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ORIGINAL ARTICLE

Endoscopic and Endoscopically Assisted Surgeries for Posterior Cranial Fossa Lesions

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ABSTRACT

Background: posterior cranial fossa basal lesions including tumors and vascular compression syndromes especially located in cerebellopontine angles (CPA) are considered one of the most complex regions due to crowded anatomy and limitations of visualization during surgery by the microscope alone, so endoscopic use as assisted visualization technique helps greatly in achieving good results, better outcomes and less morbidities. The aim of this work is to assess endoscopic role and importance as assisted tool during microscopic surgery for those lesions in neurosurgery Department in Zagazig University Hospitals from October 2016 to October 2018. M**ethods**: 33 patients included 5 cases of epidermoid, 8 cases of acoustic Schwannomas, 4 meningiomas, 10 cases of Hemifacial spasm and 6 cases of trigeminal neuralgia. in this study we used the endoscope as assisted tool to the microscope, initial dissection by the microscope then the endoscope was used to navigate in the area to detect and demonstrate the pathology and its relations to the surrounding structures, then most of the work is microscopic and the endoscope is used in different stages to detect any residuals of tumors, hidden parts, any injuries, may be used to dissect in some situations if needed, position of insulators in microvascular decompression and final view after finishing the surgery. **Results**: Endoscopy provided improved visualization of local anatomy, revealed hidden lesions and reduced unnecessary anatomical distortions.**Conclusion**: endoscopic aided technique greatly helps surgical management of CPA lesions and other disorders. This minimally invasive technique overcomes many shortcomings inherent to the traditional retrosigmoid approach. The use of the endoscope in the CPA as a tool to increase the extent of resection, minimize complications, and preserve the function of the delicate CPA structures

Key Words: epidermoid, meningioma, Schwannomas, Hemifacial spasm, trigeminal neuralgia

INTRODUCTION

Endoscopy for CPA have been studied and applied to tumors resection and vascular decompression surgery (5, 8, 10). The advantages are increasing visualization of the anatomy and inspecting around corners (6, 7, 21). The shortcomings of endoscopic-assisted surgery in the CPA have been described. The limitation of the endoscope to visualize structures proximal to the working space, the crowded anatomy of the posterior fossa and the narrow corridor between the neuro-vascular structures, places these structures at high risk.

In this paper we report on the use of a microscopic endoscopic assisted surgical techniques to increase the degree of tumor resection, and we evaluate its effectiveness in tumors (meningiomas, epidermoids and Schwannomas) and vascular decompression surgeries.

The use of the endoscope in posterior fossa is used mainly as an adjunct to conventional microscopic surgical techniques. In this modern era, many neurosurgeons prefer using endoscopy during microvascular decompression (MVD) either as a solo instrument (endoscopic MVD) or in combination with the microscope (endoscope-assisted MVD) (11, 12)

METHODS

A prospective study of 33 cases with tumors and vascular compression syndromes in the posterior fossa base treated in Neurosurgery department, Zagazig University Hospitals, Egypt and Neurosurgery department, Greifswald university, Germany during two years duration (from October 2016 to October 2018) for evaluation of the surgical outcomes of endoscopic and endoscopic assisted surgeries of posterior fossa basal lesions .

Written informed consent was obtained from all participants and the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

All cases evaluated by computed tomography (CT) and magnetic resonance imaging (MRI) brain before surgery, CT with or without contrast as initial imaging modality for lesion detection, also to detect the peri-tumoral edema, mass effect, hydrocephalus, calcifications, intra-tumoral hemorrhage or bone abnormalities as destruction, erosion, infiltration and hyperostosis. MRI Brain with contrast: imaging method of choice in the pre therapeutic evaluation.

MRI Imaging in Tumor location: in relation to side, extension, Tumor Size in crani-ocaudal and medio-lateral dimensions, Tumor Characterization: well or ill-defined edges, Solid or cystic or mixed, pattern of enhancement, presence of calcification, hemorrhage or necrosis, degree of surrounding edema and mass effect.

MRI Imaging in vascular compression, Fast Imaging Employing Steady-state Acquisition (FIESTA) protocol to determine any vascular compression even arterial or venous, Arterial ectasia, Exclusion of tumors, cysts and demyelination.

