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Full Length Research Paper

Morphometric study of endoscopic approach to the cerebellopontine angle

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Cerebellopontine angle (CPA) tumors account for 10% of all intracranial tumors. The endoscopic approach to CPA is being used increasingly as the availability of variable angled endoscope allow for operative views of lesions at angles not visible by the microscope and it is minimally invasive. The authors present findings based on the endoscopic study performed on three cadaveric heads (six sides) through the retrosigmoid approach and 10 adult dried skulls. The CPA cistern was examined using MAHE 5.0 mm rigid endoscope at 0 and 30° viewing angles and morphometric assessment of the neurovascular structures visualized was carried out. A morphometric study on skulls was performed to measure key distances relevant to surgery of CPA lesions; these distances were measured from the sino-dural angle (SDA). The cranial CPA level contains the oculomotor, trochlear, trigeminal nerves and superior cerebellar artery. The middle CPA level contains the acoustic-facial bundle and provides access through an endoscopic corridor to the abducens nerve, anterior inferior cerebellar artery and vetebro-basilar junction. The caudal CPA level contains the lower cranial nerves (glossopharyngeal, vagus, accessory and hypoglossal) and the V4 segment of the vertebral artery. The thickness of III, IV, V and acoustic-facial bundle in their cisternal course ranged from 2.2 to 2.5 mm; 0.5 to 0.8 mm, 2.5 to 3.0 mm, and 2.0 to 2.5 mm respectively. The distance between the SDA-posterior lip of porus acousticus ranged from 31 to 37 mm (median 34 mm). SDA-Meckel's cave distance was 46 to 52 mm (median 49 mm) and SDA-petrous apex distance was 59 to 67 mm (median 61 mm). The authors conclude that understanding of endoscopic anatomy of cerebellopontine angle is very useful for skull base surgeon.

Key words: Cerebellopontine angle, endoscopic, sino-dural angle, skull base.

INTRODUCTION

Cerebellopontine angle (CPA) is an extra-axial space situated in between the superior and inferior limbs of the angular cerebellopotine fissure formed by the cerebellar petrosal surface folding around the pons and middle cerebellar peduncle (Rhoton, 2003). It is an important anatomical space as vital neurovascular structures (cranial nerves III to XII, vetebro-basilar artery and its branches, cerebellum and the brainstem) are located. It is a site of multiple pathologies often requiring surgical intervention, for example, trigeminal neuralgia and hemi-facial spasm requiring microvascular decompresssion; vestibular schwannoma and other tumoral lesions and arachnoid cysts requiring excision (Mostafa et al., 2008) and aneurysm requiring clipping (Day et al., 1997). Tumoral lesions are not uncommon in the CPA, accounting for 5 to 10% of all intracranial tumors (VIlela, 2005). It is therefore important to understand the anatomy of this territory in treatment of these disease entities.

Standard approach to the CPA is through the retrosigmoid approach (Ojemann, 2000; Rhoton, 2003). Conventionally, it is done with the aid of a microscope. The optical principle of the microscope presents peculiar

