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Original Article

Combined microsurgical and endoscopic technique for removal of extensive intracranial epidermoids

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Abstract

Background: Intracranial epidermoid tumors are challenging lesions because they grow along the subarachnoid spaces around delicate neurovascular structures and often extend from one compartment to another. The purpose of this study was to determine the usefulness of endoscopic assistance in the microsurgical resection of these lesions, in which total resection is therapy of choice.

Methods: A total of 48 cases of intracranial epidermoids were treated by combined microscopic and endoscopic techniques. Initially, the tumor was removed under the microscope and after ensuring maximum excision, the endoscope was used to find out and excise any residual tumor.

Results: Out of these 48 cases complete excision was achieved in 44 cases and subtotal excision in four patients. Postoperative complications were seen in 17 patients, but none of the complications was attributed to the use of endoscope. Overall use of endoscope benefited 79% of cases.

Conclusion: We recommend combined microsurgical and endoscopic approach to achieve complete/maximum resection of extensive intracranial epidermoid tumors.

Key Words: Epidermoid, microsurgery, neuroendoscopy, skull base

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INTRODUCTION

Epidermoid tumors are fairly common and comprise approximately 0.2–1% of all intracranial tumors.[8,16,21] These tumors are congenital in nature and arise from ectodermal cell rests.[22,28] They grow slowly and spread widely along subarachnoid spaces at the base of brain. Because of this slow progression, epidermoids often reach a considerable size before they become symptomatic.[21,22] They often grow around critical neurovascular structures and may adhere firmly to them.[8,22,28] Nevertheless, total microsurgical removal is considered the therapy of choice as partial removal always leads to recurrence.[14,21-23,27,30] However, using standard microsurgical techniques, complete resection is sometimes not achieved either because of nonvisualization of the tumor in the crevices or requirement of significant retraction of the neurovascular structures which is potentially hazardous. Sometimes staged or combined (supratentorial + infratentorial) microsurgical approach is required as tumor grows from

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one compartment to another compartment. To facilitate total tumor resection and to avoid staged or combined microsurgical approach in cases of multicompartmental epidermoids, endoscopic assisted technique was developed.[6,17,18,22,25,27] Endoscope permits the surgeon to see into spaces outside the view of microscope, to look around surgical corners, and improves illumination and magnification in deep cavities, all facilitating maximum tumor resection.[6,23,25] The aim of this paper is to demonstrate the benefits of endoscopic assistance for complete surgical removal of extensive intracranial epidermoids.

MATERIAL AND METHODS

This is a prospective study done at the Post Graduate Institute of Medical Sciences, Rohtak, India and included 48 consecutive patients with intracranial epidermoids who underwent surgical resection of the tumor using combined microscopic and endoscopic techniques between January, 2010 and June, 2017. The clinical characteristics of these patients are mentioned in Table 1. There were 29 males and 19 females with a mean age of 33.6 years (range 15–65 years). Of the 48 patients, 28 had the bulk of tumor located in the cerebellopontine angle (CPA), six in Meckel's cave, four in the parasellar region, four in fourth ventricle, two in anterior interhemispheric region, two in posterior interhemispheric region, and two in quadrigeminal cistern. Twenty-six patients presented with headache, 12 had cranial nerve palsy, four had trigeminal neuralgia, nine had seizure, and two had ataxia while tinnitus, facial spasm, and behavioral disturbances were present in one patient each. All patients underwent magnetic resonance imaging (MRI) before and after surgery as well as on follow-up visit [Figures 1–3].

Table 1: Clinical profile of patients with epidermoids

Clinical feature	Number of patients
Male	29 (60.4%)
Female	19 (39.6%)
Age	15-65 years (mean 36.6 year)
Neurological presentation	
Headache	26 (54.1%)
Seizure	9 (18.7%)
Deafness	4 (8.3%)
7th, 8th, 9th, 10th, 11th CN palsy	6 (12.5%)
Diplopia	2 (4.1%)
Trigeminal neuralgia	4 (8.3%)
Facial nerve palsy	3 (6.2%)
Gait disturbance	2 (4.1%)
Tinnitus	1 (2%)
Facial spasm	1 (2%)
Hydrocephalous	2 (4.1%)
Visual deterioration	3 (6.2%)

