Epidermoid cysts of the brain stem

Report of three cases

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The authors report the cases of three patients with epidermoid cysts which insinuated themselves into the brain stem. In all three patients, the tumor occupied thepons, although in one it was predominantly located in the medulla. The cyst contents and nonadherent tumor capsule were removed in all three patients, but no attempt was made to remove tumor densely adherent to the brain stem. One patient's cyst was removed in one operation, but maximal resection in the other two required two operations. After surgery, sixth nerve function completely returned in one patient; another patient had a stable pontine gaze palsy but developed new facial weakness; and the third patient had stable cranial nerve deficits with a diminished hemiparesis. The last patient developed a pseudomeningocele and communicating hydrocephalus, and required a lumboperitoneal shunt. In all three patients, computerized tomography scans demonstrated hypodense tumors not enhanced by contrast material. Magnetic resonance imaging was performed on two patients; in both, the tumors showed increased signal intensity relative to brain on T1-weighted images and decreased signal intensity relative to brain on T2-weighted studies. Magnetic resonance imaging, the most accurate modality for localizing these lesions and determining their extent, was also invaluable for postoperative monitoring and follow-up evaluation. Safe and adequate resection includes decompression of cyst contents and removal of nonadherent portions of the cyst capsule. Cyst wall adherent to the brain stem, however, should not be removed.

Key Words • epidermoid cyst • brain stem • magnetic resonance imaging

Epidermoid cysts, or "pearly tumors," were first fully described by the French pathologist Cruveilhier in 1829. Bailey gave a detailed histological description in 1920 and reported the first two cases of successful surgical removal of intradural epidermoid cysts. Epidermoid cysts account for 0.2% to 1.8% of all intracranial tumors. They are most commonly located in the cerebellopontine angle and in the parasellar region. Those in the posterior fossa usually arise in the lateral subarachnoid cisterns and spread across the basal surface of the brain, eventually compressing neurovascular structures. Epidermoid cysts are filled with soft white flaky material containing a high concentration of cholesterol crystals. Microscopically, the cyst lining is composed of simple stratified squamous epithelium supported by an outer layer of collagenous tissue. Progressive desquamation and breakdown of keratin from the epithelial lining produce the lamellar character of the cyst contents and lead to slow expansion of the tumor. Only six cases of epidermoid cysts of the brain stem have been reported, four of those six patients died. We present our experience with three patients who had epidermoid cysts involving the brain stem.

Case Reports

Case 1

This 27-year-old man presented with a 2-year history of diplopia and headaches and a 1-year history of a slightly unsteady gait.

Examination. The patient had a right pontine gaze palsy and decreased tandem gait. Computerized tomography (CT) scans showed a hypointense mass not enhanced with contrast medium. It was centered in the prepontine cistern and pons, and extended posteriorly toward the fourth ventricle. On T1-weighted magnetic resonance (MR) images, the mass showed signal intensity higher than that of brain (Fig. 1). It appeared as if...
there were two separate masses, one located extraaxially in the preoptic cistern and one positioned intraaxially within the pons. On T2-weighted images the tumor showed predominantly decreased signal intensity (Fig. 1). We noted no significant peritumoral edema on the T2-weighted images.

First Operation. The patient was placed in the left lateral decubitus position and underwent a right suboccipital craniectomy through a retromastoid incision. After medial retraction of the cerebellum, the tumor was seen lying in the lateral cisterns and extending into the ventral brain stem at the level of the fifth nerve root. This nerve root was displaced rostrally. Tumor was dissected from both vertebral arteries and from the lower basilar trunk. The fifth and seventh through 11th cranial nerves, exposed by cerebellar retraction, were left intact; the sixth cranial nerve was not seen. Because the tumor had insinuated itself into the pons, we did not attempt further resection from this approach. Postoperatively, the patient's right pontine gaze palsy persisted, and follow-up MR images revealed residual tumor within the pons. He was discharged 1 week after surgery in excellent condition.

