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Original Research Article

Microneurosurgical aspects in the management of posterior cranial fossa epidermoids: experience of 24 cases

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ABSTRACT

Background: There is considerable debate in the surgical management of epidermoid cyst, whether gross total or subtotal resection yields better long term outcomes. We present our institutional experience in evaluating the clinical presentation, diagnosis, and surgical strategy and extent of resection in the management of posterior cranial fossa epidermoid cyst.
Methods: A retrospective review of 24 patients diagnosed with posterior cranial fossa epidermoid tumors surgically treated at the institution between January 2010 and July 2019.
Results: A total of 24 patients who underwent surgery for intracranial epidermoid lesions were identified. Of these 13 were in the Cerebellopontine angle region, eight were in the fourth ventricle, and three in lateral cerebellar convexity. The mean duration from onset of symptoms to surgery was 1.6 years. Cranial nerve dysfunction was noted in 73% of patients preoperatively, most of them being the CPA epidermoids. Total removal was achieved in 16 patients, near-total resection in 6 patients, and subtotal removal in 2 patients. Three patients developed recurrence radiologically of them only one patient became symptomatic. The mean duration of follow-up was 3.8 years. The content of the tumor was pearly white material in all cases. Complications noted in the present series were not related to the completeness of excision. Mortality was noted in one patient.
Conclusions: The present study highlights various precautions to be taken intraoperatively in the prevention of development of aseptic meningitis and concludes that total removal of epidermoids does not result in significantly increased morbidity and mortality and should be the goal of surgical treatment. However, near/subtotal resection of lesions that are densely adherent to neurovascular structures is justified, as there is no significant difference in the rate of recurrence. An endoscope can be used to assess the completeness of surgery.

Keywords: Cerebellopontine region epidermoids, Fourth ventricular epidermoids, Posterior fossa epidermoids

INTRODUCTION

Epidermoid or "pearly" tumors were described by Cruveilhier and designated the "most beautiful tumors of the body" by Dandy.[1] Epidermoid cyst (EC) are extra-axial subarachnoid congenital benign slow-growing lesions also known as cholesteatomas or pearly tumors. They usually are rare lesions and represent approximately 0.2-2 % of all intracranial tumors.[2] They are slow-growing lesions by the accumulation of keratin and cholesterol, which are the breakdown products of desquamated epithelial cells. Their slow growth and the soft consistency of cholesterin allow progressive adaptation to the neurovascular structures with preferential development along natural pathways, that is, the subarachnoidal cisterns of the skull base. So, there is no mass effect initially and remain asymptomatic for many years. Symptoms are mainly due to mass effect

when they increase in size or involvement of cranial nerves (CN). They commonly occur in the cerebellopontine angle (CPA), and parasellar location, which could be explained by the result of the proliferation of multipotential embryogenic cell rests or lateral displacement of ectodermal cells by the developing otic vesicles. Prevalently, EC extends to or involve the CPA and its vital neurovascular structures, thus commonly causing hearing loss, trigeminal neuralgia (TN), vertigo, or facial nerve palsy. As EC is neither sensitive to chemotherapy nor to radiation, surgical resection constitutes the exclusive treatment modality for these lesions. There is continued debate regarding the extent of resection, should we prefer gross total removal (GTR), which can result in unwarranted CN deficit and arterial injury, or should GTR be avoided. A safer, subtotal tumor removal (STR) be chosen. The objectives of the current paper are to report on our operative strategy and surgical technique and to identify the best operative management for posterior fossa (PF) epidermoid and extent of resection.