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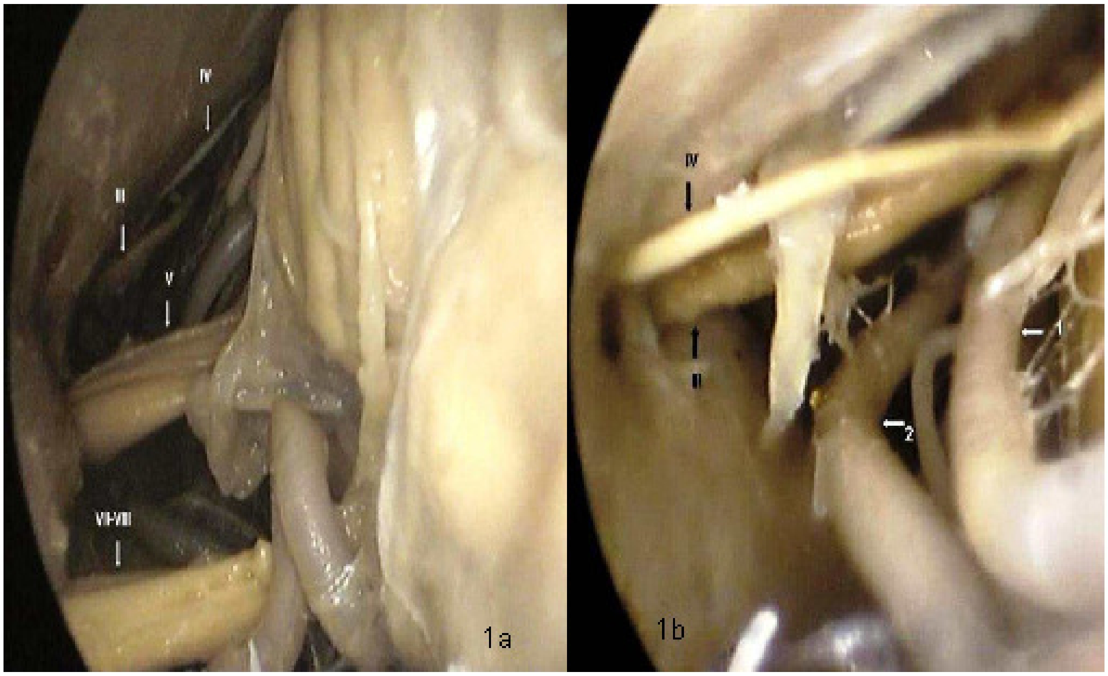

Figure 1. (a) The left CPA cistern, the cranial level contains the oculomotor, trochlear, and trigeminal nerves; (b) close up endoscopic view of the left oculomotor and trochlear nerves with posterior cerebral artery and superior cerebellar artery (III, oculomotor nerve; IV, trochlear nerve; V, trigeminal nerve; VII-VIII, acoustic-facial bundle, 1, posterior cerebral artery; 2, superior cerebellar artery).

situation of conical view, in which, as the zoom and focus is brought in to view deeper structure through the viewing window, the field of vision became smaller. Thus, the CPA became a site with narrow viewing window and regions that have angled trajectories such as the lateral aspect of internal auditory canal is difficult to view with microscope without excessive retraction and drilling of bone. This increase the risk of complications such as traction injury to the cerebellum and neighbouring neuro-vascular structures and the exposed air cells carry the risk of post operative cerebrospinal fluid (CSF) leak and meningitis.

Conversely, the endoscope's vision became panoramic and the angle of vision became wider upon entering the bony window, and as the endoscope is brought closer to the structure, the clarity of object was enhanced. The availability of variable angled scope permits viewing of structures previously difficult or impossible with the microscope. The increased usage of endoscope in recent years in surgery of the skull base (Shahinian, 2008) had propelled the field of skull base surgery. Therefore, familiarity with the regional endoscopic anatomy is important.

MATERIALS AND METHODS

Three cadaveric heads were placed in surgical position and a vertical incision was made 1 cm medial to the mastoid process.

Midas Rex pneumatic high speed drill was used to make a burr hole to expose the sigmoid-transverse sinus junction and extended 2.0 cm medially along the lower margin of transverse sinus and craniectomy with vertical height of 2 cm made; thus, a 2.0 cm diameter retrosigmoid craniectomy was done at sigmoid-transverse junction. Semicircular incision made on the dura and base was flapped towards the sinuses. The 5.0 mm rigid endoscope at 0 and 30° viewing angles (Mahe, Germany) was introduced to the CPA cistern. The endoscope is connected to Richard Wolf illuminating device and charge couple device endocam. Morphometric assessment of the visualized neurovascular structures were carried out for the six CPA regions being examined.