All Patients received general anesthesia under standard monitoring. After positioning, Craniotomy or Craniectomies are designed according to the procedure and lesion type and size using a high-speed drill or manual drill. After dural opening, cerebrospinal fluid (CSF) is allowed to slowly drain Holding arm secures the endoscope in position, allowing bimanual surgical dissection may be used. Once the surrounding critical structures are identified, tumor dissection or microvascular decompression take place guided by a zero-degree endoscope in much the same manner as the microsurgical procedure with custom designed micro instruments which slide along the endoscope. Microscopic dissection assisted by endoscope or pure endoscopic dissection may be used according to lesion site, size, and type.

The endoscope was used for the purpose of extending the approach, discovering hidden pieces of tumors, preserving neural structures, dissecting and removing tumors with the endoscopic technique when needed and confirming total removal. The angled endoscope allows complete visualization of the lateral extent of the lesions. Once tumor dissection is completed, the dura is re-approximated; the bone flap replaced and secured and the scalp is closed in anatomic layers. Following the operation, patients are typically transferred to the intensive care unit for overnight monitoring. Postoperative

Neurological follow up: Postoperative evaluations of neurological outcome were performed and recorded at 3 different times: 1) after the surgery, when the patients could be fully evaluated, and 2) at the 1- and 3-month follow- up examinations.

Statistical analysis

Data obtained pre, intra and postoperative were collected and analyzed using Statistical Package for the Social Sciences program (IBM SPSS) and described in brief in next section.

RESULTS

33 patients operated in Zagazig university hospitals and in Greifswald university hospital, Germany as described in the next table:

Table (1): Comparison between Epidermoid tumors group and Schwannomas tumors group, Meningioma tumors group, Hemifacial spasm group and Trigeminal neuralgia group in Endoscopic management of posterior fossa lesions as regard age and sex.

In 17 cases of tumors, the role of the endoscope in surgery for tumors cases.

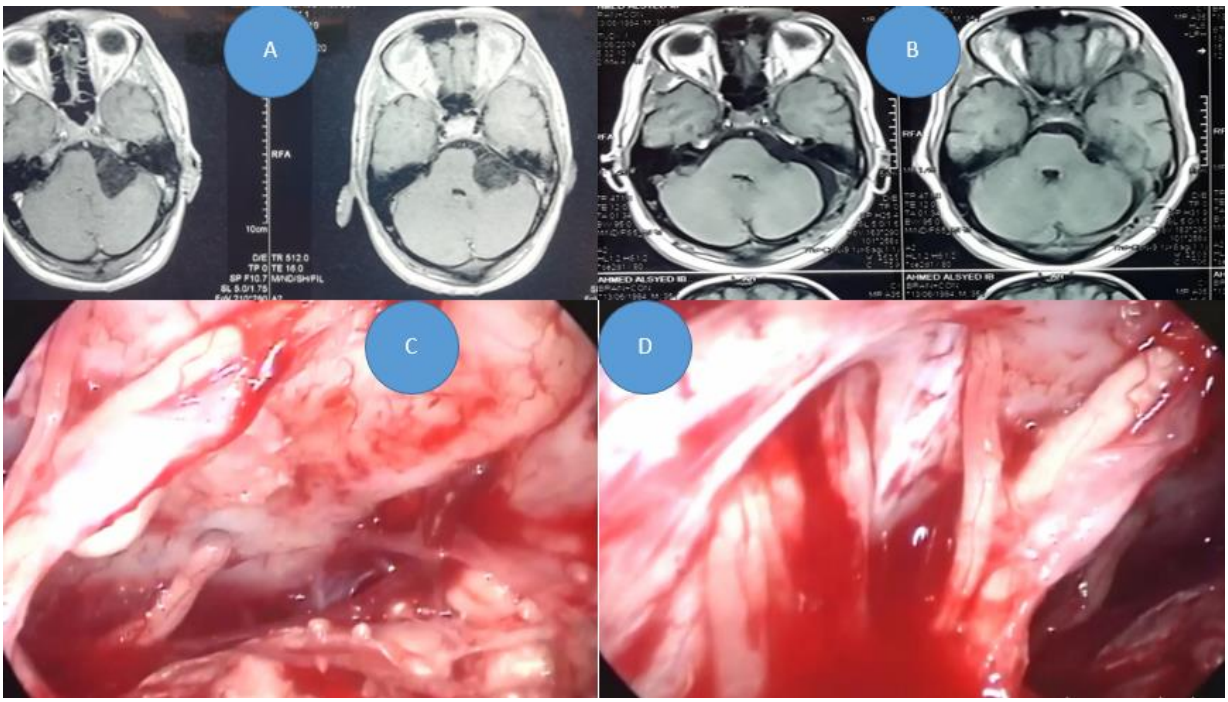
Table (2): pioneer role of the endoscope in Surgical excision of tumors (no= 17).

