Research Paper

Transcranial Extraventricular Endoscopic Surgeries: Expanding the Role of Endoscope in Neurosurgery

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ABSTRACT

Background and Aim: Transcranial endoscopic surgeries are mainly limited to intraventricular lesions. This study aims to elaborate on the various benefits of transcranial endoscopic surgeries in extraventricular regions of the brain.

Methods and Materials/Patients: It is a retrospective study of transcranial extraventricular endoscopic surgeries (TEESs) operated between June 2022 to May 2023. The authors described the surgeries done for brain lesions other than intraventricular lesions as extraventricular surgeries. Access to the intracranial region was obtained through the transcranial approach. The transnasal rigid endoscope was used for the surgeries. The surgery was performed as either pure endoscopic surgery or endoscopic-assisted microscopic surgery.

Results: The authors have performed 6 microvascular decompressions using an endoscope. Three pineal tumors, 3 craniopharyngiomas, 1 cerebellopontine angle epidermoid cyst, and 1 petrous neurenteric cyst were excised using an endoscope by transcranial approach. One internal carotid artery bifurcation aneurysm was clipped using an endoscope. All patients improved in the postoperative period. Surgeries were done using the 0-degree and 30-degree endoscopes. The endoscopic eye was able to reach the deep-seated area of surgical interest and authors were able to visualize the structures in a wide panoramic view with good illumination and magnification. There was no misinterpretation of structures.

Conclusion: Endoscope can reach the deep-seated extraventricular areas of the brain with a narrow corridor, giving good illumination and magnification at the site of surgery. An endoscope can reach beyond the obstructing anatomical structure and visualize the area behind it. It is used as a complimentary to microscope to access the microscopic invisible areas. It has increased the ease of doing surgery, decreased tissue dissection, decreased complications, and improved surgical results. TEES improves the hand-eye coordination of surgeons in transcranial surgeries and it will help in adapting to exoscope easily.

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Highlights

● Endoscopic surgeries were mainly limited to transsphenoidal and intraventricular surgeries. In this study, the role of the endoscope in transcranial extraventricular regions of the brain has been described.

● Transcranial endoscope can reach the deep-seated regions of the brain with a narrow corridor, giving good illumination and magnification at the site of surgery.

● Microscopic inaccessible areas can be visualized using an endoscope. It can be used as a complementary to the microscope.

● Authors have used transcranial extraventricular endoscopic surgeries (TEESs) for performing microvascular decompression, pineal tumor excision, craniopharyngioma excision, cerebellopontine angle epidermoid cyst excision, petrous neurenteric cyst excision, and internal carotid artery aneurysm clipping.

● TEES has shown improved outcomes in neurosurgical procedures.

Plain Language Summary

Microscopes and endoscopes show the brain structures in a magnified view, which helps in performing surgeries with good outcomes. Neurosurgical procedures are mainly performed using a microscope. Endoscopic usage is mainly limited to the surgeries performed through the nose. In this study, we have analyzed the benefits of the endoscope in surgeries performed through the head (craniotomy). We have performed 15 endoscopic brain surgeries over a period of 1 year. The endoscope was able to visualize the deep-seated areas in the brain that were difficult to see using a microscope. During surgery, deep-seated brain structures, blood vessels, and tumors were seen clearly in magnified view. The endoscope was able to go beyond the structures and see the area behind it. This has increased the ease of doing surgery, decreased complications, and improved the surgical result.

1. Introduction

Technologies are developing in neurosurgery for better visualization of surgical fields. Better vision will in turn improve surgical results. Majority of the brain surgeries are done using a microscope. The use of exoscope is a recent development in this area. Transcranial endoscopic usage is limited mainly to intraventricular lesions. Endoscopic use in extraventricular regions of the brain is not much developed due to a lack of endoscopic training and a lack of awareness of endoscopic use. The authors have taken a step ahead and used endoscopes for a wide range of transcranial surgeries other than ventricular surgeries.

Virani et al., used an endoscope to visualize vascular loops in trigeminal neuralgia (TN) and hemifacial spasm (HFS) and also to search small cerebellopontine (CP) angle lesions [1]. Authors have used endoscope by transcranial route for performing pineal tumor excision, microvascular decompression (MVD), cerebellopontine angle (CPA) lesion excision, craniopharyngioma excision, and internal carotid artery (ICA) bifurcation aneurysm clipping. The authors have analyzed the benefits of endoscopes in transcranial extraventricular surgeries.

2. Methods and Materials/Patients

This is a retrospective study of transcranial extraventricular endoscopic surgeries (TEESs) operated between June 2022 to May 2023 (1 year) in the Department of Neurosurgery. The aim was to study the benefits of the endoscope in transcranial extraventricular surgeries. The authors described the surgeries done for brain lesions other than intraventricular lesions as extraventricular surgeries. Access to the intracranial region was obtained through craniotomy or craniectomy which is called transcranial approach. The transnasal rigid endoscope (Karl Storz, Germany) was used for the surgeries (Figure 1). A ventriculoscope was not used for surgeries. Endoscopic intraventricular and endoscopic transnasal surgeries were excluded from the study. The surgery was performed as either pure endoscopic surgery or endoscopic-assisted microscopic surgery. The endoscope was navigated inside the cranium to the site of

Table 1. Clinical profile, radiological features, and treatment of patients undergoing endoscopic microvascular decompression