Key distances relevant to the CPA surgery were measured from the sino-dural angle (SDA) in ten adult dried skulls, 20 sides available. The key distances measured are from the SDA to posterior lip of porus acousticus, Meckel's cave and petrous apex.

RESULTS

The CPA could be categorized into three levels when viewed through the endoscope via the retrosigmoid approach; the cranial, middle and caudal level. The cranial level of CPA is located above the cisternal segment of trigeminal nerve, extending from its exit on the mid pons to the Meckel's cave. The trigeminal nerve is closer to the endoscope from the retrosigmoid approach as compared to the oculomotor and trochlear nerves and it is the thickest nerve bundle in the CPA cranial level (Figure 1a, Table 1). Upon forwarding the endoscope through the CPA cranial level, the cisternal segment of oculomotor and trochlear nerves can be visualized.

With the 30° endoscope, the oculomotor nerve can be

Table 1. Cisternal segment thickness of nerves measured.

Cisternal segment of nerves measured	Range of thickness (mm)
Oculomotor (III)	2.2-2.5
Trochlear (IV)	0.5-0.8
Trigeminal (V)	2.5-3.0
Acoustic-facial bundle (VII-VIII)	2.0-2.5

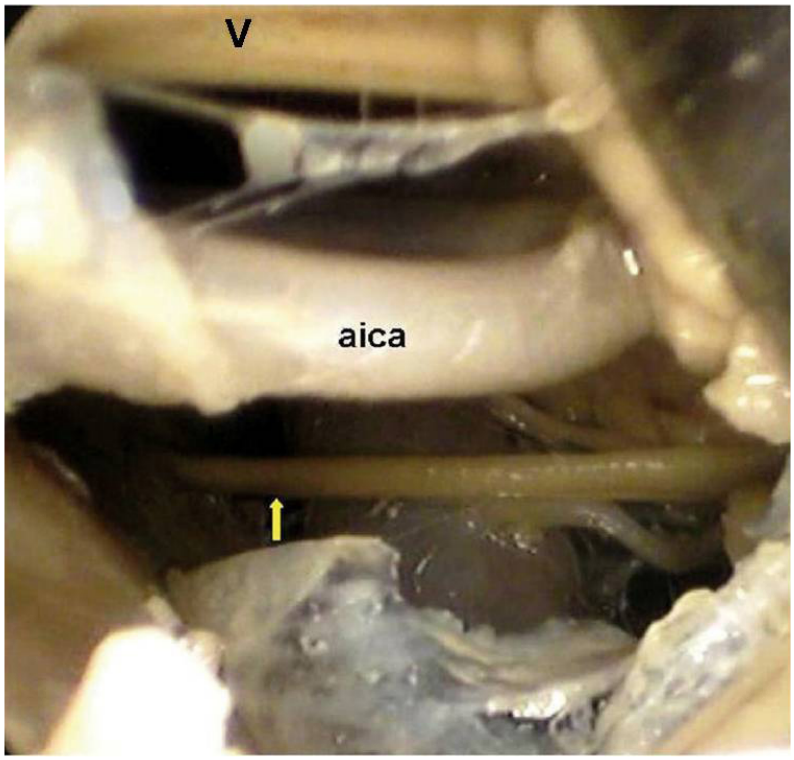

Figure 2. Endoscopic view of the left middle level of CPA. The presence of the endoscopic corridor to the abducens nerve is shown with yellow arrow (V, trigeminal nerve; aica, anterior inferior cerebellar artery).

seen exiting the midbrain, between the posterior cerebral artery (PCA) and the superior cerebellar artery (SCA) and its course to the roof of cavernous sinus could be tracked. The trochlear nerve could be seen in its cisternal course entering the posterior wall of cavernous sinus. At times, a low coursing PCA could be visualized in the cranial level of CPA (Figure 1b). The CPA cranial level contains the oculomotor, trochlear, trigeminal nerves and the superior cerebellar artery.