Second Operation. Four weeks after his first operation, the patient underwent a bilateral suboccipital craniectomy in the sitting position for removal of the remaining intramedullary portion of his tumor. Lateral retraction of the cerebellar hemispheres revealed a bulge in the floor of the fourth ventricle at the level of the lateral recesses. This bulge nearly obliterated the lumen and displaced the median raphe 1 cm to the left. The vermis was split, revealing a 2.5-cm mass at the ependymal surface. Approximately 1 mm from the surface, inspissated debris characteristic of an epidermoid cyst was also exposed. The large intramedullary mass, firmer than that previously resected from the subarachnoid space, was removed. We then irrigated the glistening smooth cyst wall with hydrocortisone solution, but did not attempt to remove the cyst wall from the pons.

Specimens from both operations contained keratinizing squamous epithelium and keratinous debris showing evidence of partial rupture (foreign body granulomatous response). The pathological diagnosis was an epidermoid cyst.

Postoperative Course. The patient's right pontine gaze palsy persisted, and new peripheral facial weakness developed. The facial weakness had almost completely resolved by the time of discharge after 7 days. Follow-up MR imaging 1 week after the second operation showed a minimal amount of residual tumor within the pons near the fourth ventricle. The patient has had no clinical evidence of recurrence during a 1-year follow-up period.

Case 2

This 27-year-old woman presented with a 3-year history of headaches, an 8-month history of diplopia, and recent mild right hemiparesis.

Examination. The patient had a left sixth nerve palsy and mild weakness of the right leg. Computerized tomography scans showed a hypodense mass in the preoptic cistern impinging upon the pons and medulla, characteristic of an epidermoid cyst. On MR imaging, a lobulated (almost dumbbell-shaped) mass with an intra-axial spherical component was revealed in the left side of the medulla, and an exophytic component was seen between the basilar artery and the ventral surface of the medulla (Fig. 2). The lesion exhibited nearly uniform hyperintensity (relative to brain) on T2-weighted images, most of it showing a signal intensity identical to fat. On heavily T2-weighted images, the lesion showed focal hypointensity, but the component in the left medulla showed slight hyperintensity (Fig. 2). The admixture of signal and the lack of peritumoral
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![Fig. 2. Case 2. Preoperative magnetic resonance images showing an epidermoid cyst located intra-axially within the medulla and extra-axially in the pontomedullary junction anteriorly. A: Sagittal $T_1$-weighted image (TR 600 msec, TE 20 msec). B: Axial $T_1$-weighted image (TR 600 msec, TE 20 msec). C: Axial $T_2$-weighted image (TR 2000 msec, TE 20 msec).](image)

edema were most indicative of an epidermoid or dermoid tumor.

Operation. The patient underwent a right suboccipital craniectomy and gross total resection of the cyst contents. The extra-axial portion was soft and putty-like, and was easily removed. A large component, however, extended into the pontomedullary junction, predominantly lying intra-axially within the medulla. Using a mirror for visualization, we removed the epithelial debris, but made no attempt to remove the intramedullary tumor capsule. Pathological specimens contained keratinizing squamous epithelium characteristic of an epidermoid cyst.

Postoperative Course. The patient had full return of her left sixth nerve function. Follow-up MR imaging 1 week after surgery showed no residual tumor, and the patient has had no clinical evidence of recurrence in the 3 years since operation.

Case 3

This 37-year-old right-handed man developed slurred speech and bilateral decreased hearing 5 years before admission. Six months before admission he developed a left hemiparesis, dizziness, and intermittent nausea and vomiting.

Examination. The patient exhibited left facial hyposthesia, mild left facial droop, decreased left gag reflex, and left cerebellar ataxia. Computerized tomography revealed an irregular-shaped lesion in the right cerebellopontine angle and interpeduncular cistern. The lesion had a density lower than that of brain but slightly higher than that of cerebrospinal fluid (CSF), and caused marked deformity of the medulla and pons. A portion of the mass within the pons was calcified. The preoperative diagnosis was not an epidermoid cyst, but ependymoma of the fourth ventricle extending through the lateral recess into the basal cistern.

First Operation. The patient underwent a bilateral suboccipital craniectomy while in a sitting position. The arachnoid over the cisterna magna was milky in appearance and thickened. Lateral retraction of the cerebellar hemispheres revealed no tumor within the fourth ventricle, but did show that the ventricular floor was bulging. Exploration of the basal cisterns and incisura revealed a cheesy white material, which was biopsied through a small opening in the ambient cistern. The tumor, located along the clivus, had literally insinuated itself into the pons and medulla. To avoid excessive retraction, no further attempt was made to remove tumor by this approach. Postoperatively, the patient was neurologically unchanged.