Sl No.	Diagnosis	Age (y) Sex	Clinical Features	Imaging (MRI)	Surgery	Duration of Stay (d)
1	Left TN	61 M	V1, V2 distribution pain for 2 years.	SCA loop compressing CN V	Pure endoscopic surgery. 00 and 300 endoscopes were used. Teflon was interpositioned between SCA and CN V.	5
2	Left TN	37 F	V2, V3 distribution pain for 7 years.	No vascular loop noted	Pure endoscopic surgery. 00 and 300 endoscopes were used. A branch from the petrosal vein separated from CN V and Teflon interpositioned.	5
3	Left TN	50 M	V2, V3 distribution pain for 5 years.	Vessels are seen abutting CN V near its entry into Meckel's cave.	Pure endoscopic surgery. 00 and 300 endoscopes were used. Multiple small vessels near the entry of CN V into Meckel's cave were separated and Teflon interpositioned.	4
4	Right TN	31 M	V2, V3 distribution facial pain for 2 years.	SCV compressing CN V.	Endoscopic assisted microscopic surgery. 00 endoscope used. Teflon was interpositioned between SCV and CN V.	7
5	Left TN	60 F	V1, V2 distribution facial pain for 6 months.	SCV was seen compressing CN V near its entry into Meckel's cave.	Pure endoscopic surgery. 00 and 300 endoscopes were used. SCV was separated and Teflon interpositioned.	6
6	Right recurrent HFS	38 M	Right-sided HFS for 10 months.	AICA loop was compressing the facial nerve near the brainstem.	Endoscopic assisted microscopic surgery. 00 endoscope used. AICA loop was separated from VII-VIII complex and Teflon interpositioned.	6

Abbreviations: MRI: Magnetic resonance imaging; TN: Trigeminal neuralgia; M: Male; F: Female; SCA: Superior cerebellar artery; CN: Cranial nerve; SCV: Superior cerebellar vein; HFS: Hemifacial spasm; AICA: Anterior inferior cerebellar artery; MVD: Microvascular decompression; V1: Opthalmic division of trigeminal nerve; V2: Maxillary division of trigeminal nerve; V3: Mandibular division of trigeminal nerve.

the lesion during surgery. Statistical analysis was done using Epi info software. The data analyzed include age, sex, diagnosis, clinical features, duration of symptoms, computed tomography (CT), magnetic resonance imaging (MRI) finding, surgery performed, endoscope used (0-degree, 30-degree), pure endoscopic/endoscopic assisted microscopic surgery, surgical findings, benefits of the endoscope, post-operative status, and postoperative duration of stay in hospital.

3. Results

The authors have performed endoscopic MVDs for 5 cases of TN and one recurrent HFS by retrosigmoid ret-

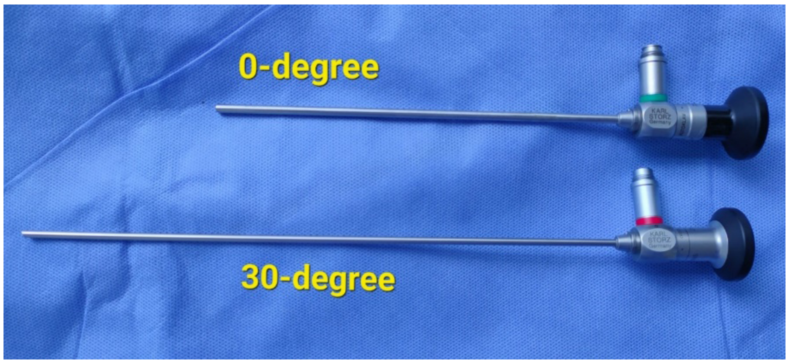

Figure 1. Transnasal rigid endoscope (Karl Storz, Germany)

The 0-degree endoscope is 4 mm in diameter and 18 cm long. The 30-degree endoscope is 3.3 mm in diameter and 25 cm long.

romastoid approach (Table 1). The endoscope was used for the excisions of 3 pineal tumors using the supracerebellar infratentorial approach and 3 suprasellar craniopharyngiomas using the right subfrontal approach. One CP angle epidermoid cyst and 1 petrous neurenteric cyst extending into the CP angle region underwent endoscopic surgery using a retrosigmoid retromastoid approach. One case of ruptured ICA bifurcation aneurysm underwent pterional craniotomy. The endoscope was used to delineate the vessels and the aneurysm was clipped. All the patients improved in the postoperative period (Table 2).

In endoscopic assisted microscopic MVD, the microscope was used only in the initial part of surgery till reaching the site of neurovascular conflict. The 0-degree endoscope was able to visualize CNs, neurovascular conflict, vertebrobasilar arteries, and the anterior surface of the brainstem under good magnification and illumination. All structures were seen in a panoramic view. The 30-degree endoscope was used to visualize the medial side of the CNs and its compression by the loop of vessels. The conflicting vessels were separated from the CN V in TN and CN VII in HFS and a Teflon patch was interpositioned between them to complete MVD (Table 1). Delineation of the neurovascular conflict was superior using an endoscope when compared to the author's microscopic experience. There was no misinterpretation of structures. The authors were very much satisfied with the endoscopic vision and comfort of doing surgery using it.

Pineal tumors were operated in left three-quarter prone positions. Midline suboccipital craniectomy was done and the tumor was reached using supracerebellar infratentorial approach. The endoscope was navigated to the superior surface of the pineal tumor and the great cerebral vein was visualized and separated. Inferiorly, the brainstem was seen clearly and the tumor was separated from it. The tumor was decompressed and the wall was excised. Since the endoscope was able to reach a deep narrow corridor of the pineal region, there was an excellent magnified vision with good illumination of the tumor, brainstem, and great cerebral vessels. The surgeon and assistants were able to stand in a neutral position during surgery. In endoscopic-assisted microscopic surgery, the microscope was used only during the initial part of surgery until the pineal region was reached.