Surgical procedure

Surgical approach was decided based on tumor location; retromastoid approach for CPA tumors, subfrontal for parasellar tumors, midline transvermian for fourth ventricular lesions, parasagittal interhemispheric for interhemispheric, and anterior petrosal approach for Meckel's cave tumors. Patient of quadrigeminal cistern was operated in sitting position via supracerebellar infratentorial (SCIT) approach. Just before start of operation, each patient received a bolus dose of 8 mg dexamethasone and then 4 mg 6 hourly in postoperative period, gradually tapered over next 4 days. Craniotomy was performed in the standard fashion and the tumor was microscopically exposed. After developing a plane between the overlying arachnoid and the shiny white tumor capsule, the capsule was incised and most of the tumor was removed in a piecemeal fashion with the aid of an operating microscope. An attempt was made to resect the tumor completely by microscope. After no visible tumor was seen under microscope, endoscopic inspection was done with the rigid rod-lens endoscope (outer diameter 4 mm) (Karl Storz GmbH & Co. Tuttlingen, Germany). On endoscopic inspection if no residual tumor was seen, we considered the case as not benefited by endoscopy. If residual tumor was seen and it was possible to further remove the tumor, we considered the case as benefited by endoscopy and tried to remove small bits of tumor using the endoscope. However, if large residual tumor was seen or the tumor was adherent to critical neurovascular structures, we reintroduced the microscope and tried to remove the tumor. Repeated endoscopic inspection was done in such cases to ensure complete excision. Endoscope was used in free hand manner and tumor was removed with

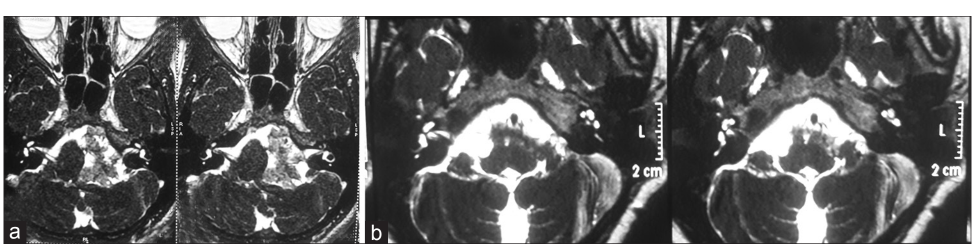

Figure 1: (a) Preoperative CISS images showing left cerebellopontine angle epidermoid with prepontine extension. (b) Postoperative CISS images showing complete excision

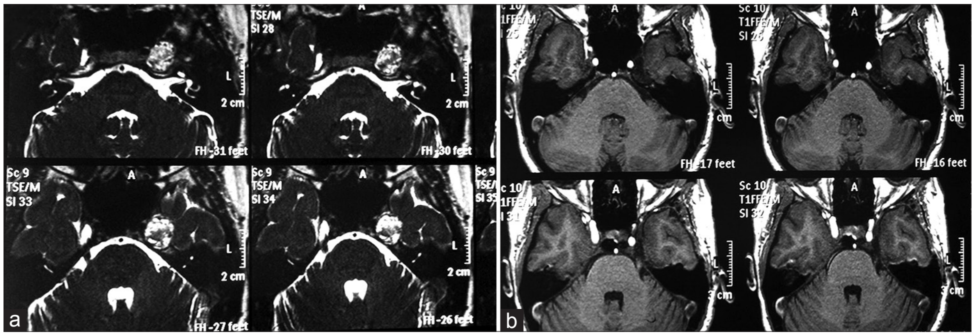

Figure 2: (a) Preoperative T2-weighted image showing left Meckel's cave epidermoid. (b) Postoperative T1-weighted images showing complete excision

