ISSN: 2083-389X
eISSN: 2084-3127

J Hear Sci, 2021; 11(2): 19–22
DOI: 10.17430/JHS.2021.11.2.2

ENDOSCOPY OF THE CEREBELLO-PONTINE ANGLE: AN OVERVIEW

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Contributions:
A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

Abstract

Introduction: The cerebello-pontine angle (CPA) is an important region in the skull base which can harbour a variety of pathologies. Because it is surrounded by numerous vital structures, surgical access is a challenge, more so when distorted by disease. Microscopes have successfully guided CPA surgery over the past three decades. CPA endoscopy has evolved today as an alternative way to explore this intriguing region with minimal morbidity to collateral structures.

Discussion: CPA endoscopy has been introduced on an experimental basis into a range of CPA surgeries, including assistance in lower cranial nerve tumor removal, microvascular decompression, vestibular neurectomy, and assistance in auditory brainstem implantation. CPA endoscopy is currently used as a surgical adjunct to the operating microscope, and it has the potential to become standard in many CPA surgeries.

Conclusions: CPA endoscopy has evolved from a diagnostic to a therapeutic tool because it allows near and clear visualization of the CPA with in-depth view of the various nerve roots arising from the brainstem and their exit foramina. This review evaluates the current status and future directions of endoscopic technology and its role in skull base surgical practice.

Key words: cerebello-pontine angle, endoscopy, skull base, cranial nerves

ENDOSKOPIA KĄTA MOSTOWO-MÓŻDŻKOWEGO – OMÓWIENIE

Streszczenie

Wprowadzenie: Kąt mostowo-móżdżkowy (CPA) jest ważnym rejonem podstawy czaszki, w którym mogą skrywać się różne patologie. Ze względu na otaczające go liczne struktury dostęp chirurgiczny do CPA jest trudny, szczególnie gdy rejon ten jest zniekształcony z powodu choroby. Przez ostatnie trzy dekady w chirurgii CPA z powodzeniem stosowano wizualizację mikroskopową. Od niedawna rozwija się endoskopia CPA jako alternatywna metoda badania tego intrygującego rejonu powodująca tylko minimalne uszkodzenia sąsiadujących struktur.

Dyskusja: Endoskopia CPA została wprowadzona eksperymentalnie w szeregu operacji kąta mostowo-móżdżkowego, w zabiegach m.in. usunięcia guza dolnej gałęzi nerwu czaszkowego, dekompresji mikronaczyniowej, przecięcia nerwu przedsionkowego, czy pomocniczo podczas wszczepiania implantu słuchowego pnia mózgu. Endoskopia CPA jest obecnie wykorzystywana jako wspomożenie mikroskopu chirurgicznego podczas operacji. Potencjalnie może być stosowana jako standard w wielu operacjach CPA.

Wnioski: Endoskopia CPA jest wykorzystywana i przy diagnostyce i przy terapii, ponieważ narzędzie to umożliwia wyraźnie uwidocznienie CPA z pełnym obrazem korzeni nerwowych wychodzących z pnia mózgu oraz ich otworów wyjściowych. Niniejszy przegląd zawiera ocenę obecnego stanu i przyszłych kierunków rozwoju technologii endoskopowych i ich znaczenia w chirurgii podstawy czaszki.

Słowa kluczowe: kąt mostowo-móżdżkowy • endoskopia • podstawa czaszki • nerwy czaszkowe

Introduction

The skull base has, for a long time, been considered to be a "no man's land" and surgically unapproachable because of the anatomical complexity and the vital importance of the structures within its boundaries. The advent of endoscopes has paved the way for minimal access approaches to the cranial contents via the ENT regions. Thereby ENT and neurosurgeons began collaborating to comprehensively navigate their way to skull-base lesions with minimal morbidity, while providing optimal outcomes. The invention and first use of the endoscope was by a German urologist Maximilian Carl-Fridrich Nitze in 1879, along with a Viennese instrument maker Joseph Leiter [1]. This initial endoscope was a cystoscope, used for urological purposes. Later in 1917, the first CPA endoscopy with this endoscope was performed by Doyen to conduct a trigeminal neurectomy. This marked the beginning of the use of endoscopy in the posterolateral skull base [2]. These initial endoscopes were rather crude in design and had limitations in lighting and magnification, and so they did not gain popularity for many decades. The operating microscope invented in the 1960s almost made endoscopes obsolete. However, in the 1990s improved technology led to the reintroduction of endoscopes into skull base surgery [3]. This overview highlights the CPA endoscopic approach, which has become a very useful minimally invasive tool to address a spectrum of CPA lesions.