The CPA middle level extend from the lower margin of trigeminal nerve to the upper margin of the lower cranial nerve bundles (IX, X and XI). It contains the acoustic-facial bundles and the anterior inferior cerebellar artery (AICA). The acoustic-facial bundle cisternal segment thickness range from 2.0 to 2.5 mm (Table 1). It is at this level that an "endoscopic corridor" was observed that could lead to the abducens nerve in its vertical course from the pontomedullary junction to the Dorello's canal (Figure 2). Following the AICA medially to its origin will lead to the vetebro-basillar junction; we noticed that a 30° endoscope is best suited to view this artery from its origin.

The CPA caudal level contains the glossopharyngeal, vagus, accessory and hypoglossal nerves. The spinal accessory nerve can be seen entering from the foramen magnum and turning laterally; it then with the central accessory nerve, glossopharyngeal and vagus nerves exit the cranial cavity through the jugular foramen. The intracranial course of the vertebral artery (V4) (Mooris, 1997) is located medial to the hypoglossal nerve bundle and the accessory nerve and shielded by these nerves (Figure 3).

Advancing the rigid endoscope through the CPA cranial level, the investigators could visualize both the oculomotor nerves, posterior cerebral arteries (PCA) and the partitioning Liliequist's membrane between the

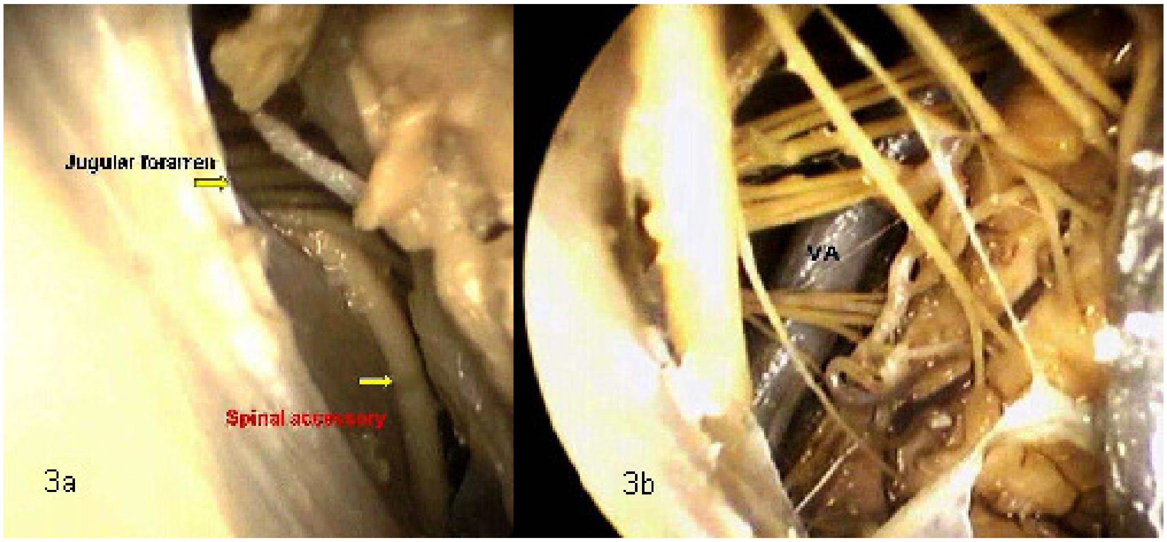

Figure 3. (a) Endoscopic view of the CPA caudal level showing the jugular foramen and the exiting lower cranial nerves and the spinal accessory nerve seen; (b) endoscopic view with 30° endoscope, showing the complex course of the vertebral artery in close proximity of various lower cranial nerves (the hypoglossal nerve bundles heading to the hypoglossal canal, the accessory nerve and the spinal accessory nerve coursing through the foramen magnum and heading towards the common destination of accessory nerve- the jugular foramen; VA, vertebral artery).

interpeduncular and the chiasmatic cistern (Figure 4a). Fine endoscopic dissection and removal of the Liliequist's membrane from its attachment to the dorsum sellae reveal the "retroinfundibular fossa", the pituitary stalk and its neighbouring optic apparatus is seen at the upper right quadrant of the endoscope. The contralateral posterior communicating artery from its origin, and the ophthalmic segment of internal carotid artery, could be trace from its proximal end to the distal end connecting it to the PCA (Figure 4b). The oculomotor nerve could be visualized just underneath the PCA.