This table denote surgical endoscope identified 100% of tumor extension.

Table (3): pioneer role of endoscope in Surgical endoscope in vascular compression cases (n=16).

This table denote surgical endoscope identified 100% the nerves and offending arteries among in vascular compression cases.

Illustrated cases



Case 1, 30 years old male, complained of LT side facial pain and numbness in v3 dermatome, 8 months duration diagnosed as epidermoid tumor. Patient underwent endoscopic assisted microscopic growth total removal of the tumor. Initial exposure was done using the microscope then navigation of the field using the endoscope 0, 30 degree, then most of dissection and decompression were done by the microscope. The endoscope was used to assess the dissection, tumor residual and used for small pieces hidden from the microscope. On discharge, the wound was clean without any new deficit. 3 months after surgery the symptoms were cleared.

Figure 1: A: MRI T1 with contrast, LT CPA epidermoid pre-operative and B: post-operative. C: picture shows endoscopic view 0 degree after microscopic removal of the lesion, 5-6-7-8-9 cranial nerves are clearly identified, small piece of the tumor attached to the 7-8 n, also some remnants from the capsule still seen near the 5th n. D: picture shows lower cranial nerves in jugular foramina

Case no 2, 28 years old female, complained of RT side hearing loss, 8 months duration. MRI CPA protocol with contrast shows RT 2*3 cm ovular enhancing lesion extending into RT internal auditory canal. Patient underwent endoscopic assisted microscopic growth total removal of the tumor. Initial exposure was done using the microscope then navigation of the field using the endoscope 0, 30 and 45 degree, then most of dissection and decompression were done by the microscope. The endoscope was used to assess the dissection, tumor residual, drilled bone. And dissection of the canalicular part of the mass.

