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Case Report

# Iatrogenic trichloroacetic acid injury causing necrotizing otitis media and deafness

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## 1. Introduction

Trichloroacetic acid (TCA; also known as trichloroethanoic acid) is a corrosive agent that can produce significant burns when applied topically to the skin or mucosal membranes [1]. This property underlies its use in numerous dermatologic and gynecologic procedures including wart removal, chemical dermabrasion, and ablation of pre-cancerous and cancerous lesions of the skin and genitals [2–4]. In otology, TCA is used topically to help small tympanic membrane (TM) perforations to heal and to calm granular myringitis; it may also be useful in the treatment of acute external otitis [5,6].

Reports of serious complications related to the use of TCA are uncommon, and none have been reported in the otology literature. We describe a case of iatrogenic chemical injury to the ears of an infant as a result of wrongful instillation of TCA following tympanostomy tube insertion.

## 2. Case report

A 10-month-old female who had passed the newborn auditory screening suffered recurrent acute otitis media for which she underwent bilateral tympanostomy tube placement under general anesthesia. At the end of the procedure, the intent was for topical Ciprodex antibiotic-steroid ear drops to be instilled into the patient's ear canals bilaterally. A few minutes after the procedures, in the post-anesthesia care unit, the surgeon was notified by the nurse about an unusual whitish appearance of the ears. The surgeon promptly came to realize that 50% trichloroacetic acid had been instilled inadvertently (Table 1). Each ear was immediately flushed profusely with saline, Ciprodex otic drops were instilled, and analgesics were prescribed. The patient experienced several days of intense pain and about seven weeks of otorrhea bilaterally. Once the drainage was suctioned at postoperative day 13, each tympanostomy tube was described as “perfect”. Specimens from the patient's right ear grew *Turicella otitidis* sensitive to penicillin, ceftriaxone, meropenem and vancomycin. The tympanostomy tubes dislodged laterally nine weeks after the procedure, leaving a 30% perforation in the right tympanic membrane and a 20% perforation on the left. By 15 weeks postoperatively, each perforation had enlarged to involve 50% of the tympanic membranes. No facial nerve dysfunction occurred. In sound field at age 12 months, responses to stimuli centered at 0.5, 1, 2, and 4 kHz were at 15, 20, 20, and 20 dBnHL, respectively; a month later, the speech reception threshold was 50 dBnHL in the right ear and 55 dBnHL on the left. The patient's family became increasingly concerned about her hearing, and she was referred to the senior author 4 months after the injury.

At the initial consultation with the senior author when the child was age 14 months, the family reported the child's speech development had been appropriate for her age prior to the incident. Exam revealed an otherwise healthy child with 60% and 75% perforations of the tympanic membranes (TM) on the right and left, respectively (all clinical ear examinations were with an operative microscope). Facial function was intact. No stenosis or inflammation of the external auditory canal (EAC) was present. Audiologic testing demonstrated maximal conductive hearing loss with type B tympanograms and increased ear canal volumes in both ears. The

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child was fit for a bone-conduction hearing aid at this time.

The damage continued to evolve with "near-total" perforation of the right TM and "total" perforation of the left TM seen six weeks later; findings were similar at ages 17 and 19 months. Audiometric testing at age 18 months was consistent with profound mixed hearing loss of the right ear and profound sensorineural hearing loss of the left ear. Magnetic resonance imaging at that time showed normal temporal bones without suggestion of labyrinthitis ossificans. After a three-month trial of bone-conduction amplification without benefit, the family opted to pursue bilateral cochlear implantation (CI).

Surgeries were done in stages. At age 20 months, the worse-hearing left ear underwent complete mastoidectomy and closure of the EAC. The chorda tympani nerve and most of the manubrium of the malleus were absent; neither the malleus remnant nor stapes moved to palpation. The stapes was represented only by the capitulum and anterior crus; the footplate moved slightly to palpation. Pathology specimens demonstrated chronic inflammation and osteomyelitis of the ossicles and mastoid. Soft tissues of the bony EAC were extremely fragile, thus a bipedicled flap of periosteum and galea was used to reinforce the closure. Four weeks later, CI with an Advanced Bionics Model CI-1500-04 was accomplished. The scala tympani was found to be ossified beyond what could be drilled out via cochleostomy, so the electrode array was implanted into the scala vestibuli.

After consensus that the left CI was indeed benefitting the patient, attention was directed to the right ear. At age 25 months, radical mastoidectomy and closure of the EAC were accomplished. Chronic osteomyelitis of the mastoid was confirmed by pathology. Three months later, an Advanced Bionics Model CI-1500-04 was implanted into the scala tympani after drilling through 4mm of ossified scala tympani. By age 30 months, the child demonstrated good functional benefit with both her left and right CIs.