In craniopharyngioma excisions, the right suprabrow frontal craniotomy was done and the endoscope was navigated through a subfrontal approach to reach the tumor. The anatomy of the optic nerves, ICAs, and optic chiasm were visualized under good magnification which helped in an easy dissection of the tumor from these structures. The endoscope was navigated inside the tumor capsule to visualize its internal architecture and tumor excision was done (Figures 2 and 3). It was able to access the sellar region, third ventricular region, and the area behind the optic nerves which are difficult to visualize using the microscope. Superior extension of the tumor into the third ventricle was visualized through an inter-optic window and further dissection like the trans-lamina terminalis approach was avoided.

One case of CP angle epidermoid was operated using endoscopic assisted microscopic surgery. The major part of the epidermoid was removed using the microscope. However, part of the epidermoid in the medial and superior aspect of CN V was not under direct vision of the microscope. The 0-degree endoscope was navigated to these inaccessible areas and the epidermoid was removed. One petrous neurenteric cyst extending into the CP angle cistern was operated using an endoscope (Figure 4). The 0-degree endoscope was able to enter the cyst wall inside the eroded petrous bone and yellowish gelatinous cyst fluid was drained. Inaccessible areas inside the eroded petrous bone were accessed using a 30-degree endoscope. Cyst wall was excised (Figure 5). One case of a ruptured ICA bifurcation aneurysm was operated by pterional craniotomy. The sylvian fissure was split using the microscope. The 0-degree endoscope showed a magnified panoramic view of the optic nerve, ICA, anterior cerebral artery (ACA), middle cerebral artery (MCA), and ICA bifurcation aneurysm. Posterior communicating artery (PCom) and anterior choroidal artery (AChA) were also visualized. The endoscope visualized all around the aneurysm and clipping of the aneurysm was done safely (Figure 6). The patient recovered in the postoperative period (Table 2).

Technical points

The authors have performed surgery using 4 hand technique in which one neurosurgeon holds and navigates the endoscope and another neurosurgeon performs surgery. Both neurosurgeons should be trained in using endoscopes to better perform these surgeries. Since the endoscope was navigated inside the cranium, there are chances of injury to vital structures. Certain techniques were used to prevent such injuries. It was navigated in and out longitudinally during the surgery. The horizontal movement was avoided when the endoscope was in a deeper location. It was placed away from the brain to prevent injury to vital structures. In the CP region, it was navigated along the petrous bone. In the

Table 2. Clinical profile, radiological features, and treatment of patients undergoing TEES

Sl No.	Diagnosis	Age (y)/Sex	Clinical Features	Imaging	Surgery	Duration of Stay (d)
1	Pineal tumor (immature teratoma)	5/F	Decreased responsiveness for 5 days. GCS was E4V2M5.	MRI: 5×3×4 cm pineal tumor.	Pure endoscopic surgery. 00 endoscope scope used. A gross total tumor excision was done.	18
2	Pineal tumor (parenchymal tumor of intermediate differentiation grade 2/3)	18/M	Headache -1 week Seizure -1 day. The right VP shunt was done for obstructive hydrocephalus.	MRI: 4.8×3.4×4.3 cm heterogenous contrast enhancing pineal tumor.	Pure endoscopic surgery. 00 endoscope scope used. Greyish white moderately vascular tumor with the capsule. Subtotal excision was done.	6
3	Pineal tumor (parenchymal tumor of intermediate differentiation grade 2/3)	62/M	Headache, giddiness, and swaying while walking for 3 days.	MRI: 4×3.5×3.4 cm lobulated solid cystic contrast enhancing pineal tumor.	Endoscopic assisted microscopic surgery. 00 endoscope scope used. Greyish moderately vascular soft suckable pineal tumor with capsule. Near total excision was done.	6
4	Adamantinomatous suprasellar craniopharyngioma.	47/F	Headache, and impaired vision since 4 months	MRI: 1.7×2.1×1.8 cm heterogenous contrast enhancing suprasellar tumour.	Pure Endoscopic surgery. 00 and 300 endoscopes were used. Gross total excision with capsule was done.	5
5	Recurrent adamantinomatous suprasellar craniopharyngioma	32/M	Generalized weakness, memory impairment, urinary incontinence, and decreased vision for 15 days.	CT: 4.2×6×3.7 cm suprasellar cystic lesion with peripheral calcification.	Pure endoscopic surgery. 00 endoscope used. The Cyst wall was opened and craniopharyngioma fluid was drained. The interior of the cyst wall was examined and near-total excision was done.	13
6	Adamantinomatous suprasellar craniopharyngioma.	13/M	Headache and vomiting for 3 weeks	MRI: 4.4×1.8×2.6 cm well-defined heterogenously enhancing suprasellar lesion.	Endoscopic assisted microscopic surgery. 00 endoscope scope used. Prefixed optic chiasm noted. Microscopic inaccessible tumor in third ventricular region visualized using an endoscope and excised. Gross total excision was done.	7
7	Right CP angle epidermoid cyst	30/F	Headache and recurrent pain over the right side of the face for 5 years	MRI: 5.8×2.8×3.7 cm T1 hypointense, T2 hyperintense right CP angle lesion with diffusion restriction.	Endoscopic assisted microscopic surgery. 00 endoscope used. Gross total excision was done.	7
8	Left petrous neurenteric cyst	56/M	Left-sided hearing loss - 5 years. Left sided facial pain - 1 year. Left cerebellar signs present.	MRI: 4.8×4.2 cm cystic lesion occupying left CP angle and left petrous region.	Pure endoscopic surgery. 00 and 300 endoscopes were used. Gross total excision was done.	5
9	Left ICA bifurcation ruptured aneurysm	50/F	Sudden onset of occipital headache for 5 days. GCS 15/15	CT angiogram: left ICA bifurcation saccular aneurysm of 2.01×1.55 mm.	Endoscopic assisted microscopic surgery. 00 endoscope used. Aneurysm clipping was done.	6