Discussion

MIRA approach to CPA endoscopy

The introduction of an endoscope into the CPA through a minimal access port, as in the minimally invasive retrosigmoid approach (MIRA), was a logical progression for the surgeon to explore boundaries in the skull base with minimal

morbidity. In otology, endoscopes have become useful in exploring the middle ear, Eustachian tube, and more recently the cochlea. These same endoscopes could be used in the CPA. Commonly used rigid endoscopes are either 2.7 mm or 4 mm in diameter, with viewing angles of zero, 30, and 70°. Since the CPA is a region of arachnoid cisterns and provides a pathway to cranial nerves and intracranial major vessels, knowledge of the microanatomy of vessels and nerves in this region is fundamental for diagnosis and functional neurosurgery. CPA endoscopy has helped classify the neuroanatomy of the CPA cistern into four levels:

- *Level I:* Trigeminal area – V and VI nerves, and superior cerebellar artery
- *Level II:* Acousticofacial area – VII and VIII nerves, anterior inferior cerebellar artery (AICA)
- *Level III:* Lower cranial nerves area – IX, X, and XI nerves, posterior inferior cerebellar artery (PICA)
- *Level IV:* Foramen magnum level – spinal root of accessory and XII nerves, vertebral basilar and PICA arteries.

CPA endoscopy offers a panoramic view of an area difficult to visualize (Figures 1, 2), which otherwise needs a wide craniotomy with cerebellar retraction. This approach enables the surgeon to visualize and carry out procedures on a wide variety of structures, including surgery for lesions of cranial nerves V to XI, arteriovenous malformation clippings, and microvascular decompression for vascular loops (Figure 3). Today, a variety of indications exist for CPA endoscopy, such as hemifacial spasm, trigeminal neuralgia, vestibular neurectomy (Figure 4), vascular tinnitus, glossopharyngeal neuralgia, endoscopy-assisted vestibular schwannoma excision (Figure 5), and for cholesteatoma/epidermoid cyst excision. Many of its indications are still evolving, but one exciting prospect in the near future is the option of performing endoscopic auditory brainstem implantation (ABI) – another novel minimal access procedure (Figures 6, 7). Setty et al. reported fully endoscopic excision of 12 cases of vestibular schwannoma without any complications such as CSF leak, cranial nerve palsy, meningitis, or wound infection. The mean per operative blood loss was only 56 mL and the average hospital stay for their patients was 3.6 days [3]. Jarrahy et al. described for the first time a fully endoscopic technique for microvascular decompression [4]. Krass et al. [5] and De Divitiis et al. [6] have reported successful endoscopic removal of epidermoid tumours. Magnan et al. reported endoscopic vascular decompression of the eighth cranial nerve in 25 patients suffering disabling positional vertigo, and endoscopic vestibular neurectomy in 45 patients with Meniere's disease [7].

Polyaxial pneumatic holding arms can hold the endoscope rigidly in place, allowing the surgeon to use both hands for instrumentation. Such holding arms can easily be moved in all planes [3]. While the retrosigmoid approach gives a more tangential view (70–90° to the long axis of the 8th nerve), another approach to CPA endoscopy, the retrolabyrinthine approach introduced by Hitselberger and Pulec, gives an angle of view of 30–70° posterior to the vestibulocochlear nerve [8].

Emerging trends in CPA endoscopy

CPA endoscopy is currently used by neurosurgeons and neurotologists as a surgical adjunct to the operating microscope. It improves visualization of bony, neural, and vascular