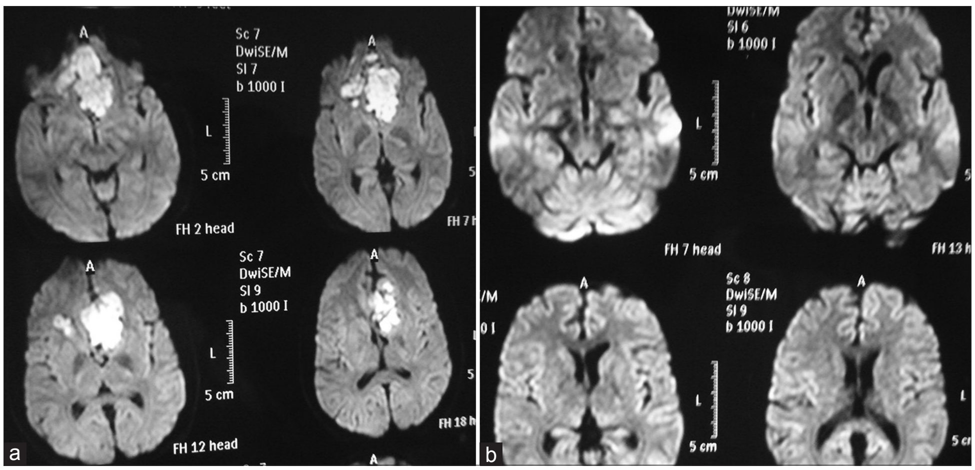

Figure 3: (a) Preoperative diffusion-weighted images showing suprasellar and suprachiasmatic epidermoid. (b) Postoperative diffusion-weighted images showing complete excision

conventional microsurgical instruments advanced and manipulated alongside the endoscope but was guided by video images provided by the endoscope (endoscopic controlled microsurgery). 0°, 30°, 45°, and 70° straight endoscopes were used which we are using for pituitary surgery. Intermittent irrigation was done with normal saline to avoid thermal injury. After ensuring complete excision, the subarachnoid space was copiously irrigated with normal saline to remove any epidermoid remnants and to prevent aseptic meningitis. After watertight closure of dura, the bone flap was replaced and wound closed in layers. We attempted to remove whole tumor using operating microscope and endoscope. Nevertheless, where it was firmly adherent to neurovascular structures, a small part of the capsule was left behind to avoid any postoperative neurological deficit. These cases were included in the subtotal resection group even though the postoperative MRI showed no residual tumor. We defined total resection as complete removal of the tumor capsule during surgery and nonvisualization of residual tumor in the postoperative MRI. The patients were followed regularly for a period ranging from 3 months to 72 months (mean 40.06 months). The histopathological examination revealed epidermoid in all cases.

RESULTS

Patient outcome is presented in Table 2. On endoscopic inspection, no residual tumor was found in 10 patients. Small residual tumor was found in 30 patients, which was removed under endoscopic control without using microscope. In eight patients, significant residual tumor was found during endoscopic inspection and the microscope was again used for removal of the residual tumor. In these patients, repeated endoscopic inspection was required for ensuring complete excision. The use of endoscope benefited in 38 (79%) out of 48 patients. Complete excision was achieved in 44 patients and subtotal excision in four patients. The capsule was left intentionally in two patients of CPA epidermoid in whom there was dense adhesion between the tumor capsule and lower cranial nerves, to avoid postoperative neurological deficits. Another patient with a large extensive epidermoid in quadrigeminal cistern, who was operated via the SCIT approach, developed severe cerebellar bulge intraoperatively, necessitating termination of surgery thus achieving subtotal resection in this patient. Postoperative complications were noted in 17 patients. Transient facial nerve palsy was seen in four patients of CPA epidermoids which improved completely at 3 months follow-up.

Table 2: Outcome analysis of patients with epidermoids

Main tumor location	Number of patients	Surgical approach	Outcome	Complication
Cerebellopontine angle (CPA) cistern	28 (58.3%)	Retromastoid	Complete resection - 26 Partial resection - 2	Facial nerve palsy -4 Aggravation of 7th, 8th, 9th, 10th, 11th nerve palsy - 4 Hearing loss - 2 Cerebrospinal fluid (CSF) leak - 1
Meckel's cave	6 (12.5%)	Anterior petrosal	Complete resection - 6	Postoperative seizure - 1
Parasellar region	4 (8.3%)	Subfrontal	Complete resection - 4	Postoperative seizure - 2
4th ventricle	4 (8.3%)	Midline transvermian	Complete resection - 4	
Interhemispheric region	4 (8.3%)	Parasaggital interhemispheric	Complete resection - 3 Partial resection - 1	Postoperative seizure - 1
Quadrigeminal cistern	2 (4.1%)	Supracerebellar infratentorial	Complete resection - 1 Partial resection - 1	Ataxia - 1 Aseptic meningitis - 1

In four patients with CPA epidermoids and 7th, 8th, 9th, 10th, and 11th cranial nerve palsies, the deficit increased in the postoperative period and they required Ryle's tube feeding. However, after 3 months, 7th, 9th, 10th, and 11th cranial nerve palsies partially improved and Ryle's tube was removed and patient could take orally. In one patient CSF leak developed which responded to conservative management. Postoperative seizures were noted in four patients who already had seizures at the time of presentation which were controlled by increasing the dose of anticonvulsants. Hearing loss was seen in two patients. Aseptic meningitis was seen in one patient who responded to intravenous steroids. Postoperative severe ataxia was noticed in the patient with quadrigeminal cistern epidermoid due to cerebellar infarct. There was no death in present series but permanent deficit was noted in five patients. Postoperative MRI revealed residual tumor in one patient. Till date no recurrence has been noted during follow-up in any of the patients. The use of endoscope was safe and no complication was attributed to its use.