Abbreviations: TEES: Transcranial extraventricular endoscopic surgery; MRI: Magnetic resonance imaging; CT: Computed tomography; M: Male; F: Female; GCS: Glasgow coma scale; EVD: External ventricular drain; EVM: Eye verbal motor; VP: Ventriculoperitoneal; CP: Cerebellopontine; ICA: Internal carotid artery.

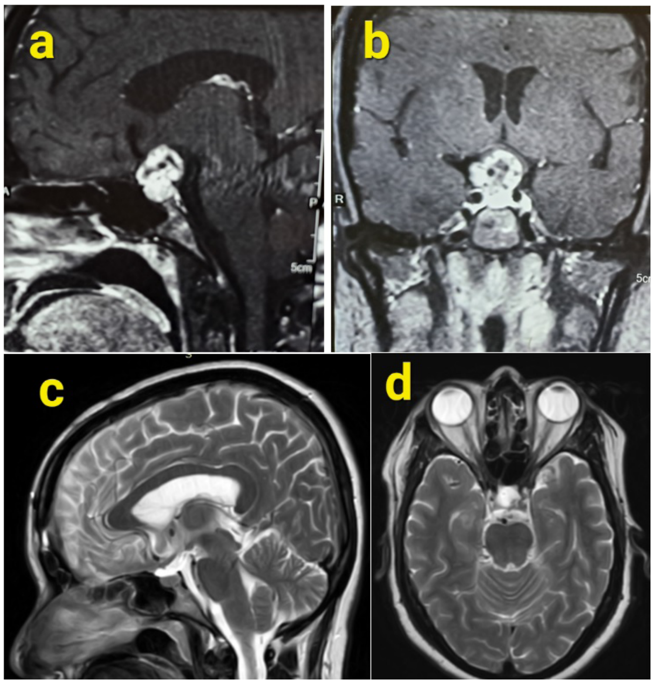

Figure 2. MRI scan of brain

Notes: Contrast sagittal (a) and coronal (b) scans show the heterogenous contrast enhancing lesion in suprasellar location with extension to the sellar, indicating craniopharyngioma. Postoperative sagittal T2W (c) and axial T2W (d) scans show total excision of the craniopharyngioma.

MRI: Magnetic resonance imaging.

pineal region, it was navigated along the tentorium, and in the suprasellar region, it was navigated along the anterior skull base. Surgical instruments were inserted only with endoscopic guidance. Surgeries were done mainly using a 0-degree scope. It was easy to navigate in and out. Higher-degree endoscopes are difficult to navigate because of their side-viewing vision. The 30-degree scope was used to visualize behind the obstructing anatomical structure and also to visualize sides and corners. The endoscope occupies extra space in the operating field and obstructs the instruments. But this was overcome by placing endoscopes and instruments at different angles. There was blood staining of the endoscopic lens and obstruction of vision. This was overcome by placing the endoscope a little away from the bleeding site and also by irrigating it with saline during surgery. The lens can also be cleared by wiping its surface. The authors noted that the difficulties of endoscopic surgeries can be overcome by operating more cases.

Benefits of endoscope

The endoscope was easily able to reach deep narrow corridors like the pineal region, CP angle region, and suprasellar region. Deep structures were visualized clearly with good illumination and magnification. There was no loss of endoscopic illumination on superficial unwanted areas. Hence less dissection was required to delineate the structures. There was no misinterpretation of structures. Surgeons were able to stand in a neutral position while doing the surgery. This has increased the ease of doing surgery, decreased complications, and improved the surgical result.

Illustrative case – microvascular decompression

A 61-year-old male diabetic patient presented with left-sided TN for the last 2 years (Table 1). MRI scan showed the neurovascular conflict between the superior cerebellar artery (SCA) loop and CN V (Figure 7). Retromastoid craniectomy was done near the transverse-sigmoid sinus junction. The 0-degree endoscope showed a loop of left SCA compressing and displacing the CN V anterolaterally. A 30-degree endoscope showed structures medial to CN V and also the entry of CN V into Meckel's cave. The vessel loop was separated medially from CN V and a Teflon patch was interpositioned between them to complete MVD. The patient was relieved of TN.