The patient continued to make progress in listening and speech development without any complications until age 39 months when the surgically closed left EAC was found to be dehiscent with a window to the middle ear through which the CI cable was visible. The patient was taken the operating room for revision mastoidectomy and repeat EAC closure using rotation advancement flaps developed from the deep scalp. The CI cable was sacrificed to provide adequate exposure of the mastoid but allowed the electrode array to remain in the cochlea. No clinical infection was found. Five months later at age 46 months, the sacrificed CI was replaced without further complications. Approximately one year later, she returned to the operating room due to breakdown of the postauricular incision. A large (17 cm) full-thickness scalp rotation flap was performed with good results.

The patient is now 5 years old. She has undergone extensive speech therapy and is a comfortable listening-speaking communicator capable of using the telephone with a stranger. With her CIs, each ear has thresholds to tones of the frequencies 0.5-1-2-4-6 kHz at 30 dBnHL or better. She has not exhibited any symptom of vestibular dysfunction.

**Table 1**
Timeline of child's ear status, injury and care.

| Age (months) | Right Ear | Left Ear |
|---|---|---|
| 10 | TCA 50% inadvertently instilled into bilateral ear canals during tympanostomy tube insertion. | |
| 14 | **Exam:** 60% inferior central TM perforation.<br>**Audiometry:** Maximal CHL suggested by behavioral studies on two separate occasions.<br>**Tympanometry:** Type B; 3.1 mL volume.<br>Fit with BCHA. | **Exam:** 75% inferior central TM perforation.<br>**Audiometry:** Maximal CHL suggested by behavioral studies on two separate occasions.<br>**Tympanometry:** Type B; 3.0 mL volume.<br>Fit with BCHA. |
| 16 | **Exam:** "Near-total" TM perforation on exam.<br>**Audiometry (behavioral):** no response in sound field unless using bone ossilator hearing aid; responded at 40, 60, and 60 dBnHL to stimuli centered at 0.5, 1, and 2 kHz; no response to 4 kHz stimuli. | **Exam:** "Total" TM perforation on exam.<br>**Audiometry (behavioral):** no response in sound field unless using bone ossilator hearing aid; responded at 40, 60, and 60 dBnHL to stimuli centered at 0.5, 1, and 2 kHz; no response to 4 kHz stimuli. |
| 18 | **MRI:** normal temporal bone without labyrinthitis ossificans.<br>**ABR:** only repeatable responses were to 2 kHz tone bursts at 90 dBnHL delivered by air conduction, and masked BC click stimuli at 40 dBnHL.<br>**Tympanometry:** Type B; 4.5 mL volume.<br>**DPOAE:** absent at 1–6 kHz. | **MRI:** normal temporal bone without labyrinthitis ossificans.<br>**ABR:** no response at maximum stimulation.<br>**Tympanometry:** Type B; 5.3 mL volume.<br>**DPOAE:** absent at 1–6 kHz. |
| 20 | | **Procedure:** Complete mastoidectomy, removal of remnant malleus and incus and complex closure of EAC. |
| 21 | | **Procedure:** Cochlear implantation into scala vestibuli. |
| 25 | **Procedure:** Radical mastoidectomy with removal of malleus and incus and closure of EAC. | |
| 28 | **Procedure:** Cochlear implantation into scala tympani (labyrinthitis ossificans encountered intraoperatively). | |
| 39 | **Exam:** Healthy EAC ending in blind cul-de-sac.<br>**CT:** Mastoid and middle ear opacified with tissue. | **Exam:** Dehiscence of surgically closed EAC with cochlear implant cable visible in middle ear.<br>**CT:** Air within mastoid and middle ear space suggestive of flap degradation. |
| 41 | | **Procedure:** Revision to radical mastoidectomy with repeat complex EAC closure; CI cable severed with preservation of CI electrode array and canister in situ. |
| 46 | | **Procedure:** Removal of nonfunctioning CI and placement of new CI canister. |
| 56 | **Audiometry:** Responses in the normal to borderline range<br>**MLNT Word List:** 46% correct (words); 84% correct (phonemes) | **Audiometry:** Responses in the normal to mild range<br>**MLNT Word List:** 63% correct (words); 89% correct (phonemes) |
| 59 | | **Procedure:** Full-thickness scalp rotation flap for coverage of dehiscent postauricular incision. |
| 61 | **Exam:** Healthy EAC ending in blind cul-de-sac. | **Exam:** Healthy EAC ending in blind cul-de-sac. Well-healing rotation flap. |

ABR, auditory brainstem response; BC, bone conduction; BCHA, bone-conducting hearing aid; CHL, conductive hearing loss; CI, cochlear implant; dBnHL, decibel normal hearing level; DPOAE, distortion product otoacoustic emissions; EAC, external ear canal; MRI, magnetic resonance imaging; TCA, trichloroacetic acid; TM, tympanic membrane; MLNT, multisyllabic lexical neighborhood test.