The key distances measured from the sino-dural angle (SDA) to the posterior lip of porus acousticus ranged from 31 to 37 mm (median 34 mm). SDA-Meckel's cave distance was 46 to 52 mm (median 49 mm) and SDA-petrous apex distance was 59 to 67 mm (median 61 mm).

DISCUSSION

Cerebellopontine angle is a common site for multiple pathologies, and CPA tumors are among the most common intracranial tumor accounting for 5 to 10% (VIlela, 2005). Conventional approach to the CPA is through the retrosigmoid approach with optical aid by the microscope (Ojemann, 2000; Rhoton, 2003), the associated morbidity of the surgery such as acoustic-facial nerve injury, CSF leak and meningitis, cerebellar retraction injury and devastating vascular injury had been related to the inability to visualize the important structures during dissection and the need for greater retraction and large bony window due to the "conical view" phenomenon of the microscope.

The neurosurgical fraternity had constantly looked for better way of viewing this anatomical space and thus, improvement of the surgical outcome. The endoscope is being used more frequently by the skull base surgeons in the treatment of CPA lesions, both tumoral and vascular in origin (Eby et al., 2004; Kabil et al., 2005).

The anatomy of the CPA had remained the same and most skull base surgeons are familiar with the regional microscopic anatomy. However, as this study shows, CPA when viewed through the endoscope, especially the angled endoscope, these structures appear to be in unfamiliar orientation. The endoscope despite being provided a new viewing tool to visualize the CPA, also presented new challenges in forming proper 3-dimension perspective to the regional endoscopic anatomy. Thus, manoeuvring the endoscope in this "familiar" territory needed re-orientation and re-understanding in order to ensure safe passage to this region. The endoscope had enabled the surgeons to visualize the microscope "blindspot", the midline structure without much retraction needed. Perhaps, this is one of the major advantages as compared to the microscope, less cerebellar retraction.

The division of the CPA into three levels is to aid in assessing the possibility of the approach to different anatomical region. On the cranial level, the investigators were able to trace the cisternal segment of trigeminal nerve from its exit on the lateral mid pontine region to the Meckel's cave. It is possible to apply this endoscopic knowledge to be used in the treatment of trigeminal n euralgia (Kabil et al., 2005), Meckel's cave schwannoma and meningioma.