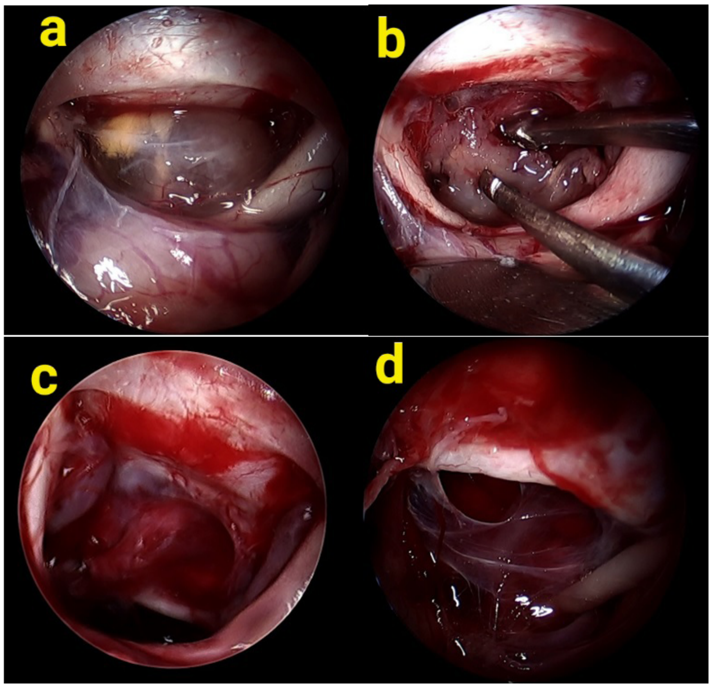

Figure 3. Endoscopic view during craniopharyngioma excision

a) 0-degree endoscopic view of bilateral optic nerves, b) 0-degree endoscope showing the tumor being decompressed to free the optic nerves, c) 30-degree endoscopic view of bilateral optic nerves, ICAs, optic chiasm, and pituitary stalk after tumor excision, and d) 0-degree endoscopic view of basilar artery, right PCA, and right oculomotor nerve.

ICA: Internal carotid artery; PCA: Posterior cerebral artery.

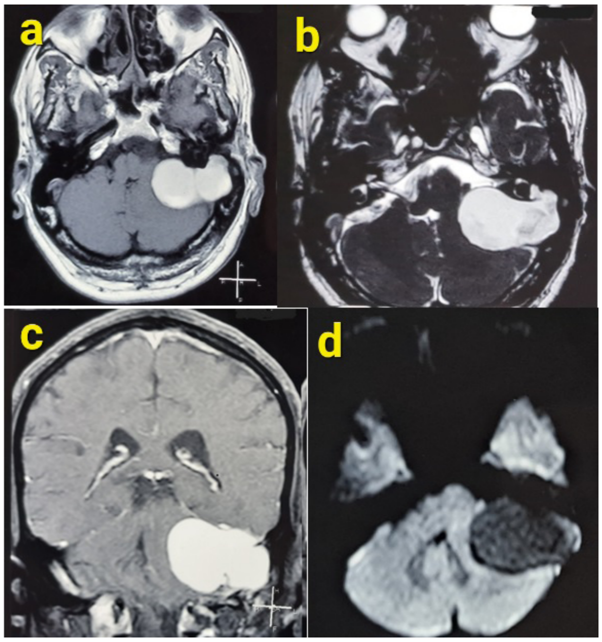

Figure 4. MRI scan of petrous neurenteric cyst

Notes: T1W (a) and T2W (b) axial MRI scan showing hyperintense well-defined lesion occupying left CP angle and left petrous region with erosion of the petrous bone. Contrast coronal (c) MRI scan showing no contrast enhancement of the lesion. DWI (d) showed no diffusion restriction of the lesion.

Abbreviations: MRI: Magnetic resonance imaging; CP: Cerebellopontine; DWI: Diffusion-weighted image.

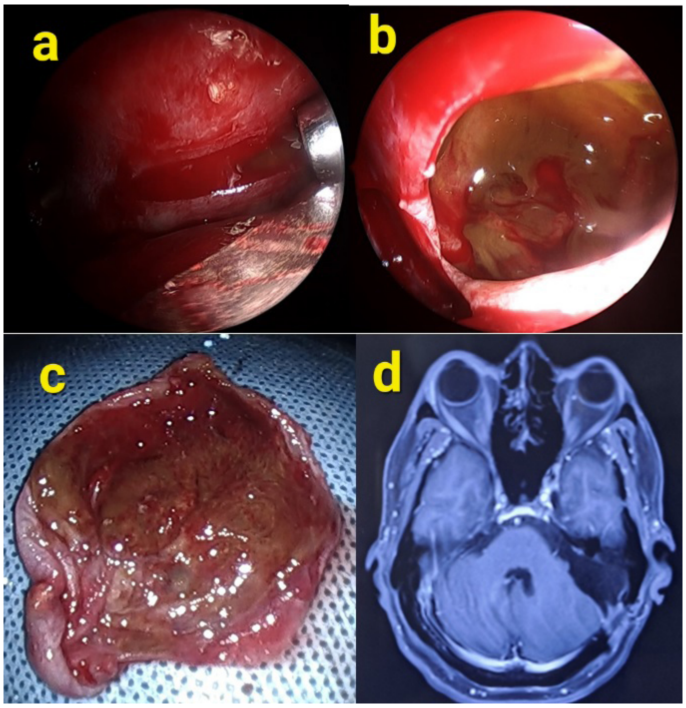

Figure 5. Operative findings and postoperative MRI scan of petrous neurenteric cyst

(a) 0-degree endoscopic view of drainage of the yellowish gelatinous cyst fluid after opening the cyst capsule, b) 0-degree endoscopic view of the interior of the petrous part of the cystic lesion, c) Excision specimen of the cyst wall, d) Postoperative axial contrast MRI scan showing the excision of the lesion

MRI: Magnetic resonance imaging.