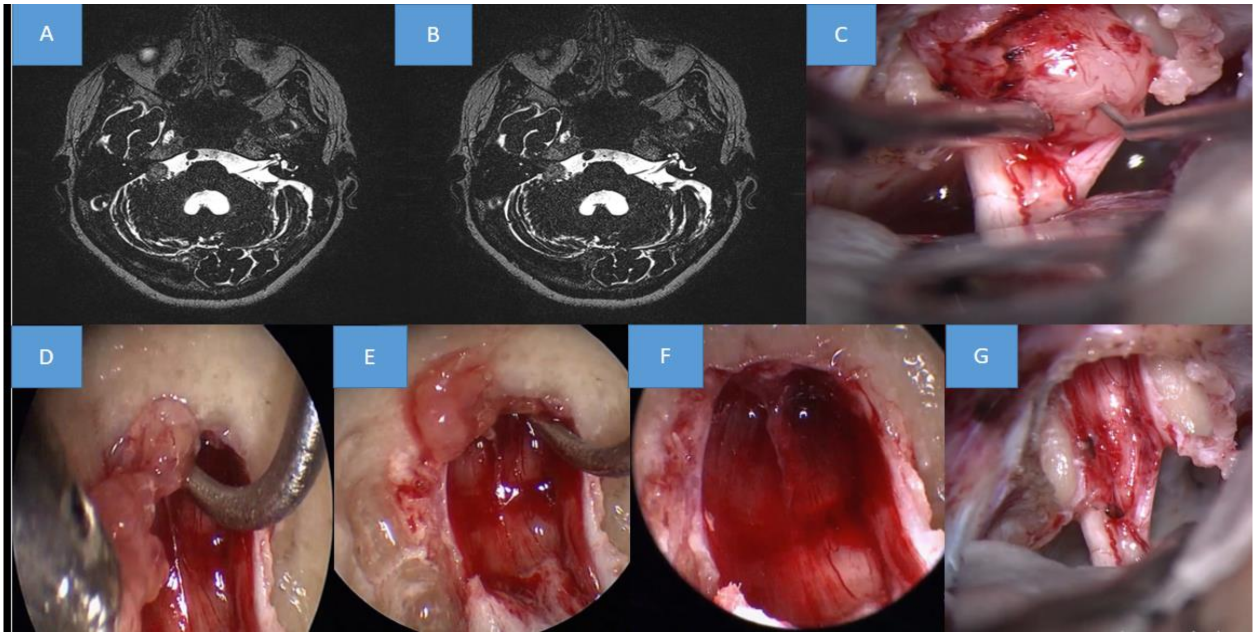


Figure 2: A & B: MRI T2 show round RT CPA Schwannoma extending into the internal auditory canal. C, microscopic dissection of the tumor from the facial nerve in the internal auditory canal. D & E, endoscopic removal of last hidden pieces of the tumor. F, final view by the endoscope and G, the microscope.

Case no 3, 49 years old male, complained of LT side Hemifacial spasm daily 2 to 3 attacks starting from around the eye then all the LT face, 6 months duration, the patient injected with toxolinium one time after one month from the onset without any improvement regarding frequency or duration of the attacks. MRI FIESTA protocol shows LT tortious vertebral artery course compressing the facial nerve in exit zone area also anterior inferior cerebellar artery (AICA) and posterior inferior cerebellar artery (PAICA) seem to be included in compression. Patient underwent endoscopic assisted microscopic vascular decompression of the facial nerve using TEFLON insulator as a spacer between the arteries and the nerve exit zone. Endoscopic role: initial exposure was done using the microscope then navigation of the field using the endoscope 0 & 30 degree to detect sources and sites of compression, then most of dissection and decompression were done by the microscope. The endoscope was used to assess the decompression, insulator position and perforators. On discharge the frequency and duration of the attacks were decreased to satisfactory level to the patient. 3 months follow up visit, the patient became free of symptoms with no more spasms.