METHODS

The study population constitutes a total of 24 patients who were diagnosed with PF epidermoid cyst. All 24 patients included in the study underwent surgery in Sri Venkateswara Institute of Medical Sciences (SVIMS), between the period of January 2010 to July 2019. Retrospectively collected data includes clinical presentation, radiological findings, surgical approach, the extent of resection (EOR), complications, and neurological outcome were studied. PF epidermoid cyst patients who were managed conservatively were excluded from the study. CT and MRI were used in all cases for diagnosis and follow-up. The location of the tumor determined the surgical approach. The aim of surgery was maximum safe resection with an emphasis on the preservation of CN to give our patients the highest quality of life possible following surgery. EOR was planned preoperatively based on MRI or computed tomography (CT) but ultimately decided intraoperatively when a tumor's adherence to critical structures could be best ascertained. The EOR was determined by examining surgical records and follow up imaging. Postoperatively, all patients received a CT scan in the immediate postoperative period to look for any surgical complications. During follow-up, all patients underwent an MR imaging examination to detect any residual or recurrence. The EOR was considered total if the whole keratinous debris from the core of the tumor, as well as the entire tumor capsule, had been removed. The EOR was considered near-total if the entire keratinous content had been resected, but adhesive parts of the tumor capsule remained in situ. The EOR was considered subtotal if some part of the tumor could not be excised for any reason. The mean follow up period was 3.8 years. No patient dropped out during follow-up. We reviewed the current literature in the context of previous clinical series on PF epidermoid tumors.

RESULTS

The total number of patients was 24 (M:F=13:11). Age range, 19-56 years. The mean duration from the onset of symptoms to surgery was 1.6 years. The commonest age group of the presentation was 31-40 yrs, 13 cases EC were located in the CPA region, in 8 cases, EC was located in the fourth ventricle, and in 3 cases, EC was located in lateral cerebellar convexity. Among 13 cases of EC located in CPA, in 3 cases, EC was extending to the opposite side through the prepontine cistern, in 3 other cases, CPA epidermoid was extending to middle cranial fossa. Clinical features were according to the location and extent of the tumor. Headache, CN deficit (73%), cerebellar symptoms were the commonest symptoms in PF epidermoid cyst. Cerebellar signs, including gait ataxia, dysmetria, dysarthria, and nystagmus. Among the CPA epidermoid, TN was noted in six patients. Facial weakness and facial spasms were noted in two patients, hearing loss was noted in two patients. Lower CN palsy was noted in 2 patients.

Table 1: Clinical features of posterior fossa epidermoid cyst.

Clinical features	Number of patients %
Headache (suboccipital region)	17(70.83%)
Cerebellar symptoms	8(33.33%)
Cranial nerve deficit	
Trigeminal neuralgia (lancinating pain on one half of the face)	6 (25%)
Hearing impairment and Tinnitus and vertigo	4 (16.6%)
features of seventh cranial nerve palsy	2(8.3%)
Diplopia	2(8.3%)
Nasal regurgitation	2(8.3%)
Hydrocephalus	6 (25%)

Table 2: Common clinical features according to location.

C P angle epidermoids	Fourth ventricular
Headache	Headache in suboccipital region
Involvement of cranial nerve • V in the form of trigeminal neuralgia • VIII in the form of vertigo, hearing impairment and tinnitus • VII in the form of LMN features • VI on the form dipolpia • Lower cranial nerves in the form nasal regurgitation	Cerebellar symptoms Swaying while walking Slurring of speech Unsteady gait
Cerebellar symptoms	Symptoms of hydrocephalus

Table 1 depicts clinical features in PF epidermoids, (Table 2) shows clinical features according to location.

CT and MRI brain was done for all cases. In the CT scan, hypodense lesion, which showed minimal contrast uptake in the periphery. In the MRI study, the epidermoid was hypointense in T1 and hyperintense in T2 weighted images. Proton density (PD) differentiated the cyst from the cerebrospinal fluid (CSF). Hydrocephalus with features of raised Intracranial Pressure was in six cases, and pre-excision CSF diversion was done in 3 cases. The neurosurgical approach to EC depends on tumor location and growth pattern. Different micro neurosurgical approaches were used for EC at various sites. The suboccipital retro sigmoid retro mastoid approach was preferred route in all CPA epidermoid.

Midline suboccipital craniectomy (trans vermian) in fourth ventricular EC. In one case, the combined suboccipital and sub temporal approach was used as the tumor was extending from posterior fossa to middle fossa. Paramedian suboccipital craniectomy was done for lateral cerebellar convexity EC. The content of the EC in all cases was pearly white material. In the present study, GTR was possible in 16 cases.