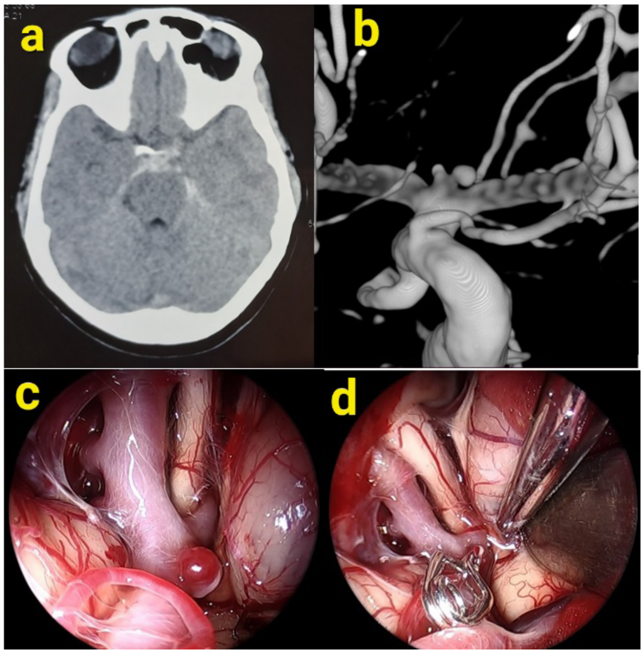

Figure 6. MRI scan and operative findings of ICA aneurysm

a) Axial plain CT scan of head and subarachnoid haemorrhage in basal cisterns, b) CT scan of angiogram and the left ICA bifurcation saccular aneurysm, c) 0-degree endoscopic view of the optic nerve, ICA, ACA, MCA, PComA, AChA, and ICA bifurcation aneurysm, d) 0-degree endoscopic view of the clipped ICA bifurcation aneurysm.

Abbreviations: CT: Computed tomography; ICA: Internal carotid artery; ACA: Anterior cerebral artery; MCA: Middle cerebral artery; PComA: Posterior communicating artery; AChA: Anterior choroidal artery.

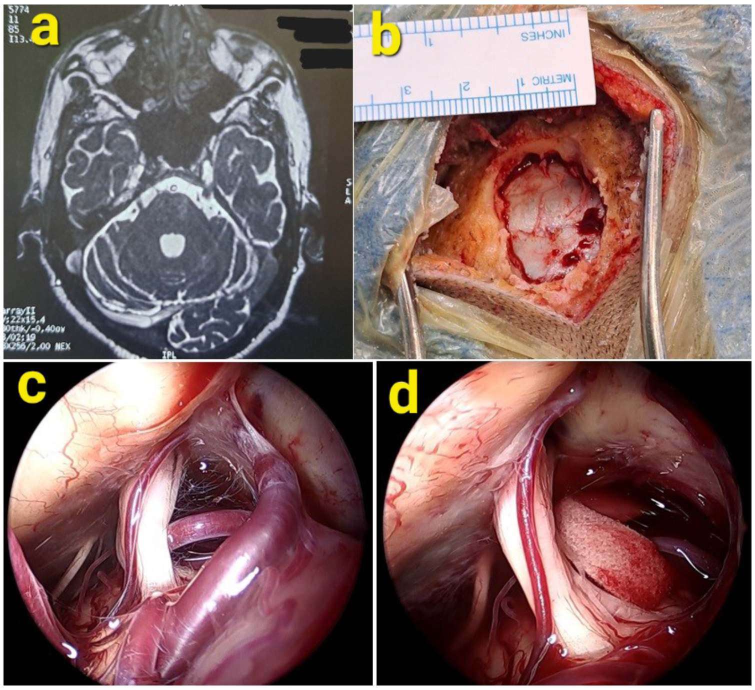

Figure 7. MRI and operative findings of microvascular decompression

a) T2W axial MRI scan showing left SCA compression over CN V, b) Image showing 2×2.5-cm left retromastoid suboccipital craniectomy, c) 0-degree endoscopic view of the SCA loop compressing CN V. The CN VI is also visualized in the field, d) 0-degree endoscopic view of MVD using Teflon.

Abbreviations: MVD: Microvascular decompression; SCA: Superior cerebellar artery; CN: Cranial nerve.

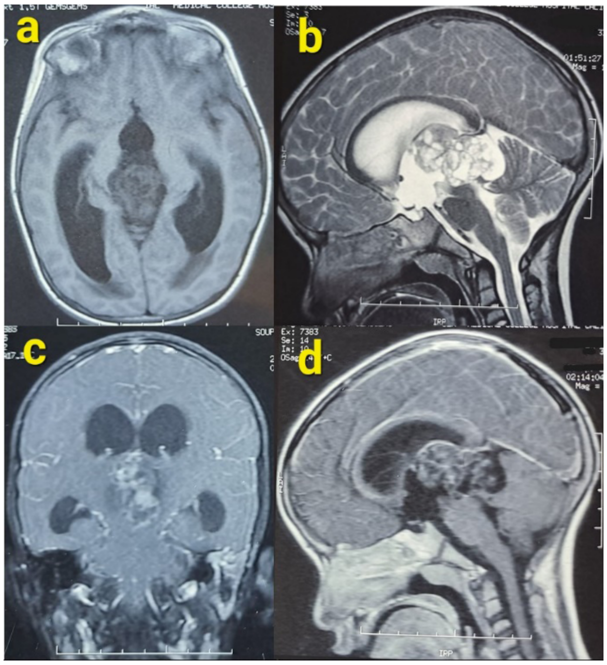

Figure 8. MRI scan of pineal tumor

Notes: T1 axial MRI scan showing hypointense lesion in pineal region causing obstructive hydrocephalus (a), T2 sagittal MRI scan showing hyperintense pineal tumor with cystic changes (b); contrast coronal (c) and sagittal (d) MRI scans showing heterogenous contrast enhancing pineal tumor displacing the brainstem and cerebellum and causing obstructive hydrocephalus.