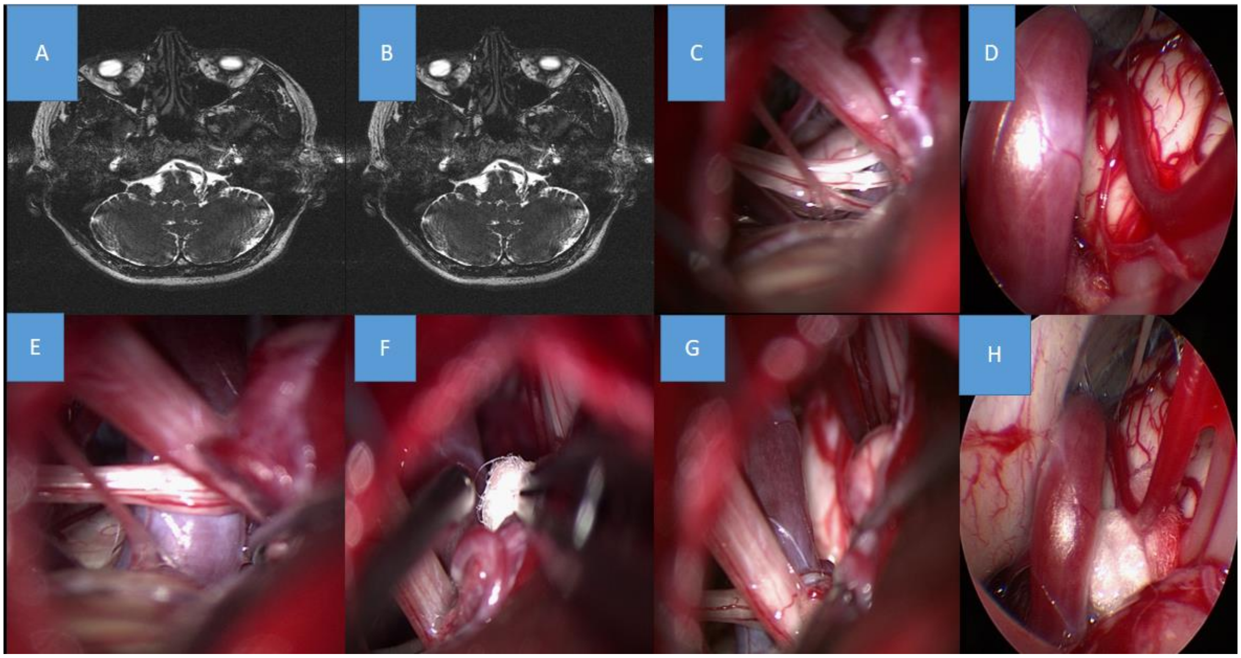


Figure 2: A &B, MRI showing vertebral artery ectasia and tortious course compressing the 7TH nerve in exit zone area. C, initial view of microscopic. D, endoscopic view. E, microscopic dissection and separation of the artery from the nerve and TEFLON inter-positioning to decompress. F, continuous dissection and final Teflon position between the vertebral artery, AICA and the brain stem exit zone area of the facial nerve. G, final microscopic and H, final endoscopic views.

Case no 4, 59 years old male, complained of RT side facial pain typical trigeminal pain in v2 and v3 dermatomes, 5 months duration, and the patient received medical treatment with oxcarbazepine and gabapentin reaching maximum doses with only partial improvement regarding frequency and duration of the attacks. MRI FIESTA protocol shows RT superior cerebellar artery SCA course may compress the 5th nerve in entry zone area. Patient underwent endoscopic assisted microscopic vascular decompression of the facial nerve using TEFLON insulator as a spacer between the artery and the nerve entry zone. The endoscope was used to assess the decompression, insulator position and perforators. On discharge, 2 weeks and 3 months follow up visit, the patient became free of symptoms with no more pain.