In the remaining cases, it was not possible for complete removal as vital structures needed to be preserved. Near-total resection was done in six patients. A minute amount of tumor was left behind the basilar artery in two cases and two cases tumor capsule adherent to brain stem was left behind. One case was a recurrent case operated elsewhere, so some amount of tumor adherent to the brain stem and lower cranial nerves was left behind. Two cases underwent STR was done. In four cases, an Endoscope was used to check the completeness of resection. All patients underwent an early postoperative CT brain in the first 24 hrs to check for any complications. Table 3 shows the post complication. The neurological deficits are newly developed CN deficits post operatively.

Table 4 shows the fate of preoperatively present CN deficits in relation to recovery (early or late) or worsening or persistence. Out of six patients with TN who underwent surgery four patients had complete relief of symptoms postoperatively remaining two patients had relief of symptoms very slowly.

Table 3: Complications noted in this study in relation to extent of resection.

Complications	GTR	STR and NEAR
Aseptic/chemical meningitis	-	1
Transient cranial nerve palsy		
• Third CN palsy	1	-
• Sixth CN palsy	1	2
• Seventh CN palsy	-	1
• Lower CN palsy	2	1
Permanent cranial nerve palsy		
• Lower CN palsy	1	1
Post meningitic hydrocephalus	3	2
Hemiparesis	1	-
CSF rhinorrhea	2	-

(GTR- gross total resection, STR- subtotal resection, CN - cranial nerve)

Table 4: Cranial nerve outcome following surgery.

	Preoperatively	Postoperative period			
		Recovered		No recovery	Worsening
		Early	Late		
Trigeminal neuralgia	Six	4	2		
Hearing deficit	Two	No recovery		2	No worsening
Facial nerve palsy	Two	No recovery		2	
Lower cranial nerve palsy	One				Worsened in one patient
Diplopia	One	Late recovery			

Table 5: Comparison of the present study with various other studies in literature.

Name of the study	No. of cases	GTR (%)	Mortality (%)	Recurrence (%)	Follow up (Years)
Kobata et al [7]	30	56.7%	0	6.6%	11.4
Akar et al [11]	28	75%	3.5%	7%	6
Samii et al[12]	40	75%	2.5%	7.5%	5.7
Schiefer et al[14]	24	54%	0	25%	4.3
Yasargil et al[10]	22	95%	0	9%	5.2
Choudary et al[15]	23	73.9%	4.3%	NA	3
Kato et al[16]	27	10%	5%	20%	NA
Present study	24	66.6%	4.1%	4.1%	3.8

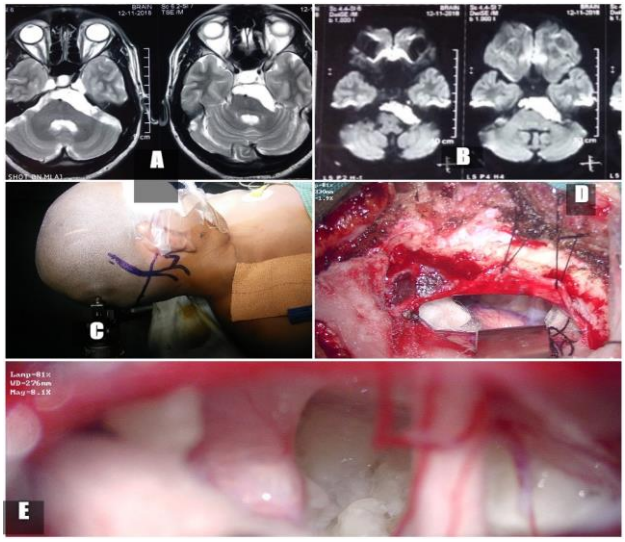

Figure 1: Imaging and intra-operative pictures cp angle epidermoid cyst (A) MRI showing CPA epidermoid extending anterior to the basilar artery on to the opposite side (B) DWI showing restriction (C) operative picture of the patient with lesion and marking of incision for undergoing retrosigmoid retromastoid suboccipital craniectomy.(D) After the opening of the dura and placing spatula to retract cerebellum and visualizing the lesion. (E) pearly white lesion seen along with fifth and seventh cranial nerves.