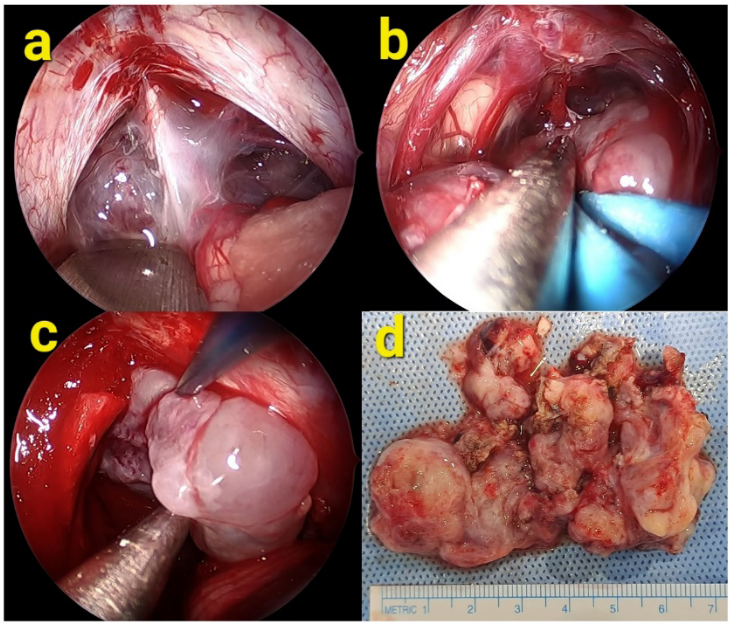

Figure 9. Operative findings of pineal tumor excision

a) Endoscopic view of pineal tumor between inferior surface of tentorium and superior surface of cerebellum, b) Endoscopic view of the great cerebral vein being separated from the superior surface of the tumor, c) Endoscopic view of pineal tumor delivered through supracerebellar infratentorial approach, d) image of gross total pineal tumor excision specimen.

Illustrative case - pineal tumor

A 5-year-old female child was presented with reduced responsiveness with a Glasgow coma scale (GCS) score of E4V2M5 (E: Eye, V: Verbal, M: Motor). MRI scan revealed a 5x3x4 cm heterogenous contrast-enhancing pineal tumor with obstructive hydrocephalus (Figure 8). Magnetic resonance (MR) angiogram and MR venogram were normal. External ventricular drain (EVD) was inserted into the right frontal horn to drain cerebrospinal fluid (CSF) and the patient was taken up for surgical excision of pineal tumor. The tumor was reached using a supracerebellar infratentorial approach. Zero-degree endoscope showed an excellent view of the pineal tumor. Internal decompression of greyish red, moderately vascular lobulated pineal tumor was done. The tumor was separated from the great cerebral vein superiorly and the brainstem inferiorly. Capsule was reflected all around and gross total excision was done (Figure 9). EVD was removed in the postoperative period and the

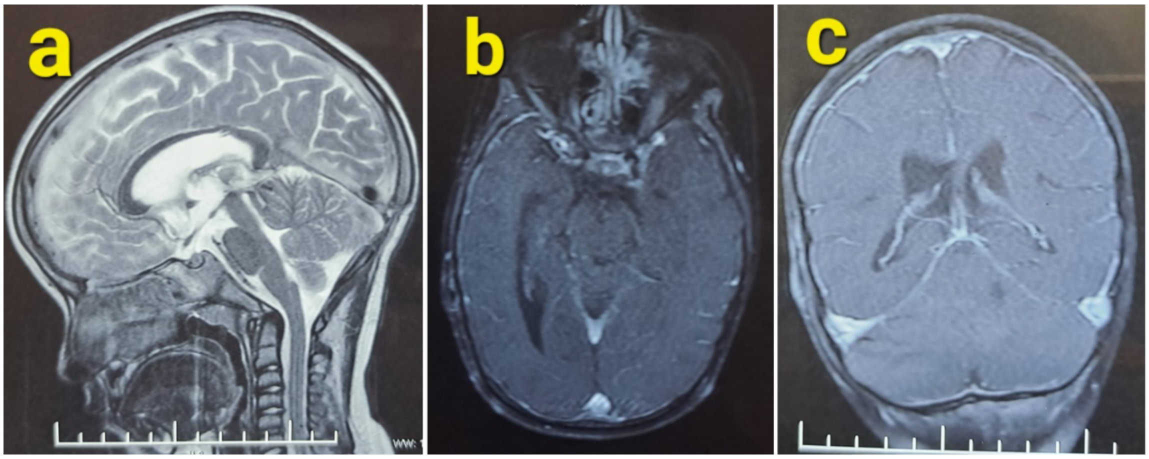

Figure 10. Postoperative MRI scan of pineal tumor excision

Notes: a) T2W sagittal MRI brain scan, and contrast coronal (b) and sagittal (c) MRI brain scans showing gross total excision of the pineal tumor.

patient recovered well with a GCS score of 15/15 (Table 2). Postoperative MRI showed gross total excision of the tumor (Figure 10).