Second Operation. Four weeks later, the patient underwent a right frontotemporal craniotomy for translentorial removal of his remaining epidermoid tumor. When the temporal lobe was elevated from the tentorium, exposing the arachnoid at the incisura, the brain stem was seen to be expanded by a flaky white epidermoid cyst. After more exposure, it was apparent that the tumor had insinuated itself into the midportion of the pons and medulla. A calcified nodule, which had been disclosed by CT, was embedded in the pons and was left in place. All inspissated tumor was removed. Care was taken not to perforate the capsule over the seventh and eighth cranial nerves or within the brain stem. Postoperative CT showed only a small residual calcified nodule within the pons.

Specimens from both the first and second procedures contained acellular fibrillar material resembling keratin, as well as a small amount of gliotic tissue. The pathological diagnosis was an epidermoid cyst.

Postoperative Course. The patient's left hemiparesis and ataxia diminished, but the left facial hypesthesia, left facial droop, decreased hearing, and slightly decreased left gag reflex persisted. Because of the development of a pseudomeningoele and communicating
hydrocephalus, a lumbo-peritoneal shunt was placed 1 week after the second operation. He was discharged 1 week after shunt placement and returned to work in 7 months. There has been no clinical evidence of recurrence during the 8-year follow-up period.

Discussion

Intracranial epidermoid cysts usually occupy the cerebellar-pontine angle or the parasellar region in the middle fossa. They also are found in the suprasellar region, cerebral and cerebellar hemispheres, ventricular system, and pineal region. Epidermoid cysts of the brain stem are extremely rare, with only six cases previously reported.

Epidermoid cysts probably develop from inclusion of ectodermal elements at the time of closure of the neural groove between the 3rd and 5th weeks of embryonic life. This inclusion can result in heterotopia of these elements. The median location of some of these tumors can be explained by the separation of neuroectoderm and its cutaneous counterpart, which occurs dorsally along the midline. Laterally situated lesions may result from inclusion of ectoderm at a later stage of embryogenesis, specifically during the formation of the secondary otic and optic cerebral vesicles.

It is thought that the growth of this tumor is linear and similar to that of skin. Thus, if a single tumor cell remained after resection, a tumor of the same size as the one resected could recur after a time equal to the patient's age at the time of resection plus 9 months. This supports previous observations that even if a small amount of tumor is left behind, the likelihood of a clinically significant recurrence is small. The slow growth of epidermoid cysts was confirmed by the lack of recurrence in our patients, although their average follow-up period has been only 4 years.

All three of our patients had epidermoid cysts at least partially located in the pons, although one of the cysts predominantly occupied the medulla. Each of the tumors appeared to have arisen in the preponine cistern and to have insinuated itself into the brain stem. This pattern is similar to that seen in previously reported cases of cysts with exophytic components. Epidermoid cysts appear to grow in cleavage planes between nerve fibers, extending along vessels into the subarachnoid space. From there, they usually take the path of least resistance and fill the subarachnoid space before displacing neurovascular structures. In our patients, it appeared that the tumor burrowed into the brain stem and became largely intra-axial even before it had filled all available subarachnoid spaces. None of the tumors in our three patients were solely intramedullary; previously, only the cases reported by Weaver and Coulon and Ogawa, et al., were entirely intra-axial without an exophytic component.

Of the six previously reported patients with epidermoid cysts of the brain stem, four died. Three of these patients were treated before CT was available at their institutions. One of these underwent surgical aspiration of cyst contents and later had a ventriculostomy shunt placed; one had a negative exploration via a craniotomy, then had a ventriculoperitoneal shunt placed; and the third underwent aspiration and then radical excision of the cyst, including its entire wall. All three patients died shortly after treatment. Increased ability to diagnose and localize these lesions, brought about by the advent of CT scanning and MR imaging, has greatly influenced surgical management and appears to have resulted in a lower mortality rate.

