adult ($n=23$) than pediatric ($n=16$) ears. Table 2 lists the indications for SPMO along with other ear characteristics. There were four reported deaths in the medical records. Two patients died over 4 years after their last ear surgery at 90 and 74 years of age from causes unrelated to their ears. Two patients died of causes unrelated to their SPMO and CI within 1 year of their procedure. One patient requiring chronic pain palliation and debilitated from nasopharyngeal cancer died in his sleep without any specific otologic complaints. One patient 81 years of age died before receiving a functioning replacement CI after explantation of her initial CI for a postoperative infection. At the time of her passing, the patient's surgical site was without infection and she had no otologic complaints. Except for this patient, all other cases received successful CI with control of middle ear disease after SPMO.

Complications

There were no episodes of major complications such as meningitis or cholesteatoma after SPMO and CI in either children or adults. Minor complications were rare in children with only one case of electrode extrusion through a break down in the ear canal blind pouch 5 months after simultaneous surgery. The electrode was repositioned at a separate surgery within weeks of discovery, and the device did not require explantation or further intervention.

In adults, 3 ears developed abscesses, all after simultaneous SPMO and CI. One patient mentioned in the mortality discussion above had a history of cleft palate, profound hearing loss and prior canal wall down mastoidectomy with atelectasis and COM. After undergoing simultaneous SPMO and CI, she developed a surgical site infection. This was debrided and irrigated 2 months postoperatively but continued to demonstrate evidence of infection. The CI was explanted 5 months postoperatively. Following 6 weeks of antibiotics, the patient's symptoms resolved and she was noted to have no evidence of infection at both her last otolaryngology and last infectious disease clinic evaluation. Unfortunately, the patient expired from unknown causes before receiving her scheduled reimplantation. In another case, a patient with immune deficiency as well as history of immunosuppressant therapy for

autoimmune hearing loss developed an abscess requiring incision and drainage within 1 week of simultaneous SPMO and CI. The device was explanted 2 weeks later and the infection resolved with intravenous antibiotics. Reimplantation was successfully performed 3 months later. The third case of severe wound infection underwent simultaneous SPMO and CI due to the sclerotic nature of his mastoid preventing adequate surgical exposure. The patient developed an infection requiring debridement of the external auditory canal and intravenous antibiotics. Two weeks later with no improvement, the CI was explanted. The infection improved, and a new CI was successfully reimplanted 4 months after his initial CI.

Noninfectious complications in adults were rare. In one case involving infracochlear cholesteatoma with petrous extension, an ear developed a subcutaneous accumulation of air 8 months after staged SPMO and CI. The patient underwent a transnasal ablation of the Eustachian tube with fat harvested from the ear lobe, and the subcutaneous air resolved. Due to the patient's diabetes, severe obstructive sleep apnea and morbid obesity, the CI and nasal procedure were performed under MAC. In another case, a patient required revision of her ear canal skin closure after staged SPMO due to granulation tissue forming prior to her CI. Overall complications including infectious and noninfectious were less common and less severe in the staged SPMO and CI than the simultaneous performance of SPMO and CI (6.90% vs 40% $p=0.0284$).

Discussion

Pediatric and adult middle ears can present distinctly different challenges for the CI surgeon. Early Eustachian tube dysfunction often results in RAOM, and congenital anomalies are more frequently encountered in congenitally deaf children. Adult ears, on the other hand, are more likely to involve cholesteatoma, previous mastoid surgery or other tumor pathology and, in our series, had a higher rate of complications. In this review, pediatric ears did remarkably well with SPMO and CI with only one complication noted. Overall pediatric ears had not only fewer but also less severe complications after SPMO and CI than adult ears. This is likely due to more severe middle ear disease in adult ears undergoing SPMO and CI compared to pediatric ears. In either age group, ensuring a safe middle ear was essential to permit and sustain the CI ear. The SPMO achieved this objective in all cases except one regardless of age.

While the combination of SPMO and CI has been demonstrated in children in other studies, a direct comparison between adult and pediatric outcomes has not been previously performed. Furthermore, the use of an obliterative technique as a primary management strategy for controlling RAOM in pediatric CI candidates has not been emphasized in the literature. The contrast with the adult experience in this study underscores the particular safety of SPMO for the younger CI population.

A number of studies support the use of MT for the management of OM in pediatric CI candidates.[10-12] Due to the inherent bias in clinical decision-making based on disease severity, we did not seek to compare the outcomes in patients managed by MT with those undergoing SPMO in this retrospective review. In other series, the complications that are noted for nonobliterative management often required additional surgeries to address the tympanic membrane including SPMO or canal closure. The earlier application of SPMO in ears prone to OM eliminates the risk of middle ear disease and provides an ear that does not require continued microscopic evaluation or possible tympanic membrane surgery. This is particularly relevant for syndromic children who may present a more challenging clinical exam. SPMO allows for a life-time of CI use without the risks of recurrent or chronic ear disease. A 4-6 week delay in CI placement and the need for a second anesthetic represent the

downsides of staging SPMO and CI. However, in children prone to OM, we feel the advantages SPMO and CI often outweigh these disadvantages.