DISCUSSION

Epidermoids are congenital neoplasms that grow through desquamation of keratin, cholesterol, and cellular debris.[14] These tumor are histologically benign but rarely malignant degeneration does occur.[14] These tumors generally occur at the base of cranium either in sellar or parasellar region, prepontine cistern or cerebellopontine cistern. Epidermoid tumors usually spread along path of least resistance, invade crevices, insinuate around nerves, and vessels and may firmly adhere to them. The ideal goal in epidermoid surgery is complete excision with removal of capsule but not at the expense of neurological deficit. These are curable tumors and only real chance of this cure is the first operation. Recurrent tumors are notoriously difficult to treat and are never curable. Technically speaking, removal of these tumors is easy because their contents are soft and easily dislodged with suction or simple manipulation. The real issue in surgery is difficulty in removing every bit of capsule as sometimes it is densely adherent to critical neurovascular structures and its removal leads to extremely distressing neurological deficits. Small remnants of the capsule that are firmly adherent to important neurovascular structures should be left in place rather than taking risk of neurological deficit.[2,21,22,27] Its our strategy to attempt a total removal of capsule. However, when capsule is firmly adherent to critical neurovascular structures, we leave the adherent part in place. Although, the capsule remnants probably will result in recurrence, but this will occur many years after surgery. Berger and Wilson[2] reported that it may take 30–40 years for recurrent symptoms to develop, a finding that supports the rationale of avoiding radical excision. In present series, the follow-up is small to know the recurrence.

Epidermoids frequently spread along the basal cisterns and have considerable extensions along the skull base. The extent of resection is not only influenced by the tumor's adhesion to surrounding structures but also by its pattern of extension.[6,16,20,25] Sometimes, two or more compartments are involved, such as the posterior and middle cranial fossae. Combined microscopic approaches have been recommended in such cases, although not necessary when endoscope is used.[22] The endoscope is extremely helpful while removing tumor parts, which are hidden behind the dura (e.g. tentorium Figure 4b) or bony corners [Figure 4c] as well as behind the neurovascular structures [Figure 4a]. The epidermoids, which are involving two compartments, can frequently be resected via a single craniotomy performed in one of the compartments when endoscopes are used.[22] The use of dental mirror has been advocated in epidermoid surgery;[22] however, the image quality and illumination is much poorer compared with endoscope. Perneczky and Fries[18,19] pioneered the concept of endoscopic assisted microsurgery. Endoscope-assisted microsurgery combines the advantages of the microscope and the endoscope. The microscope with its high resolution, excellent color

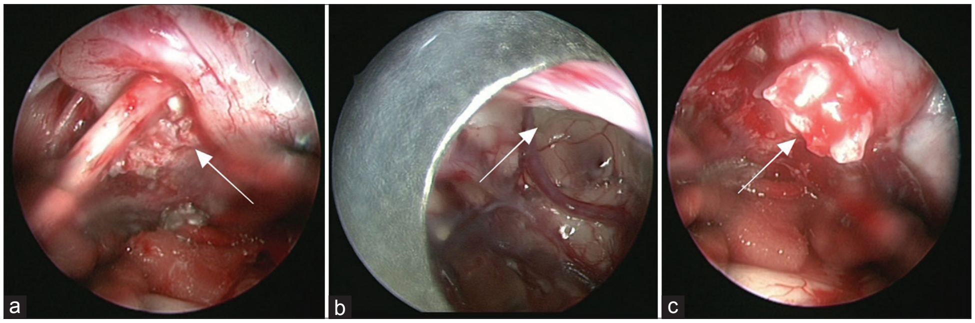

Figure 4: (a) Endoscopic view showing tumor hidden behind the neurovascular structures. (b) Endoscopic view showing tumor hidden behind the tentorium. (c) Endoscopic view showing tumor hidden behind the bony corners