4. Discussion

The endoscope helps with in-depth perception, tactile sensation, and maneuverability. It provides an angled view and can access small regions. The disadvantage includes blood obscuring the field. Its use is limited to some procedures only [2]. To improve navigation during interventions in the posterior fossa, endoscopic-assisted techniques with surgical corridors have been described. The pineal region was accessed through a supracerebellar infratentorial approach and the CPA region was accessed through a retrosigmoid approach [3].

The utilization of the endoscope in MVD allows for unparalleled panoramic views and illumination of the neurovascular structures. The endoscope can be used as an adjunct to the microscope in MVD surgery. It has a wide field of view compared to the microscope. It allows for less brain retraction and reduces the morbidity for the patient [4]. Matmusaev et al. [5], performed an endoscopic MVD for an 83-year-old female patient with HFS. The offending vessel anterior inferior cerebellar artery (AICA) was successfully decompressed. No surgery-related complications occurred and there were excellent outcomes with the complete resolution of HFS immediately after the operation. Endoscopic surgery can provide a more panoramic surgical view than conventional microscopic surgery. However, it has a learning curve and is technically challenging [5]. Authors have performed 6 MVDs using an endoscope.

Surgical approaches to pineal lesions present a challenge because of limited visibility and maneuverability within the posterior fossa. Shahrestani et al. [6], used a pure endoscopic supracerebellar infratentorial approach for pineal tumors. They noted that this approach is a safe and effective approach for deep-seated pineal lesions. It allows for visibility and maneuverability around the lesion and facilitates high rates of gross total resection (GTR) [6]. The authors noted that the pineal tumor was well visualized when the endoscope was navigated to the deep narrow corridor of the pineal region. The great cerebral vein and the brainstem were visualized and hence were protected while excising the tumor.

CP angle and prepontine epidermoid tumors grow along the subarachnoid spaces around the neurovascular structures. Chowdhury et al. [7] performed a similar case by pure endoscopic visualization through a retrosigmoid retromastoid lateral suboccipital approach. The epidermoid tumor was removed nearly totally using a 0-degree endoscope. The petrosal vein and trigeminal nerve were completely freed. Visualization provided by the endoscope is outstanding and this advantage can minimize the risk of morbidity to vital neurovascular structures [7].

Cai et al., clipped a posterior communicating artery aneurysm using a transcranial neuroendoscopic approach. Transcranial endoscopic clipping of aneurysm is very rare [8]. In transcranial aneurysm surgery, the endoscope can carry out a supportive role in planning surgical maneuvers and in verifying whether clipping has been performed correctly or not. The 30-degree endoscope can view concealed areas without retraction. This prevents the possibility of the aneurysm being ruptured and also reduces the use of temporary clips [9]. Authors have performed endoscopic assisted microscopic surgery to clip ICA bifurcation aneurysm.

Wu et al. [10], performed an endoscopic transcranial transdiaphragmatic approach for giant pituitary adenomas with suprasellar extension. They noted that this approach can be efficiently and safely performed for maximal excision of tumor [10]. The authors used an endoscopic subfrontal approach for suprasellar craniopharyngiomas. They were able to delineate the vital neurovascular structures clearly and the tumor was separated from them. The tumor in the third ventricular area was not visualized in the microscope, but easily visualized through the inter-optic window on using an endoscope. This eliminated the need for a translamina terminalis approach. Hence with minimal dissection, an endoscope helped in craniopharyngioma excision.

One drawback of an endoscope is the intracranial blind area between the field lens of the endoscope and the site of the dural opening. This blind area cannot be viewed on the endoscopic monitor, and accidental intracranial neurovascular structural injury can occur in this area [11].

Authors noted that only a few centers are using an endoscope for transcranial extraventricular regions, and many of them are performing endoscopic surgery for one pathology only. A single center performing TEES for a wide range of pathologies in different areas of the brain as described by the authors is rare. The training in various TEES will improve hand-eye coordination and improve adaptability to the endoscopic monitor during transcranial surgeries. This will decrease the training necessity for the neurosurgeons who are shifting from microscope to exoscope. Authors believe that it is very important to train neurosurgeons in TEES because of its wide applications.

5. Conclusion

Endoscopic magnified close vision of the deeper extraventricular structures helps in decreasing the damage to vital structures and enhances the surgical result. TEES is very beneficial for operating on deep-seated lesions like the pineal region, CP angle region, and suprasellar region. In aneurysm surgery, it helps to preserve the vessels around the aneurysm and also helps to confirm the completeness of clipping. The endoscope is used as a complementary to the microscope to access the microscopic invisible areas. TEES improves hand-eye coordination in transcranial surgeries which helps in adapting to exoscope easily.

Limitations

This is a retrospective study. A smaller number of cases is the limitation of the study.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Institutional Ethical Committee of Government Medical College (Code: GMCKKD/RP2023/IEC/155). Appropriate consent was obtained from the patients whose clinical details are described in the illustrative cases.

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Authors' contributions

Conceptualization and study design: Binoy Damodar Thavara; Data collection: Binoy Damodar Thavara, Shanavas Cholakkal, Shinas Hussain and Radhakrishnan Maniyan; Data analysis and interpretation: Binoy Damodar Thavara, Byjo Valiyaveetil Jose; Drafting the article: Binoy Damodar Thavara, Rajeev Mandaka Parambil and Prem Kumar Sasi; Supervision, review and editing: Rajeev Mandaka Parambil and Binoy Damodar Thavara; Final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

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