SPMO also effectively addresses more severe and destructive middle ear disease. Previous case reports together with the current study confirm the utility of SPMO and CI in ears with cholesteatoma or destructive COM.[1-7, 9, 13] These ears with more advanced disease were more common in adults and likely account for the higher incidence of complications in the adult patients compared to the pediatric population.

Utilizing MAC for the staged CI placement and rehabilitating ears suffering from COM following radiotherapy to the skull represent two underreported application for which SPMO and CI plays an important role. After radiotherapy for skull base malignancies, ears can develop profound SNHL and be plagued with difficult COM. Following SPMO, it is feasible to perform the staged CI under local anesthesia as illustrated by 3 cases in our series. One patient implanted under MAC suffered from severe trismus following re-irradiation of his nasopharyngeal cancer that prohibited transoral intubation. The alternative anesthesia avoided a potential tracheostomy that would have otherwise been necessary. In another case with morbid obesity, severe sleep apnea, and diabetes, utilization of MAC for CI placement spared a patient a general anesthetic and difficult intubation.

Conclusions

The potential of the SPMO in preparation for CI and treatment of chronic ear disease is supported in this study looking at pediatric and adult ears separately. Especially in the pediatric population, the postoperative course of SPMO can be expected to maintain definitive treatment of middle ear disease with a low risk of complications. In adults and ears with severe disease, postoperative surveillance for infections and complications remains crucial. In difficult anatomy, removal of the posterior canal and tympanic membrane enhances exposure of the cochlea. When considering individual candidate ears with middle ear disease or anatomic limitations, SPMO is a reliable adjunct to cochlear implantation for both children and adults.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Demographics

	Adult	%	Pediatric	%
n	23	63.9	13	36.1
Age(years)	59.9±17.8		4.08±3.36	
Male	12	52.2	8	61.5
Female	11	47.8	5	38.5
Total Ears	23	59.0	16	41.0

Table 2**Preoperative Characteristics**

	Adult n=23	%	Pediatric n=16	%	p-value
SPMO Indication					
Cholesteatoma	5	21.7	0	0.0	0.0660
RAOM	0	0.0	7	43.8	0.0007
COME	1	4.3	2	12.5	0.557
CSOM	8	34.8	6	37.5	1.00
Atelectasis/Retraction	2	8.7	0	0.0	0.503
CWD Mastoid Cavity	2	8.7	0	0.0	0.503
Surgical Anatomy	4	17.4	1	6.25	0.631
Contralateral Explanted for Infection	1	4.3	0	0.0	1.00
Previous Ipsilateral Surgery					
Mastoid	7	30.4	0	0.0	0.0288
Myringotomy Tubes	5	21.7	10	62.5	0.0184
Comorbidities					
Syndrome	3	13.0	7	43.8	0.0598
Cleft Palate	2	8.7	3	18.8	0.631
NPC/XRT	2	8.7	0	0.0	0.631
Immune Deficiency	2	8.7	2	12.5	1.00

Table 3**Surgical Details**

	Adult	%	Pediatric	%
CI				
Left Only	8	34.8	3	18.8
Right Only	15	65.2	7	43.8
Simultaneous Bilateral (total ears)	0	0.0	2	12.5
Sequential Bilateral (total ears)	0	0.0	4	25.0
Planning				
Planned SPMO	21	91.3	8	50.0
Unplanned SPMO	2	8.7	8	50.0
Staging				
Staged SPMO before CI	17	73.9	10	62.5
Simultaneous	6	26.1	4	25.0
Staged SPMO after CI	0	0.0	2	12.5
Obliteration				
Fat	7	30.4	5	31.3
Muscle	16	69.6	10	62.5
Bone Pate	0	0	1	6.25
Drain				
Passive Drain	16	69.6	8	50.0
No Drain	7	30.4	8	50.0
Anesthesia				
MAC CI	3	13.0	0	0.0
No MAC CI	20	87.0	16	100

Table 4

Postoperative Outcomes

	Adult	%	Pediatric	%	p-value
Complications					
Total	5	21.7	1	6.3	0.370
Meningitis	0	0.0	0	0.0	1.00
Cholesteatoma	0	0.0	0	0.0	1.00
Abscess	3	13.0	0.0	0.0	0.255
Air Pocket	1	4.3	0.0	0.0	1.00
Canal Granulation	1	4.3	0.0	0.0	1.00
Electrode Extrusion	0	0.0	1	6.3	0.410
Device Status					
Explant for Device Failure	2	8.7	1	6.3	1.00
Explant for Infection	3	21.7	0	0	0.255
Reimplant	4	17.4	1	6.3	0.630
Success	22	95.7	16	100	1.00