fidelity, and binocular view is applied for the dissection of structures that are visible in a straight line. The endoscope provides superior visualization within deep surgical cavities compared to the microscope because it brings the light source deeper into the site and allows for angled and magnified views around corners in the operative field. In fact, we noted that in 79% of our cases the endoscope allowed us to visualize tumor that could not be clearly seen with microscopic visualization alone. Use of the endoscope may also help to reduce the need for brain retraction and skull base drilling.[6,16,17,19,25] As noted by previous investigators as well in present series that with use of 30°, 45°, 70° endoscope, we are able to see areas of residual tumor that previously went unnoticed, increasing the extent of resection and potentially contributing to increased time to symptomatic recurrence.[6,22,25] This technique requires some training because hand/eye coordination is initially difficult. When moving the endoscope or surgical instruments in and out in the surgical field, care has to be taken to avoid injury to the neurovascular structures, which are behind the endoscope tip and, therefore not in the viewing field of the endoscope. Furthermore, it is of utmost importance to keep in mind that the endoscope tip can get really hot which may cause damage to the neurovascular structures, so frequent irrigation is recommended. To avoid fogging of lens after insertion of endoscope, we put the scope in warm saline at 37°C before use. The lens is cleaned by irrigation and wiping.

The benefits of using endoscope for microsurgical resection of epidermoids have been previously reported.[6,22,25,27] Only few case reports of pure endoscopic removal of epidermoids of middle cranial fossa, CPA, and pineal region have been reported in the literature.[4,5,7,16,19,24,26,28] Peng *et al.*[17] described a series of six patients of CPA cistern excised by pure endoscopy and complete excision was achieved in five patients. Hu *et al.*[10] retrospectively analyzed the result of only endoscopically treated CPA epidermoids in 30 patients with recurrence of 6.5%, but did not include other patients of epidermoids which were not treated by pure endoscopic approach.

However, we have selected the combined microscopic and endoscopic approach because the dissection of capsule from neurovascular structures demands accurate procedure. Moreover, only endoscopic removal in such extensive epidermoids is time consuming and may lead to neurovascular injury due to frequent in and out movement of endoscope. Also, the high fat content of the tumor can disturb clear endoscopic visualization.[20]

Combined microscopic and endoscopic removal of intracranial epidermoids has also been described previously.[6,17,22,25,27] Tuchman *et al.*[25] described a series of 12 patients of intracranial epidermoid undergoing endoscope-assisted resection and 85% of their patients were benefited by use of endoscopy. Ebner *et al.*[6] described the use of combined microscopic and endoscopic technique in seven recurrent post-fossa epidermoids and five (70%) patients were benefited by use of endoscope. Schroeder *et al.*[22] described a series of eight patients of CPA epidermoids undergoing endoscope-assisted resection and 50% of their patients were benefited by use of endoscopy. In present series, the use of endoscope had benefited 79% of patients. In all previous series angled endoscopes were used specially meant for endoscopic assisted microsurgery. Tuchman *et al.*[25] had used four-handed, two-surgeon technique for excision of residual tumor following endoscopic inspection. Schroeder *et al.*[22] had used free hand technique for endoscopic inspection and endoscope was fixed to self-holding device for excision of residual epidermoid. However, we have used straight endoscope which we are using for pituitary surgery via free hand technique in all cases as use of self-holding device may lead to excessive heading in surgical field and chances of thermal injury are more due to heat. Moreover, we have removed only small remnants via endoscope and if large residual tumor or capsule was present, we again used microscope.

The rates of radical removal have ranged from 0% to 97%.[2,4,6-9,16,17,20-22,25-27,30] Our rates of total tumor resection (91.6%) and surgical complications are comparable with previous reports. Aseptic meningitis is reported to be most common cause of postoperative morbidity. The incidence of aseptic meningitis has ranged from 10% to 40%; in recent series this rate has decreased.[1-4,6,8,9,11-13,15-17,20-22,25,27-30] In our series the aseptic meningitis was seen in one patient (2%) and was managed with intravenous corticosteroids. Lower risk of aseptic meningitis in our series was attributed to complete excision, abundant irrigation, and routine use of corticosteroid therapy in postoperative period.

CONCLUSIONS

We conclude that combined microsurgical and endoscopic resection is ideal to achieve maximum resection of epidermoid tumors extending to multiple cranial fossae. The endoscope is a safe and effective adjunct to the microscope in the resection of epidermoid tumors, and facilitates further inspection and resection in most patients.

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Conflicts of interest
There are no conflicts of interest.

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