The investigators noticed that by advancing the

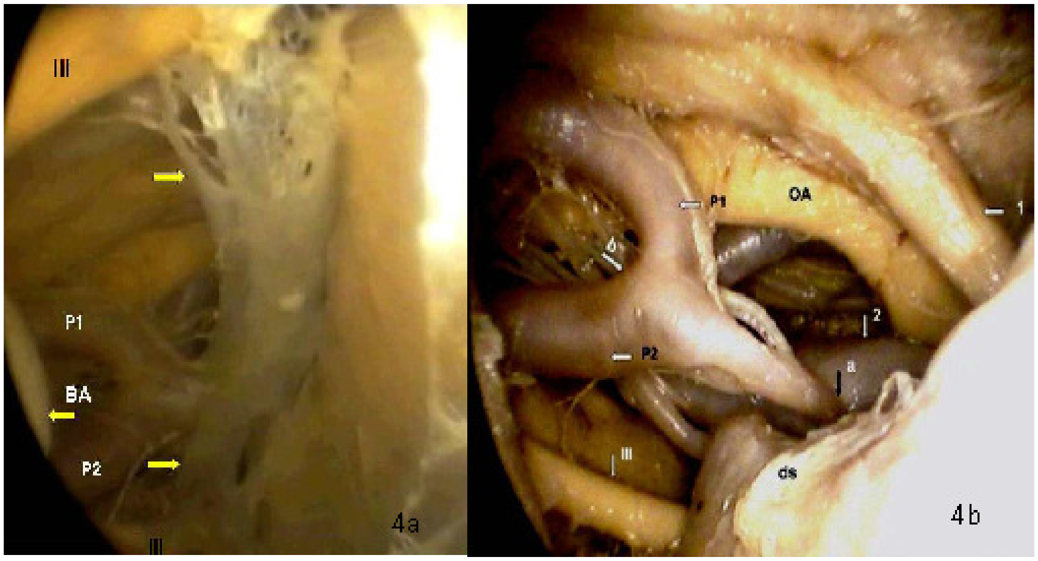

Figure 4. (a) Endoscopic view from the right CPA cistern with 30° endoscope. The Liliequist's membrane (yellow arrow) is seen with both the right and left oculomotor nerve (on top left top and bottom b=corner respectively) and left posterior cerebral artery visualized; (b) the Liliequist's membrane was removed revealing the "retroinfundibular fossa". The left oculomotor nerve, optic apparatus, ophthalmic segment of left internal carotid artery and its branch, the posterior communicating artery are seen (III, oculomotor nerve; P1 and P2, pre-communicating and post-communicating segment of left posterior cerebral artery; BA, basilar artery; 1, pituitary stalk; 2, ophthalmic segment of left ICA; OA, optic apparatus; ds, dorsum sellae; a and b, proximal and distal end of posterior communicating artery respectively).

endoscope through the cranial level, it leads to the "retro-infundibular fossa". This study shows that through the endoscopic retrosigmoid approach, lesions arising from or CPA lesions extending till the clival or the retroinfundibular region could be reached.

The neurovascular structures visualized in all three levels are clear and no retraction of the cerebellum was needed despite a small craniotomy window that was used. Using the angled endoscope multiple corner, medial and lateral spots which are difficult to view with microscope could be viewed easily. The anatomical landmarks and the detail of the structures are easily identified with endoscope.

We concluded that the understanding of endoscopic anatomy of cerebellopontine angle is very useful for skull base surgeon.

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REFERENCES

Day JD, Fukushima T, Giannotta SL (1997). Cranial base approaches to posterior circulation aneurysm. J. Neurosurg., 87(4): 544-554

Eby JB, Ocon M, Shahinian HK (2004). Fully endoscopic excision of vestibular schwannomas. Minim. Invasive Neurosurg., 47(6) 329-332.

Kabil MS, Eby JB, Shahinian HK (2005). Endoscopic vascular decompression versus microvascular decompression of the trigeminal nerve. Minim. Invasive Neurosurg., 48(4): 207-212.

Mooris P (1997) Practical neuroangiography. Lippincott Williams & Wilkins, Florida.

Mostafa BE, Sharnoubi ME, Youssef AM (2008). The keyhole retrosigmoid approach to the cerebello-pontine angle: indications, technical modifications, and results. Skull Base, 18(6): 371-376.

Ojemann RG (2000). Suboccipital approach to acoustic neuroma (vestibular schwannoma), Churchill Livingstone.

Rhoton AL (2003). The cerebellopontine angle and posterior fossa cranial nerves by the retrosigmoid approach. Lippincott Williams & Wilkins, Florida.

Shahinian HK (2008). The fully endoscopic retrosigmoid approach. Endoscopic skull base surgery: a comprehensive guide with illustrative cases. Humana Press, Totowa, Chapter 9.

Vilela MD, Britz GW, Rostomily RC (2005) Cerebellopontine angle tumors, second edition. Elsevier Mosby, Philidelphia.