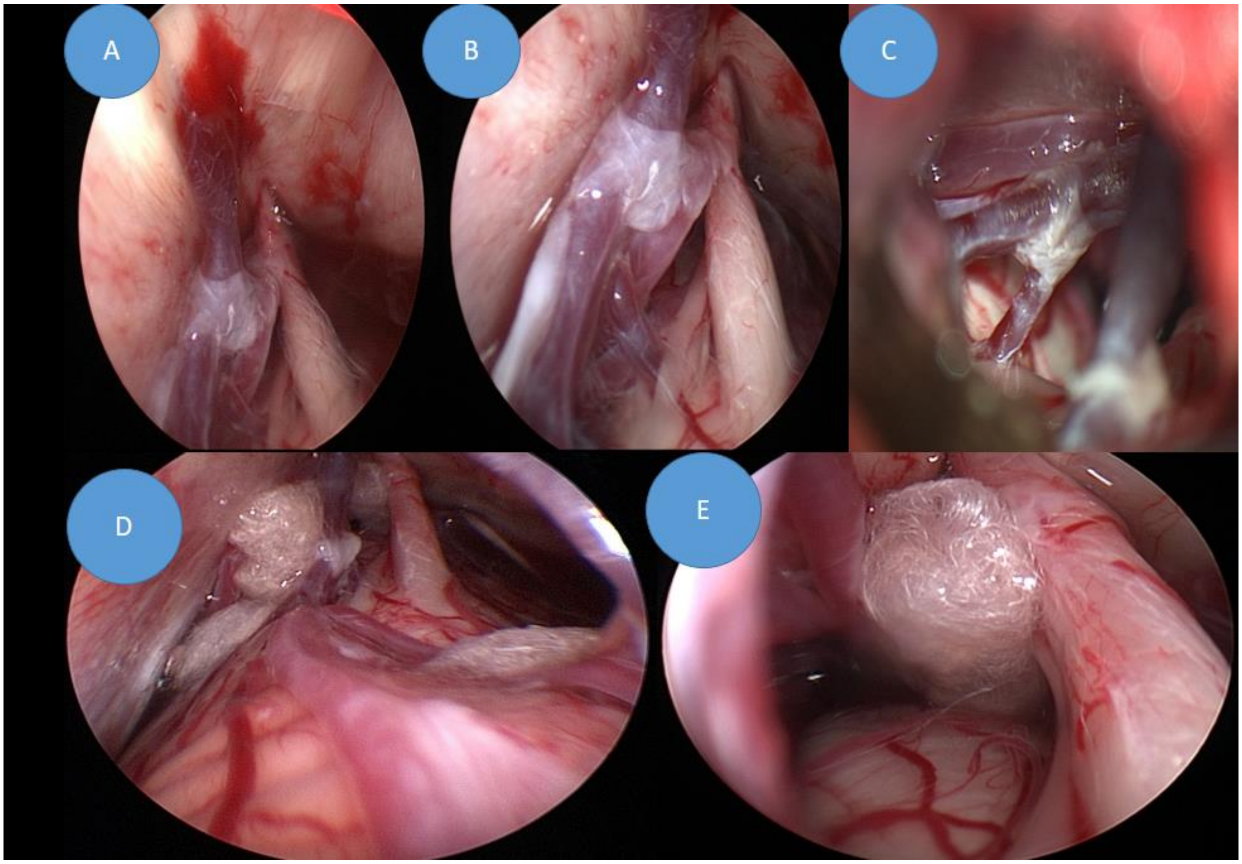


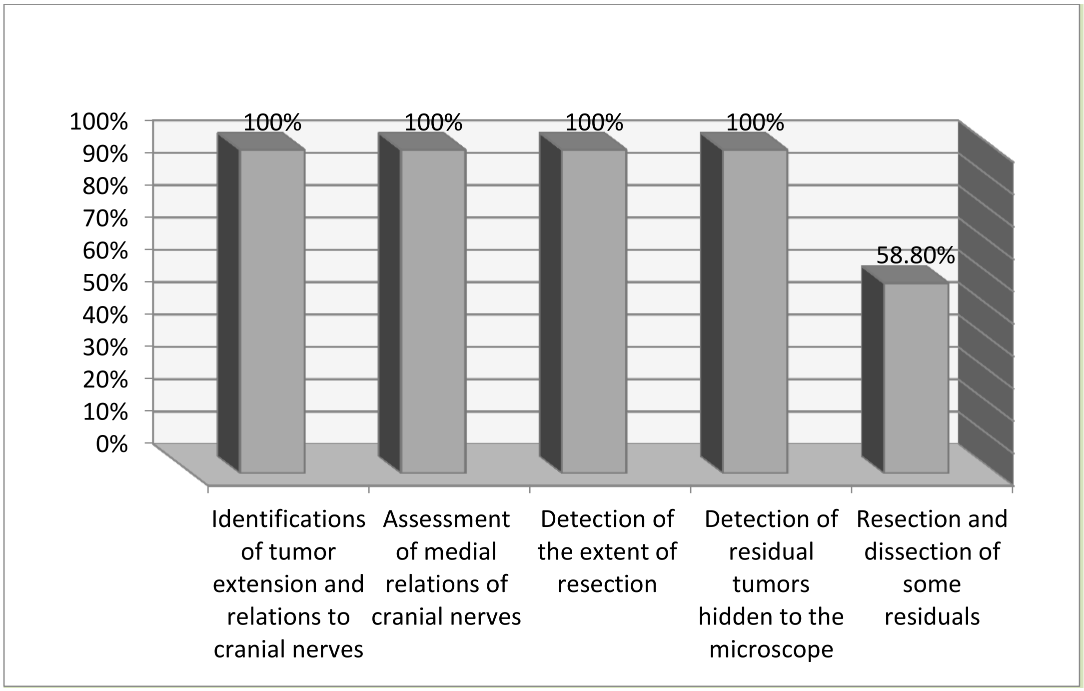
Figure 3: A & B, endoscopic view 0 degree showing tent, petrous dura, superior petrosal vein, SCA and 5th nerve compressed by the artery. C, microscopic dissection. D & E, endoscopic view of final TEFLON insulator between the artery and 5th nerve.

Table 1. Comparison between Epidermoid tumors group and Schwannomas tumors group, Meningioma tumors group, Hemifacial spasm group and Trigeminal neuralgia group in Endoscopic management of posterior fossa lesions as regard age and sex.

	Studied groups					**Test of sig**	**p**
	Epidermoid tumors No=5	Schwannomas tumors No=8	Meningioma tumors No=4	Hemifacial spasm No=10	Trigeminal neuralgia No=6		
Age per years Mean ±SD min-max	36.4±7.5 30-49	53±19 28-83	52±8.4 44-60	53.8±10 38-70	65±18.5 33-84	F= 2.9	0.04 (S)
Sex no (%)						χ^2= 3.2	0.52 (NS)
Female	3(60)	6(75)	3(75)	5(50)	(2)33.3		
Male	2(40)	2(25)	1(25)	5(50)	(4)66.7		

This table demonstrates all groups in regarding age and sex

Table 2. Pioneer role of the endoscope in Surgical excision of tumors (no= 17).



