Cerebrospinal Fluid Otorrhea Treated by Extended Subtotal Petrosectomy with Obliteration

Abstract—Extended subtotal petrosectomy as a treatment for stubborn cerebrospinal fluid (CSF) otorrhea is presented. Nine patients were successfully operated on by this technique, all previously having undergone surgery for brain or base of skull lesions; other interventions used had failed to seal the fistula. The retrosigmoid cells, facial cells, and internal auditory canal were found in our study to be the most commonly involved during pervious neurosurgery and so constituted the usual path for CSF leakage. Total exenteration of middle ear and mastoid cell tracts, skeletization of sigmoid sinus, jugular bulb and facial nerve, drilling out of the semicircular canals, vestibulum, and cochlea, and skeletization of the internal auditory canal are the main steps of this approach.

Cerebrospinal fluid (CSF) otorrhea may occur following brain and base of skull surgery, temporal bone fractures, tumors with erosion of the temporal bone, and congenital anomalies, particularly those of the inner ear, as in Mondini dysplasia. Rarely, complications of chronic ear, middle ear, and mastoid surgery and spontaneous cases occur.[1,2] Although readily treated in most cases, it presents in some a dangerous and life-threatening problem. The cases following surgery are usually easy to diagnose, the CSF fluid leakage being found along the path of the operative injury; in others, recognition of the leakage may be more difficult. Three routes have been reported for CSF entry into the middle ear, namely, the internal auditory canal, the cochlear aqueduct, and the mastoid air cells.[3,4] In paradoxical rhinorrhea the eustachian tube provides the pathway for fluid from the middle ear cavity to the nose.

Subtotal petrosectomy was first introduced by Fisch[5] in 1970, who used the infratemporal type A approach for infralabyrinth and petrous apex lesions, infratemporal type B approach for tumors of the clivus, and infratemporal type C approach for parasphenoid, parasellar, and nasopharynx tumors. As treatment for CSF otorrhea, it was first described by Coker et al[6] in 1986. We have extended that approach to the inner ear to seal all possible pathways for CSF leakage.

We present nine patients who underwent extended subtotal petrosectomy for persistent CSF otorrhea, all previously having undergone surgery for brain or base of skull lesions; other interventions had failed to seal the fistula.

SURGICAL TECHNIQUE

Subtotal petrosectomy attempts to exenterate and obliterate all accessible pneumatized spaces of the temporal bone with preservation of the otic capsule, facial nerve, and a cortical plate over the carotid artery, middle and posterior cranial fossae; it is carried out in four main steps:

1. Blind sac closure of the external canal.
2. Complete exenteration of middle ear and mastoid cells.
3. Drilling out of the inner ear cavities and skeletization of the internal auditory canal.
4. Obliteration of the middle ear eustachian tube and mastoid cells.

Through a posterior auricular incision, an anteriorly based subcutaneous-periostal flap is elevated, the external auditory canal cut, and the skin of the lateral part of the external canal everted and sutured. After blind sac closure

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of the external canal, secured by the subcutaneous-periostal flap, total exenteration of middle ear and mastoid cell tracts is performed, including the retrosigmoid, retrofacial, posteromedial, posterosuperior, subarcuate, epitympanic, supralabyrinthine, peritubal, and infralabyrinthine cells. All mucosa is removed and the bone polished with diamond burrs. A thin bony plate is left over the carotid artery and the dura of the middle and posterior fossae. Skeletization of sigmoid sinus, jugular bulb, and facial nerve follows, from the stylomastoid foramen to its entrance into the internal auditory canal. The semicircular canal, vestibulum, and cochlea are completely drilled out and the internal auditory canal skeletonized. The eustachian tube is plugged with small pieces of muscle and Gelfoam, the surgical cavity obliterated by free abdominal fat grafts, and above it is placed a large pedicled rotated temporalis muscle graft.

SUMMARY OF CASES

Nine patients with persisting CSF otorrhea following neurosurgery were referred during the years 1985–1989 (Table 1). Follow-up periods were 1 to 6 years. Four patients had undergone suboccipital removal of an acoustic neurinoma, in two a reexploration of the posterior fossa had failed to close the fistula. Two developed recurrent meningitis. The leak was found to be via the eroded internal auditory canal in two patients and was located lateral to the sigmoid sinus in the others. Three patients had otogenic brain abscess with bone erosion into the mastoid cavity, drained in a previous operation; radical mastoidectomy did not stop the leakage. In all three a large defect was found in the middle fossa dura. One patient operated on for a glomus tumor and referred to our department had a posterior fossa dura defect in the retrolabyrinthine area. Another patient operated on previously for a large facial nerve neurinoma eroding the skull base and invading the posterior fossa developed a chronic fistula with episodes of recurrent meningitis; exploration of the mastoid revealed many bony sequesters, bone wax, and a large tumor in the mastoid cavity arising from the geniculate area of the facial nerve. The dura in the retrolabyrinthine and retrosigmoid area was torn. All tumor tissue was removed. Two of the patients with acoustic neurinoma had recurrent meningitis. The fistula in five patients led through the retrosigmoid cells, in four through the perifacial and retrofacial cells, in four through the internal auditory canal, in two through the tegmen tympani, and one through retrolabyrinthine cells (Table 2).