But patients with hearing loss did not regain hearing even after complete excision. Two patients required postoperative external ventricular drainage for postoperative hydrocephalus. One patient needed ventriculoperitoneal shunting as a consequence post, meninigitic hydrocephalus. (patient developed meningitis post-EC removal) Regarding post-operative complications, following fourth ventricular epidermoid tumor were CSF leak, complications following CPA Epidermoid were related to facial nerve palsy which resolved in due course, transient CSF rhinorrhea (in one CPA epidermoid), and sixth nerve palsy and chemical meningitis in one patient. And one patient had lower CN palsy, which was managed by RT feeding and subsequently recovered. The complication was minimal after the removal of lateral cerebellar convexity EC. One CPA epidermoid patient died due to meningitis.

Table 5 shows results in the present study along with results from various studies from literature, the results of present study are more or less same.

Salient operative steps common to all procedures in study were;

- positioning and incision depend on location
- dural opening
- placement of cotton pads surrounding the tumor to prevent spillage of cystic contents into subarachnoid space thereby preventing chemical meningitis
- careful inspection of anatomy and gradual, piecemeal reduction of the tumor thereby creating working space between tumor capsule and surrounding neurovascular structures
- sharp dissection of capsule done to and free it from adjacent neurovascular structures
- if the capsule is tightly adherent and removal of the capsule is likely to injure vital structures, capsule may be left behind.
- The leftover capsule should never be coagulated.
- Irrigation of surgical site continuously with hydrocortisone (100mg/l in lactated ringer solution) also reduces the chances of post-operative communicating hydrocephalus and aseptic meningitis.
- Intraoperative steroid administration (dexamethasone)
- Careful attention was paid to identifying and preserving the arachnoid plane at the tumor–brainstem interface, which facilitated complete tumor resection and minimized small vessel and brainstem injury.
- All open mastoid cells were sealed with bone wax to prevent CSF leaks.
- Usage of the endoscope allows inspection of obscured but important corners of the operating field without the need to retract neurovascular structures or to resect dura and bone edges. Compared with a microscopic surgical field alone, the endoscope provides a view of the operative field from a different angle.

Figure 1 shows the preoperative imaging of a patient from the study along with operative position and intraoperative picture after opening dura and appearance of epidermoid cyst.

DISCUSSION

Many studies suggest EC has no male or female predilection, as in our study, females (11) and males (13). EC patients typically are between 20 and 40 years of age.[3] Present study most of the patients were in the fourth decade correlating with previous studies. The commonest age group in our study was 31-40 years. The range of patient age was 19-56 yrs. The most common location of PF epidermoids in the present study being CPA, 13 of 24 (54%). Literature suggests 60% of all intracranial epidermoids occur in CPA. The commonest tumors in the CPA region are acoustic neuromas and meningiomas, EC being the third commonest in that region.[4] Literature suggests that the second most prevalent location in the PF is the fourth ventricle accounting for 5-18% of all intracranial epidermoids, 8 of 24 in the present study were noted in the fourth ventricle. Three were noted in lateral cerebellar convexity. Spinal epidermoid is very rare.[5] The mean duration of symptoms in the present study was 1.6 years. EC has a thin capsule composed of keratinized stratified squamous epithelium, which

desquamates and gives rise to the cyst contents, keratin, and cholesterol. They tend to grow very slowly along natural cleavage planes, sulci, fissures, cisternal spaces, ventricles until all available subarachnoid space is used up. Symptoms become clinically apparent, because of this, the symptoms are noticed in the delayed stage. Symptoms and signs tend to appear at the later stage due to the physical presence of tumor-causing irritative effects. Infratentorial epidermoids cause CN deficits and cerebellar symptoms. The most common presenting symptoms in patients with CPA epidermoids are TN and hearing impairment, followed by dizziness, headaches, diplopia, and facial nerve paresis.[6]

Table 6: Differential diagnosis of cystic lesions of brain.