Role of the endoscope in Surgical excision of tumors (no= 17).

Table 3. pioneer role of endoscope in Surgical endoscope in vascular compression cases (n=16).

Parameters	number	%
Identification of the nerves and offending arteries	16	100
Identifications of the blind areas to the microscope in medial and inferior direction	16	100
Confirm the compression	16	100
Clearly seeing the pathological effects on the nerves like indentation, thinning and atrophy	14	87.5
Evaluation of perforators state	14	87.5
Evaluation of Teflon insulators if it separates the artery well or not, also if it encroaches the perforators or not.	14	87.5
Exclusion of compression	2	12.5
Evaluation of rhizotomy	2	12.5
Evaluation of Teflon insulators if it separates the artery well or not, also if it encroaches the perforators or not.	14	87.5
Teflon repositioning one time	7	43.8
Teflon repositioning 2 times	5	31
Teflon repositioning 3 times	2	12.5

This table denote surgical endoscope identified 100% the nerves and offending arteries among in vascular compression cases.

DISCUSSION

The anatomy of the CPA, with its unique location, narrow spaces and complex relationships, makes surgery for lesions in this area a challenge. The endoscopic assisted surgical techniques appears to be helpful in CPA surgery (1). the endoscope with different diameters, angles and lengths, meeting need for exposure of CPA structures, especially those hidden from the microscope. This allows improved tumors excision while maximizing preservation of normal anatomy. This is the most important advantages of the endoscope (1, 4). Endoscopy also provides a better illumination and clearer images than the microscope. This reduces the chance of injury to tissues. [2, 3]

Microscope has a limitations in skull base surgery. The linear light source, located outside the surgical field, created many blind recesses due to the nature of the CPA (4). Although some of these corners could be visualized better with larger openings, cerebellar retraction, or manipulation of these structures can increase morbidity while still leaving many areas not well illuminated, potentially leading to injuries to adjacent structures (5,6, 7, 10, 8, 9). The endoscope allowed for full visualization of the CPA from cranial nerve 4 at the level of the tent to the foramen magnum as well as from the cerebellar hemispheres to the petrous temporal bone (13, 14). In addition, angled endoscopes, allowed for improved visualization into the internal auditory canal (15, 16, 17, 18, 28).

In our study, we state that endoscopic-assisted microsurgery is a reliable, safe and effective for surgical treatment of CPA lesions. The technique allowed inspection of the tumor relations and vascularity, detection of any residual, providing a chance for gross total resection with less tissue damage or vascular injury as well as convenient clinical outcome. It proved very useful for tumors that grow around corners between neurovascular structures and going to pockets especially epidermoids.

Hitotsumatsu et al. (20) concluded that during conventional microscopic surgery the illumination may be poor due to small opening and narrow field. However, the endoscope can bring more light inside the depth providing the surgeon with a panoramic view to differentiate between the abnormal and normal anatomy.

Abolfotoh et al. (22) study concluded that endoscopic techniques provided better visualization and dissection techniques through approaches to the CPA tumors and it extended the field and increased the radicality of tumor resection with good outcomes.

In agreement with the above results, we find in our study that the endoscope had provided superior intraoperative illumination and magnification in addition to help us for looking around the corners which is considered one of the most important advantages.

The endoscope, allows visualization of a residual lesions in locations not seen through the microscope. The microscope is limited in its angles of observation because its focus begins outside the field. Because the neurovascular structures cannot be retracted, lesions can be hidden from the microscope’s point (23, 26, 25, 27). The endoscope overcomes this, it obtains its target point within the surgical field, and the angled lenses allow seeing in a trajectory away from the microscopic working trajectory (24, 19, 21).

Our study further emphasizes the endoscope’s essential complementary role in identifying and allowing for the resection of remnant tumors in these locations. In addition, the magnification, and illumination facilitate better inspection of the dura and bone.

Our study highlighted the poor reliability of the microscope alone in measuring the extent of resection during surgery. The endoscope improved intraoperative inspection after tumor resection. In 17 patients, gross-total resection was believed to be achieved after microscopic dissection, but the endoscope identified additional tumor in 17 patients (100%). the endoscope was highly predictive of postoperative MRI findings. These findings demonstrate the superiority of the endoscopy to assess the degree of resection in patients with posterior fossa lesions.