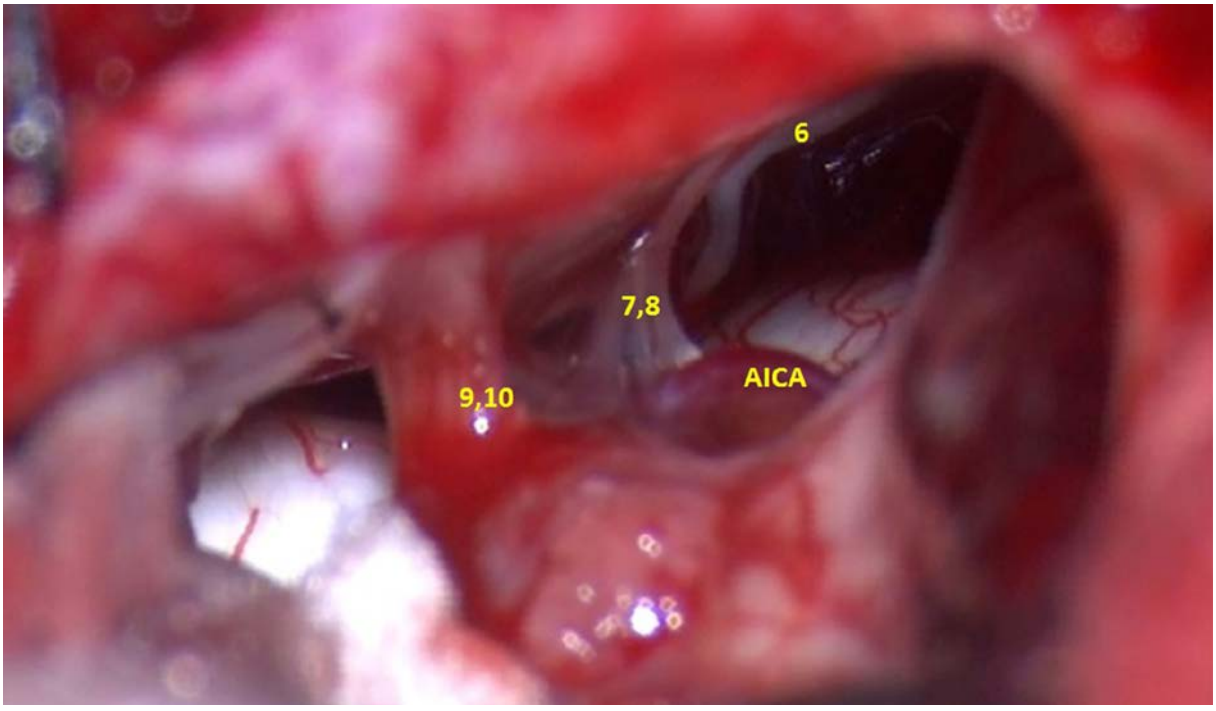

Figure 1. Left CPA endoscopy showing panoramic view of the 6th to 10th cranial nerves. AICA = anterior inferior cerebellar artery

structures, while minimizing retraction of these structures. Endoscopic exploration after tumor removal can reveal the presence of residual tumor or air cells that may otherwise result in recurrent tumor or cerebrospinal fluid (CSF) otorhinorrhoea post-operatively. Endoscopes fitted with high definition cameras provide high magnification and illumination of the operative field, but blood soiling the tip of the endoscope can make visualization difficult. There is also a risk of potential thermal injury, and maintaining 3D orientation in the posterior fossa requires experience. Such technical issues are being refined and full-fledged CPA endoscopic surgery may emerge in the near future. Thereby, exciting prospects like endoscopic microvascular decompression, endoscopic aneurysmal clipping, endoscopic tumor removal, and minimally invasive endoscopic auditory brainstem implantation may all become standard skull base surgery.

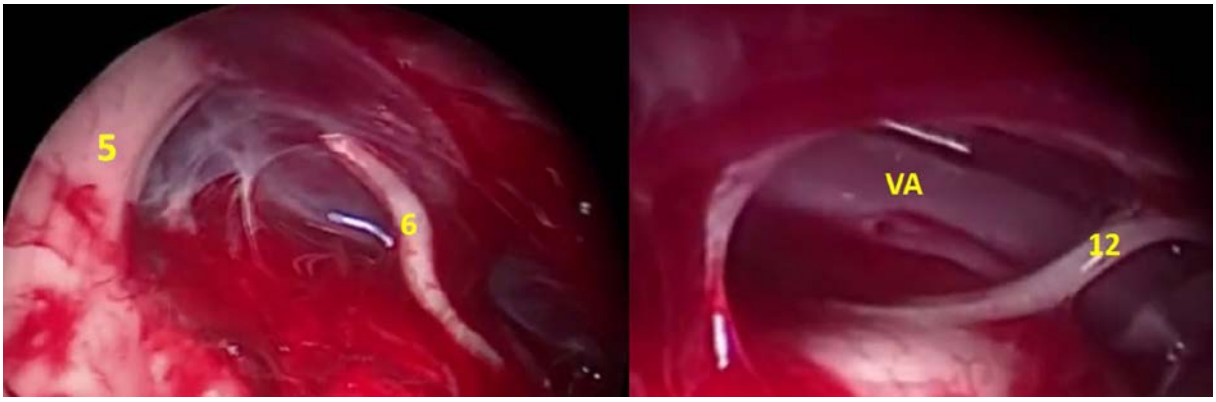

Figure 2. Right CPA endoscopy showing superior (left) and inferior (right) views. 5 = 5th cranial nerve; 6 = 6th cranial nerve; VA = vertebral artery, 12 = 12th cranial nerve

