An unusual site of a CSF leak following resection of a retrosigmoid acoustic neuroma

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Abstract
Cerebrospinal fluid (CSF) leaks may occur after acoustic neuroma resection. These leaks are usually the result of an iatrogenic injury during removal. The retrosigmoid approach is commonly associated with leaks that occur through the lateral end of the internal auditory canal, through the perilabyrinthine cells extending to the region of the internal auditory canal, or through the retrosigmoid air cells. We describe a case of an infracochlear CSF leak that developed following the retrosigmoid resection of an acoustic neuroma. To the best of our knowledge, this leak was unique for both its location and etiology.

Introduction
Cerebrospinal fluid (CSF) rhinorrhea is a known complication of acoustic neuroma resection. Iatrogenic CSF leaks commonly occur through the cells of the petrous apex to the tympanic cavity or eustachian tube, through the perilabyrinthine cells to the mastoid antrum, through the mastoid air cells at the craniotomy site, or through an opened vestibule and oval window. We present the case of a patient who underwent acoustic neuroma removal via a retrosigmoid approach and subsequently developed a CSF leak through an infracochlear air cell tract. This case is unique for both the location of the leak and its proposed etiology.

Case report
A 40-year-old woman with a history of neurofibromatosis type 2 presented to our clinic for evaluation of progressive left-sided hearing loss, tinnitus, and imbalance. Four years earlier, she had undergone a subtotal resection of a right-sided acoustic neuroma. One year later, she received Gamma knife radiation for treatment of a left-sided acoustic neuroma. Since that time, she had been followed with serial magnetic resonance imaging (MRI).

Prior to the patient’s presentation to our clinic, an MRI demonstrated an increase in the size of the left-sided neuroma (figure 1). At that time, she had a profound sensorineural hearing loss bilaterally and a House-Brackmann grade III facial weakness. In view of the worsening of her symptoms and the enlargement of the tumor, she elected to undergo surgical removal of the left-sided mass. She underwent an uneventful left suboccipital resection of the cerebellopontine angle mass, which on histopathologic examination was found to be an acoustic neuroma. Drilling of the lateral end of the internal auditory canal had been required because of the large size and extension of the tumor. The drilling created an opening in the posterior semicircular canal. At the conclusion of surgery, the lateral internal auditory canal and all other visible air cells were occluded with bone wax. Postoperative computed tomography (CT) obtained the day of surgery demonstrated minimal pneumocephalus and pneumolabyrinth. The patient’s postoperative course was uneventful. Her postoperative hearing was unchanged, and her facial weakness was classified as House-Brackmann grade V. She experienced no rhinorrhea and denied a salty taste in her throat. She was discharged on postoperative day 5.

On postoperative day 75, the patient experienced significant rhinorrhea and presented to the emergency room. She denied trauma or straining prior to her presentation. MRI revealed the presence of a large CSF-filled arachnoid cyst at the site of the tumor resection in the left cerebellopontine angle (figure 2, A). CT demonstrated significant pneumocephalus (figure 2, B). Closer examination of the CT revealed a large infracochlear connection between the left middle ear cavity and the intracranial subarachnoid space. A rereview of the presurgical CT revealed that the same bony defect had in fact been present prior to the tumor resection (figure 3).

The patient was taken to the operating room for explor-
atory tympanotomy and repair of the CSF leak. The round window and oval window were examined first, and no leakage was encountered. Continued exploration detected a 2 × 3-mm infracocharlear tract leading intracranially. CSF flowed rapidly though the connection. The tract was plugged with bone wax, Tisseel, and fascia. The eustachian tube was occluded with bone wax, and the middle ear was obliterated with fat. A lumbar drain was not placed because of the significant degree of pneumocephalus that was present. The patient was discharged home on postoperative day 3 after CT imaging demonstrated resolution of the pneumocephalus. At the 3-month follow-up, no recurrence of the CSF leak was evident.

Discussion
CSF leaks after retrosigmoid acoustic neuroma resection have been reported to occur in 0 to 27% of patients. These leaks commonly occur through the lateral end of the internal auditory canal, through the perilabyrinthine cells extending to the region of the internal auditory canal, or through the retrosigmoid air cells. To the best of our knowledge, this article is the first report of a postoperative CSF leak occurring through an infracocharmear air cell tract.

Another unique feature of this case was the etiology of the leak. Preoperatively, a connection between the middle ear and subarachnoid space was visible on CT (figure 3). At that time, the presence of the tumor plugging the area and the intact surrounding dura apparently prevented CSF leakage. Once the tumor was removed, only dura prevented CSF from freely flowing into the infracocharlear air cells. The development of an arachnoid cyst in the cerebellopontine

Figure 1. Preoperative axial T1-weighted postcontrast MRI shows the large left-sided acoustic neuroma (arrow) and the smaller right-sided tumor.

Figure 2. A: On postoperative day 75, T2-weighted MRI demonstrates the large arachnoid cyst (arrows) in the cerebellopontine angle. B: High-resolution CT of the temporal bone obtained the same day demonstrates the pneumocephalus and the infracocharlear connection (arrow) between the middle ear cavity and the intracranial subarachnoid space.
angle facilitated the leakage of CSF. The pressure of the enlarging arachnoid cyst thinned and penetrated the dura and allowed CSF to flow freely through the infracochlear air cell tract. This explains the delayed nature and the high flow of the CSF leakage seen in this patient. If the CSF leakage had been caused by the opening of an air cell during the procedure, an immediate postoperative CSF leak would have been expected. Also, the communication of the arachnoid cyst with the air cell tract explains the high-flow nature of the CSF, which would not be present in a routine case of CSF leakage. Violation of the vestibule during the initial surgery could account for postoperative rhinorrhea if a defect in the oval or round window had also existed. However, on intraoperative examination, both windows were intact and the leakage was isolated to the infracochlear tract. Examination of the preoperative CT and MRI is important to best evaluate the cause of postoperative CSF leakage.

Another important point that this case illustrates is that the opacification of a few opened air cells in the mastoid and the retrosigmoid area was initially thought to represent the location of the CSF leak; as a result, the patient was initially scheduled for a reopening of the retrosigmoid wound by the neurosurgery team. However, careful examination of the CT imaging revealed that the infracochlear air cell tract was opened. The opacification of the few opened mastoid air cells actually represented bone wax rather than CSF. This obviated the need for a significantly more extensive procedure and allowed us to treat the patient with a transcanal procedure.

The only question that remains is why the infracochlear air cell tract was opened intracranially. While this phenomenon may have been developmental, it is possible that the radiation the patient received to the area may have adversely affected the health of the bone there. The subsequent expansion of the tumor within the internal auditory canal may have led to the thinning of the bone that separated the air cells from the intracranial cavity and led to the opening of the air cells. Gamma knife radiation has been associated with CSF rhinorrhea in the treatment of pituitary tumors. This may be attributable to hydrocephalus caused by radiation or necrosis of the dura surrounding the tumor. To our knowledge, no association exists between gamma knife radiation and CSF leakage in acoustic neuroma treatment.

While CSF leaks in the infracochlear region are uncommon, they should be considered when investigating the source of a leak after acoustic neuroma resection. When a leak develops in a delayed fashion, an MRI is warranted to look for the formation of an arachnoid cyst in the area. A leak in the infracochlear location can be managed via a transcanal approach with minimal morbidity.

References

Figure 3. A reevaluation of the preoperative high-resolution temporal bone CT shows the same infracochlear connection (arrow) that was seen following the tumor resection.