Another factor contributing to morbidity and mortality is the extent of resection. In each of our cases, only cyst wall not adherent to the brain stem was removed. An attempt at a more aggressive resection might well have resulted in a poorer outcome. Radical resection, which included the cyst wall adherent to the brain stem, was attempted in two previously reported cases. In one instance the patient had severe bulbar problems and a difficult postoperative course which included CSF leakage, infection, and ultimately death. The other patient had the cyst wall stripped away except for a 1- to 2-mm remnant at the pontomedullary junction. Manipulation of this remnant resulted in unstable vital signs. Thus it is clear that no attempt should be made to remove cyst wall or tumor flakes which are densely adherent to neurovascular structures, particularly the brain stem.

All three of our patients underwent subtotal resection of their tumors, and all had good outcomes. One patient had new facial weakness which steadily improved; one had complete return of her sixth nerve function; and one had no change in his brain-stem findings but had a diminished hemiparesis. The patient developed postoperative communicating hydrocephalus, requiring a lumbo-peritoneal shunt.

In two of our three patients, two separate procedures were necessary for safe removal of the tumor contents. Total resection of cyst contents and nonadherent cyst wall is the goal of treatment, and the greater the resection the smaller is the likelihood that the tumor will show a clinical recurrence. Thus, one should not hesitate to perform two separate procedures in order to provide the necessary exposure for maximal resection. Most epidermoid tumors, however, can be approached through a one-stage procedure. In retrospect, the cyst in our Case 3 probably could have been resected in one stage rather than two, since minimal tumor was removed at the first operation.

Care must also be taken to avoid spilling cyst contents into the subarachnoid space. Of the six previously reported patients, two presented with recurrent aseptic meningitis after spontaneous rupture or leakage of cyst contents and five had aseptic or bacterial meningitis postoperatively. None of our three pa-
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tients showed clinical evidence of postoperative aseptic meningitis, although meningeal involvement probably caused communicating hydrocephalus in the third patient. We use hydrocortisone solution for irrigation during the procedure and use perioperative systemic steroids for prophylaxis against aseptic meningitis.

On CT scans, epidermoid cysts appear as hypointense or isointense areas not enhanced with contrast material. This was confirmed by CT scans of our patients, which showed masses that were hypointense compared to brain and failed to enhance with contrast medium.

On MR images, the signal intensity of an epidermoid cyst depends on the relative amount of lipid and to some extent on the amount of cholesterol and keratin within the tumor. Variability is seen on both T1- and T2-weighted images. On T1-weighted images, epidermoid cysts usually exhibit a signal intensity intermediate between that of brain and CSF. On T2-weighted images, signal intensities of epidermoid tumors are usually greater than that of either brain or CSF. According to Vion-Dury, et al., T2 relaxation time relative to that of surrounding parenchyma is increased in 57% of epidermoid cysts, decreased in 15%, and the same in 26%. The variability seems independent of echo delay time and relaxation time. Horowitz, et al., correlated MR images with in vitro 1H spectroscopy of epidermoid cyst specimens, and found T1 shortening associated with cysts with high lipid contents of mixed triglycerides and unsaturated fatty acid residues, but no cholesterol. The T1 prolongation was present in cysts with reduced lipid content consisting of trace amounts of cholesterol but no triglycerides or fatty acids. Microcalcifications and a high proportion of cholesterol and keratin in crystalline form may also contribute to T1 and T2 shortening. Epidermoid cysts typically do not exhibit peritumoral edema on T2-weighted images, an observation supported by our findings.

Only one brain-stem epidermoid cyst evaluated by MR imaging has been reported, and it showed areas of both increased and decreased signal intensity on T2-weighted images. The tumors of both of our patients who had MR images demonstrated increased signal intensity relative to brain on T1-weighted images, and predominantly decreased signal intensity on T2-weighted images. This pattern of signal intensity has appeared in many of our patients with midline epidermoid tumors (unpublished observations), whereas epidermoid cysts situated laterally tend to show signal characteristics similar to those reported previously. The reason for this difference is not clear. Regardless, MR imaging allows accurate localization of the tumor preoperatively and has been the mainstay of evaluation postoperatively.

Epidermoid cysts which have insinuated themselves into the brain stem should be managed by decompression of cyst contents and removal of nonadherent portions of the cyst capsule. Cyst wall adherent to the brain stem, however, should not be removed. Safe and adequate resection may require two operative approaches.

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References


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