17Our study further emphasizes the endoscope’s essential complementary role in identifying and allowing for the resection of residual lesions in these locations. Heat from the endoscopic light source has the potential to cause thermal damage to surrounding structures, creating a significant hazard. To avoid this, we utilize a thin sleeve over the endoscope and intermittent irrigation to control high temperatures.

In Epidermoid tumors, Schroeder et al. (30) reported 8 cases of CPA epidermoids; the tumor was removed microscopically with the use of the endoscope for verification and removal of some parts. The endoscope revealed microscopically hidden tumor in all cases.

Safavi-Abbasi et al. (29) reported 11 cases in which the endoscope was used for inspection after microscopic resection in epidermoid cysts. They were against the use of the endoscope for dissection in epidermoids, recommended it to be used only for inspection.

In our study, patients with epidermoid tumors were 5 cases and they got benefits from the endoscopic-assisted techniques because these tumors tend to travel away from their primary origin, often extending to the middle fossa, crossing the midline, and expanding in the CPA. The endoscope can extend the microscopic approach to follow the epidermoid materials into the middle cranial fossa and even to the contralateral side of the brainstem. In addition, hidden pieces are easily removed under the endoscope. Finally, because MRI does not clearly show the residual capsule, we believe that the endoscopy is the best for evaluating the degree of resection.

In Meningioma tumors, Schroeder et al. (31) reported a series of meningiomas treated with an endoscopic-assisted techniques, 23 of which were in the CPA. In this study, the endoscopic view visualized tumors hidden from the microscopic in 56% of cases and thus demonstrated the high utility of the endoscope in identifying hidden parts.

In this series, 4 cases of meningiomas, the unique advantage of using the endoscope with meningiomas was identifying abnormal dura and bone affected by the tumor, which was not easy with the microscope. Removal and coagulation of the invaded dura, as well as the drilling of hyperostotic bone, was completed with the endoscope. The disadvantages we find of using the endoscope in meningiomas are the frequent need to clean the lenses because of the bloody nature of the meningiomas and the accumulation of bony dust. For this reasons, we recommend using the endoscope as late as possible in dissection of meningiomas.

In Schwannomas tumors, The use of the endoscope for schwannoma tumors surgery has been frequently reported. This review of the literature demonstrated the utility of the endoscope in increasing the degree of resection and improving functional outcomes (33).

Our findings corroborate those of other studies that the endoscope is helpful in removing tumors at the canal fundus. The microscopic view, on the other hand, requires excessive drilling of the internal auditory canal (IAC) for visualization, and this can be reduced with the endoscope. In our series 8 cases, endoscopes of different angles were used to visualize residual lesions at the IAC. The endoscope was also used to facilitate excision of the tumors in all cases. Our experiences can be summarized as follows: debulking of the tumor helps create space for endoscope, good hemostasis helps avoid the need to frequent clean the endoscope, the endoscope is an adjunct to the microscope, which should be used when needed.

In Vascular compression syndromes, Endoscopy provides clear visualization of CPA anatomy including cranial nerves and blood vessels, and proves to be useful in procedures such as trigeminal rhizotomy, vestibular neurectomy and vascular decompression surgeries (34).

The vascular decompression procedures aided by endoscopy in this series are 16 cases, results are satisfactory resolution of trigeminal neuralgia 6 cases and hemifacial spasm 10 cases symptoms, with no complications. We feel that endoscopy is especially indicated in vascular decompression to achieve better results. We find that endoscopic assisted techniques provide more accurate assessment of the compression by blood vessels and therefore more accurately help decompression results.

CONCLUSIONS

In the present study, we emphasize endoscopic significant role in skull-base surgery. The use of the endoscope improved access to a variety of CPA tumors and was effective in expanding the approaches into additional intracranial compartments. It also increased the ability to evaluate the extent of resection during surgery. Most importantly, it improved the ability to achieve total resection of the tumors which improve the clinical outcome. Also endoscopic use in microvascular decompression surgeries provide surgeons with additional views of compression sites and perforators states. Position of insulators can be assessed and modified easily using the endoscope.

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