Lesion	Differentiating radiological characteristics
Classical epidermoid	• Epidermoids classically follows a CSF intensity pattern on CT and MRI. • Hypodense on noncontrast CT, as they are avascular, no enhancement on contrast CT • hypointense on T1WI-MRI, hyperintense on T2WI-MRI, • suppress on FLAIR (used to differentiate them from the arachnoid cysts which do not suppress on FLAIR) and show diffusion restriction. • These tumors are usually solid and have no triglycerides. These classical epidermoids are referred to as black epidermoids.
Atypical epidermoid (white epidermoid)[17]	• Hypodense on CT, Restriction absent on DWI [18] • Hyperintense on MRI T1W1, Hypointense on MRI T2W1
Malignant transformation of benign epidermoid cyst [19]	• Histological diagnosis is confirmatory • presence of edema and tissue invasion, rapid growth, and new enhancement on contrast are some features of malignant transformation of epidermoid cyst • Immunohistochemistry of the malignant epidermoid cyst reported in the literature showed the positivity of tumor cells with P53 protein.
Dermoid cyst	• Midline location, grow fast and rapid, leading to the occurrence of clinical features • It contains dermal appendages like hair follicles, teeth, lipids. • The dermoid cyst appears in 2nd to 3rd decade of life. • Hypodense on CT, Hyperintense on T1WI and iso-hyperintense on T2WI • The lining of a dermoid cyst is a simple stratified squamous epithelium supported by collagen.
Arachnoid cyst	• located mostly at middle cranial fossa • hypointense on both FLAIR and DWI
Neurenteric cyst	• Ovoid, extra-axial, well-delineated lesion located at the midline in the posterior fossa. • It may be spontaneously hyperdense on CT. • MRI, the cyst usually appears hyperintense to CSF signal on T1, T2, and FLAIR sequences, owing to protein-rich content. No enhancement or restricted diffusion is typically seen.
Colloid cyst	• Mass arising at the foramen of Monro frequently manifests as obstruction of the lateral ventricles. • The well-defined round cyst may be from several millimeters to 3 cm in size and attaches to the superior anterior aspect of the third ventricle roof • hyperattenuating at nonenhanced CT, it has variable signal intensity at MR imaging and is often hyperintense on T1-weighted and FLAIR images.

In the present study, six patients had TN four of these patients relieved in the immediate period after surgery. TN and hemifacial spasm may result from nerve compression by an artery displaced by the EC or from nerve displacement towards the artery by the tumor. Kobata et al, highlighted that in patients with EC, hemifacial spasm occurs only in cases of neurovascular conflict.[7]

At the same time, TN may often also result from displacement or kinking of the trigeminal nerve related to the presence of a tumor, and in cases unrelated to a tumor may also be caused by arachnoid adhesions or venous pathology. They believe that this difference is related to the length of the Redlich-Obersteiner zone, which is sensitive to direct compression or displacement and is nearly three times longer for the trigeminal nerve compared to the facial nerve (2.2 mm vs. 0.8 mm). As a result, TN due to trigeminal nerve displacement is more likely than hemifacial spasm due to facial nerve displacement. In my present study, two patients had hemifacial spasm compared to six with TN.

Rarely EC may present with a recurring history of chronic aseptic meningitis with prolonged episodes, which can occur due to spontaneous rupture of cyst contents into subarachnoid space, which is highly irritative. No patient in the present study presented with recurrent aseptic meningitis the clinical features in the present study matched to those in literature. The appearance of EC on MRI shows low signal intensity on T1WI and high signal intensity on T2WI. Conventional MR images sometimes cannot reliably be used to distinguish EC from arachnoid cysts since both lesions are very hypointense relative to brain parenchyma on T1-weighted MR images and very hyperintense on T2-weighted images. Fluid-attenuated inversion recovery (FLAIR) and diffusion-weighted (DW) sequences can successfully be used for the diagnosis of EC by revealing its solid nature.[8] DW imaging is superior to other MR sequences in delineating the borders of the epidermoid cyst. FLAIR MR imaging is based on the nulling of the signal from CSF. EC characteristically present on this sequence as heterogeneous lesions with central parts of the tumor being hyperintense relative to the hypointense CSF.DWI is hyperintense and has a high value on ADC. Capsular enhancement of the cyst is not often seen; the high contrast enhancement of epidermoid capsule is rare. All the patients in the present study needed MRI DWI images for confirmation of diagnosis. The primary differential diagnosis for an EC is arachnoidal cysts, dermoid cysts, cystic neoplasms, neurocysticercosis, neurenteric cyst, etc. (Table 6) differentiates EC from all these lesions.

