A novel treatment approach to cholesterol granulomas

Technical note

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✓The authors report a novel technique for the treatment of cholesterol granulomas. An extradural middle fossa approach was used to access the granuloma, with drainage through silastic tubes into the sphenoid sinus via the anteromedial triangle between V1 and V2.

Cholesterol granulomas occur when the normal aeration and drainage of temporal bone air cells is occluded, resulting in vacuum formation and transudation of blood into the air cells. This process results in anaerobic breakdown of the blood with resulting cholesterol crystal formation and an inflammatory reaction. Traditional treatment of this lesion involves extensive drilling of the temporal bone to drain the granuloma cyst and establish a drainage tract into the middle ear. Such drainage procedures can be time consuming and difficult, and potentially involve structural damage to the inner ear and facial nerve. An extradural middle fossa approach provides easy access to the granuloma and anterior petrous bone entry into the granuloma for resection. Granuloma drainage is then achieved using shunt tubing in the sphenoid sinus via a small hole in the anteromedial triangle between V1 and V2.

Five patients with symptomatic cholesterol granuloma were treated without complication using this novel extradural middle fossa approach. One patient required reoperation 1-year postoperatively for cyst regrowth and occlusion of the drainage tube. At the 5-year follow-up examination, no patient reported recurrent symptoms.

Extradural middle fossa craniotomy and silastic tube drainage into the sphenoid sinus is a viable alternative method for treatment of cholesterol granuloma. (DOI: 10.3171/JNS-07/08/0446)

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Cholesterol granulomas are the most common cystic lesions found in the petrous apex, and the prevalence of these lesions is estimated to be one of every 30 acoustic neuromas, with an incidence rate of less than 0.6 cases per million people/year.1,6,7 A cholesterol granuloma is a foreign-body giant-cell reaction to cholesterol deposits, demonstrating associated fibrosis and vascular proliferation. The primary development mechanism of this pathogenic lesion within the temporal bone is an occlusion of the air cell system, either from trauma or from another disease.2 Mucosal swelling occludes the narrow petrous apex air cell outflow tracts, and absorption of the trapped gas leads to the development of a vacuum. This negative pressure leads to transudation of blood into the unventilated mucosal spaces, and the subsequent anaerobic breakdown of red blood cells liberates cholesterol. The cholesterol incites a foreign body reaction with sterile inflammation that may result in bone erosion.3

Cholesterol granulomas may occur anywhere within the pneumatized spaces of the temporal bone.2 The petrous apex is the region of the petrous pyramid bounded medially by the clivus, laterally by the inner ear, anteriorly by the carotid artery, and posteriorly by the dura mater of the posterior fossa.5 Cholesterol granulomas arising within the petrous apex are relatively uncommon because the petrous apex is pneumatized in only 30% of temporal bones. Compared with other primary petrous apex lesions, however, cholesterol granulomas are more common than either cholesteatomas or mucoceles.2 Primary cholesterol granulomas of the petrous apex may be associated with prior otologic surgery or trauma, but many patients have no predisposing factors to these lesions.3

Cholesterol granulomas tend to remain clinically silent until they encroach on adjacent cranial nerves causing hearing loss, gait imbalance, facial numbness and weakness, and/or diplopia.2,10 Patients may also present with hemifacial spasm or headache.3 It is important to distinguish between cholesterol granulomas and cholesteatomas, mucoceles, and other vascular, neoplastic, and infectious processes.3 On computed tomography scans, both cholesterol-
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of granulomas and other lesions of the petrous apex are expansive and erosive. Magnetic resonance imaging is a more precise modality for locating cholesterol granulomas. A characteristic hyperintense appearance on T1- and T2-weighted MR images is a unique feature of cholesterol granulomas.

**Surgical Approaches to Cholesterol Granulomas**

Surgical goals for cholesterol granuloma cyst removal are relief of patient symptoms and acquisition of tissue for histopathological confirmation of diagnosis. Surgical objectives are best accomplished by lesion drainage and the creation of a well-aerated cavity to prevent obstruction and reaccumulation of cyst contents. Most authors advocate cholesterol granuloma management via drainage into the middle ear or mastoid and the creation of a permanent window to aerate the lesion. Postoperative stenosis of the tract used to exteriorize the cyst is a common surgical drainage complication. Stenosis of the cyst opening results in reaccumulation of the cyst contents and eventual recurrence of symptoms, often requiring multiple revision surgeries to maintain adequate drainage.

To prevent cyst stenosis, an alternative approach is to use silastic drainage tubes in the middle ear. The cholesterol granuloma cyst is entered, drained, irrigated, and stented using the largest possible silicone catheter. The goal of draining the cyst is to prevent reaccumulation of the cyst contents.

Many current surgical approaches used to access cholesterol granuloma cysts are invasive, requiring removal of large bone flaps and entry into the dura. A less invasive approach would ease the operative process for both surgeons and patients, and preserve patient cranial nerve function. More than 10 years ago, Griffith and Terrell reported on two patients in whom an endoscopic approach was used to drain the cholesterol granuloma of the petrous apex into the sphenoid sinus. In both patients, however, a stent was not placed into the granuloma and reaccumulation of the cyst contents required further surgical drainage.

We have developed a novel technique involving silastic tube drainage from the cholesterol granuloma cyst in the petrous apex into the sphenoid sinus. Our technique combines the advantages of using a conservative surgical approach with eliminating the risk of recurrence.

The sphenoid sinus is aerated and as such is an ideal site for bacterial colonization, but careful experience with trans-sphenoidal techniques for pituitary and other surgery demonstrates that working through the sphenoid sinus does not usually result in infection. Furthermore, the technique we describe is entirely extradural, which lessens the possibility of developing meningitis and serious infection. Finally, the air cells of the mastoid are themselves air sinuses and can be colonized with bacteria, and it is the occlusion of these sinuses that results in cholesterol granuloma. All middle fossa surgical techniques used to treat cholesterol granuloma involve fenestration of the granuloma to or through the extradural space, and this procedure does not usually result in infection. In the patient series we describe in this report, there were no complications from infections.