All patients were operated on by the technique already described. No recurrent CSF otorrhea or episodes of meningitis were seen after surgery.

DISCUSSION

The incidence of postoperative CSF otorrhea in acoustic neurinoma varies from 6 to 30%.[7] Most can be easily managed during the original surgery, but in some the leakage remains unrecognized until later. The dural defect in such cases can be up to 2 cm in diameter and cannot seal off spontaneously. CSF otorrhea is usually diagnosed easily on otoscopy when fluid is seen in the middle ear. When the tympanic drum is not perforated, rhinorrhea (paradoxical rhinorrhea) results. X-ray studies are not of localizing value and the use of radioactive tracers will generally only confirm the obvious diagnosis.

The degree of pneumatization of the petrous portion of the temporal bone is a major factor in fistula etiology. Highly pneumatized temporal bones are more prone to CSF leakage and primary intracranial closure of the defect is less effective.[6]

Treatment procedures for CSF otorrhea have included: flow-regulated continuous spinal draining, intracranial or extracranial repair. The first method is widely recommended for small fistulas but is effective only if started immediately and requires bed rest of at least 7 days.[8] The intracranial posterior fossa approach can be difficult, the identification of the fistula in many cases impossible, sealing of multiple small defects in the skull base ineffective, and moreover it bears significant morbidity.[1,3]

The areas of potential fistulas are the internal auditory canal and the mastoid air cells. Four cell tracts connect the internal auditory canal and the tympanic cavity; the subarcuate, the posterosuperior, the posteromedial, and the anterolateral. Drilling of the roof of the internal

Table 1. Extended Subtotal Petrosectomy with Obliteration

Case	*Age*	*Follow-up (yr)*	*Original Pathologic Diagnosis*	*Presentation*	*Place of Leakage**	*Meningitis*
1	58	1	Acoustic neurinoma	Rhinorrhea	IAC, RS	+
2	46	4	Acoustic neurinoma	Rhinorrhea	IAC, RL, RF	+
3	52	5	Acoustic neurinoma	Otorrhea	IAC, RS	+
4	53	1	Acoustic neurinoma	Otorrhea	IAC	−
5	13	4	Brain abscess	Otorrhea	TT	−
6	26	6	Cerebellar abscess	Otorrhea	TT	−
7	22	6	Brain abscess	Otorrhea	TT	−
8	54	4	Glomus tumor	Otorrhea	RS, RF	−
9	53	5	Facial neurinoma	Otorrhea	RF, RS	−

*IAC: internal auditory canal; RL: retrolabyrinthine cells; RF: peri- and retrofacial cells; RS: retrosigmoid cells; TT: tegmen tympani.

Table 2. Possible Route of Cerebrospinal Fluid

Path of Leakage	*No. Cases (%)*
Retrosigmoid cells	5 (56)
Peri- or retrofacial cells	4 (44)
Internal auditory canal	4 (44)
Tegmen tympani	2 (22)
Retrolabyrinthine	1 (11)

auditory canal from the posterior fossa in an attempt to remove the intracanalicular part of the tumor may open these cell tracts. The retrosigmoid cells, facial cells, and internal auditory canal were found in our study to be the most commonly involved during previous neurosurgery and so the usual path for CSF leakage. Obliteration of the mastoid cavity was adopted many years ago as a treatment for otorrhea,[9,10] using fascia and adipose tissue, bone paté,[11] or fibrin glue.[12] Anteriorly pedicled temporalis muscle to obliterate the radical mastoid cavity in chronic ear surgery was described by Rambo[9] and Hicks et al.[13] The use of autogenous material (abdominal fat) and a rotation flap muscle gives the best cosmetic and infection-resistant results. Subtotal petrosectomy with obliteration of the middle ear cleft seems to be an efficient solution for stubborn CSF otorrhea.[2,5,6] It differs from the mastoidectomy of chronic ear surgery in that all cell tracts, particularly the infralabyrinthine and peritubal tracts communicating with the middle ear, are exenterated. In 44% the CSF leakage was through the internal auditory canal; therefore we find it advisable to extend this technique to the inner ear and skeletonize the internal auditory canal in order to seal possible leakage from this point. A reliable result can be achieved only by total exenteration of the temporal bone cavities, the semicircular canale, vestibulum, and cochlea, with skeletization of the internal auditory canal. This seems to be the best and safest method, although requiring close cooperation between neurosurgeon and neuro-otologist.

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