White EC is atypical in that they, due to their high protein content and consequently high viscosity, they are hyperintense on T1WI sequence, hypo- to hyper-intense (commonly hypointense) on T2 and show no diffusion restriction. They are usually cystic, and in addition to their high protein content, they typically have high lipid content with mixed triglycerides containing polyunsaturated fatty acids and no cholesterol, further contributing to their high viscosity. There is no uniform opinion regarding the extent of surgery in EC in literature. Some advocate GTR others advocate STR and leaving behind tumor adherent to vital neurovascular structures. Berger and Wilson did not perform in any of their cases, reporting minimum patient morbidity and no recurrences over 4.5 years of follow-up. On the other hand, Yasargil et al, achieved total removal in 95% of patients with minimum morbidity and a 9% recurrence rate of over 5.2 years of follow-up.[9,10] All other reports fall somewhere in between these ends of the spectrum. In the present study, 16(66.6%) patients underwent GTR to 2(8.3%) patients of STR.

Although the universal goal of surgery is the complete removal of the lesion without damage to adjacent neurovascular structures, portions of the capsule adherent to these structures often make this extremely difficult. Akar et al, found that the presence of CN dysfunction before surgery increased the incidence of dysfunction postoperatively, which was also consistent with experience.[11] Chemical meningitis can occur by spillage of the cyst contents during operation, which usually is transient and self-limiting and can be managed successfully with steroids. Excision of the capsule by sharp dissection, irrigation of the CPA cisterns with hydrocortisone solution during the surgery, and delayed withdrawal of steroids in the post-operative period.[12] have been advocated as possible measures for preventing chemical meningitis. There was one death in the present study that occurred in CPA epidermoid, and it was due to meningitis. Due to the risk of recurrence, GTR should be the goal of the surgery, but in other reports was found no difference in the risk of recurrence between completely and incompletely removed tumors.

Role of endoscope

Compared with a microscopic surgical field alone, the endoscope provides a view of the operative field from a different angle. This feature improves the assessment of the extent of the surgical excision. In 1998 Fries and Perneczky evaluated their experience with endoscope-assisted microsurgery in the treatment of 205 brain tumors.[13]

The authors did not report whether their patient population included EC or other CPA tumors. However, they concluded that endoscope-assistance might reduce the trauma related to resection and improve operative outcomes. In present data, although endoscope was used only in four cases (CPA epidermoids), author used to see the completeness of resection and extent to the opposite side. No complications were attributed to the direct application of the endoscope in the present study.

CONCLUSION

EC are rare slow-growing tumors that primarily increase in size by desquamation of epithelial cells rather than by multiplication. Multiple CN deficits are more noted in CPA epidermoids. EC is soft friable, avascular, and easy to resect. Most of the time, the brain is lax and easy to retract. GTR is the treatment of choice. Meticulous care to be taken to excise an EC always the goal should be to completely resect at the same time to preserve the neurological function of the patient by microsurgical operative steps. For achieving a GTR, the most important is the complete resection of capsule. While teasing off the capsule of epidermoids away from the nerve or vessel, the neurovascular structure may be injured and resulting in postoperative morbidity. Sometimes it is better to leave off some tiny portions of tumors attached to the neurovascular structures. Therefore, while removing the capsule one should be careful. In many CPA epidermoids, hearing loss and diplopia persisted after surgery, whereas marked improvement was observed in the TN. Finally, the time taken by recurrent EC to produce symptoms is a very long period, so it is better to follow up on a small recurrent case of EC than to produce

a neurological deficit in the quest for GTR. This is true in CPA epidermoids. Prevention of aseptic meningitis can be done by covering all the exposed areas of the brain with cotton pledgets, intraoperative steroid cover, and continuous irrigation of field with steroid with normal saline. The endoscope can be used to assess the completeness of resection, allows inspection of obscured but important corners of the operating field without the need to retract neurovascular structures or to resect dura and bone edges. No attempt should be made to remove either the lesion or its capsule with the endoscope alone.

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