**Surgical Technique**

For this new technique, an extradural middle fossa approach is used to access the cholesterol granuloma, with silastic tube drainage into the sphenoid sinus via the anteromedial triangle between V1 and V2. Standard intravenous prophylactic antibiotics are administered prior to skin incision. Facial nerve monitoring is required for all extradural middle fossa procedures and anesthesia induction should not include chemical paralysis.

Once anesthesia is induced in the patient, and prior to final positioning, a lumbar drain is placed to relax the temporal lobe and decrease the necessary degree of brain retraction. The patient is placed and secured in the head holder in a lateral position. Minimal hair shaving from in front of the tragus to approximately 2 cm above the superior temporal line (Fig. 1 upper left) is standard procedure, as is povidone-iodine–based skin preparation. To further aid brain relaxation, intravenous mannitol is administered at the skin incision and 50 ml of cerebrospinal fluid is drained by opening the lumbar drain during the craniotomy.

A skin incision is made and the temporalis muscle is split parallel to its fibers to the level of the zygoma. A cerebellar retractor is then used to retract the temporalis muscle and overlying soft tissues and skin. Care is taken to minimize the use of monopolar coagulation to minimize the degree of temporalis muscle atrophy and soft tissue damage. The zygomatic arch can be drilled down if it is large and hinders access to the middle fossa, although this procedure is not typically required. A rectangular craniotomy is fashioned two thirds in front of, and one third behind, the root of the zygoma. The inferior edge of the craniotomy is made flush with the middle fossa floor using a high-speed drill (Fig. 1).

The middle fossa dura is then elevated beginning at the MMA, which is bipolar coagulated, and cut. Dural elevation then proceeds posteriorly to anteriorly, protecting the GSPN, which is encountered medial to the MMA. This extradural dissection proceeds anteriorly and medially until V3 is encountered and the dura propria is elevated apart from V3, exposing the trigeminal roots and ganglion.

Petrous apex granulomas are usually located in the Ka- wase triangle. This triangle is defined as the posterior border of V3 and the gasserian ganglion, GSPN, and the line between the geniculate ganglion and the petrous apex. Care must be taken to avoid damaging the petrous carotid artery, which lies laterally in the triangle, particularly if the osseous floor is dehiscent. Care also must be taken to avoid damaging the cochlea, which lies at the posteromedial aspect of this triangle. A diamond bur is used to resect the bone of the petrous apex and enter the granuloma cyst (Fig. 2).

Once the cyst is entered and the thick viscous material of the granuloma is identified and removed, attempts at curettage of the cyst wall can be undertaken. Usually it is not possible to resect the cyst wall in its entirety. Using a high-speed diamond drill, a sphenoidotomy is made in the anteromedial triangle between V1 and V2. This maneuver creates a fenestration into the sphenoid sinus anterior and medial to the foramen rotundum. Once the sphenoid sinus is entered, a silastic tube can be placed into the cyst cavity and into the sphenoid sinus (Fig. 3). This tube can be secured with a silk suture placed into the dura overlying the cavernous sinus and trigeminal ganglion. When meticulous hemostasis is obtained, closure proceeds in the same manner as in a standard craniotomy.
Fig. 1. Illustrations of the extradural middle fossa craniotomy showing a linear skin and muscle incision with cerebellar retractor in place. A square-shaped craniotomy is made approximately two thirds in front of, and one third behind, the root of the zygoma (upper left). The craniotomy should proceed until flush to the middle fossa floor.

Fig. 2. Illustration of the floor of the middle fossa, showing the cut MMA, GSPN, and trigeminal nerve (CN V). The cholesterol granuloma, geniculate ganglion, petrous carotid artery, cochlea, and cranial nerves (CNs) VII and VIII are illustrated to show that they are within the petrous bone.
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Results

Five patients with symptomatic cholesterol granuloma were treated using this extradural middle fossa approach without complications. One patient required reoperation 1-year postoperatively for occlusion of the drainage tube and cyst regrowth. At the 5-year follow-up examination, no patient had experienced recurrent symptoms and there was no evidence of cyst recurrence on computed tomography scans.

Illustrative Case

This male patient presented with a history of headaches. Results of a neurological examination were unremarkable, and cranial nerve function was intact with normal auditory function. Magnetic resonance imaging revealed a lesion on the left side of the petrous apex that was cystic and bright on T1- and T2-weighted MR imaging (Fig. 4). The characteristics of the lesion were consistent with those of a cholesterol granuloma of the petrous apex. Elective silastic tube drainage of the cyst into the sphenoid sinus via a middle fossa approach was undertaken, as previously described. The cyst was identified intraoperatively, the thick viscous material was aspirated, and a silastic tube was placed (Fig. 5). Postoperatively, the patient’s headaches resolved. Long-term follow-up with MR imaging (Fig. 6) showed the silastic tube draining the cyst into the sphenoid sinus, with a marked reduction in cyst size. This procedure has been performed on four other patients who did not experience a recurrence of cyst formation.

Conclusions

This novel technique of silastic tube drainage of petrous apex cholesterol granulomas into the sphenoid sinus combines the advantages of a less invasive approach, lower morbidity than with invasive approaches, preservation of patient cranial nerve function, and successful treatment of the granuloma.

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Fig. 6. Axial T2-weighted MR image obtained at the 5-year follow-up demonstrating the silastic tubing draining the cholesterol granuloma into the sphenoid sinus with marked reduction in the size of the cyst.

References