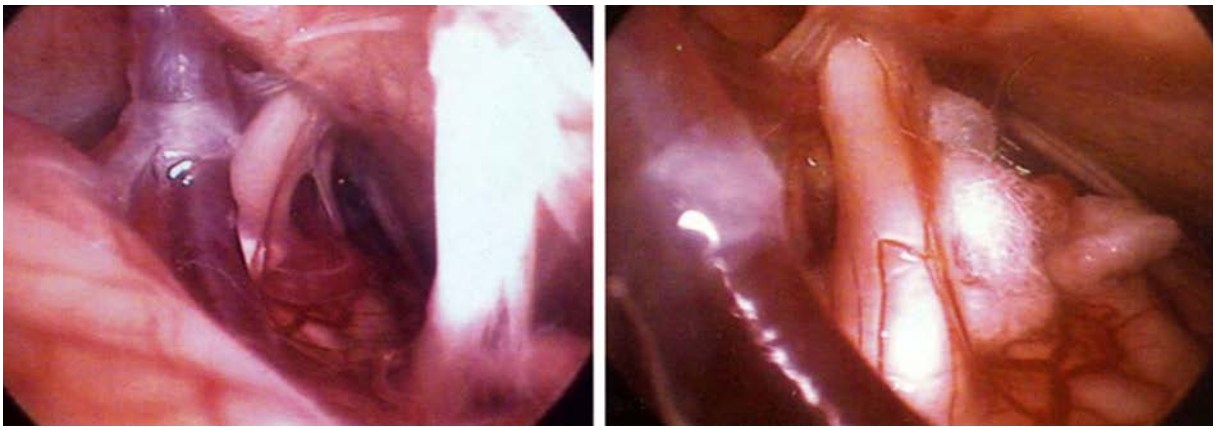

Figure 3. Left: Endoscopic view of superior cerebellar artery (SCA) pressing the Vth nerve and causing trigeminal neuralgia. Right: Micro-vascular decompression using a Teflon pad

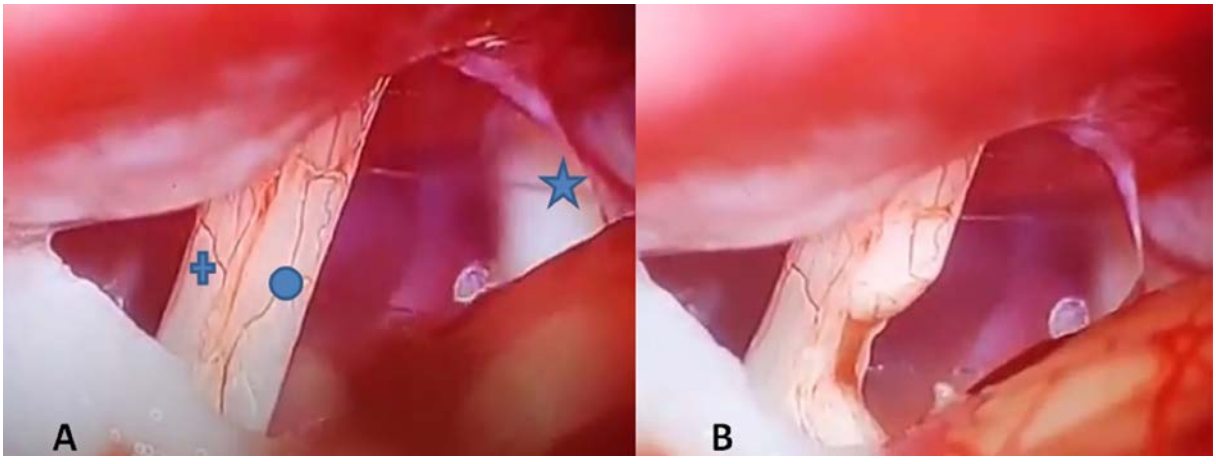

Figure 4. Left CPA endoscopy showing superior vestibular nerve section (before, left; after, right). Blue cross = inferior vestibular nerve; blue circle = superior vestibular nerve; blue star = trigeminal nerve superiorly

Figure 5. Endoscopic picture of the mid-zone of the right CPA showing a moderate size cisternal vestibular schwannoma with its origin in the internal auditory canal (IAC)

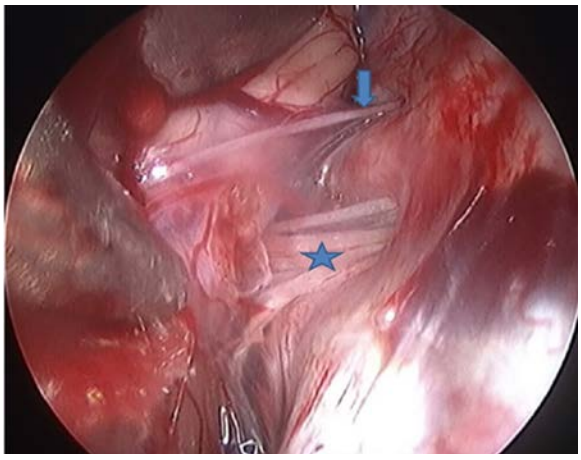

Figure 6. CPA endoscopy (right side) in a child for ABI showing facial nerve alone passing through the IAC (blue arrow) with an absent 8th cranial nerve. The 9th and 10th cranial nerves are seen passing through the jugular foramen (blue star)

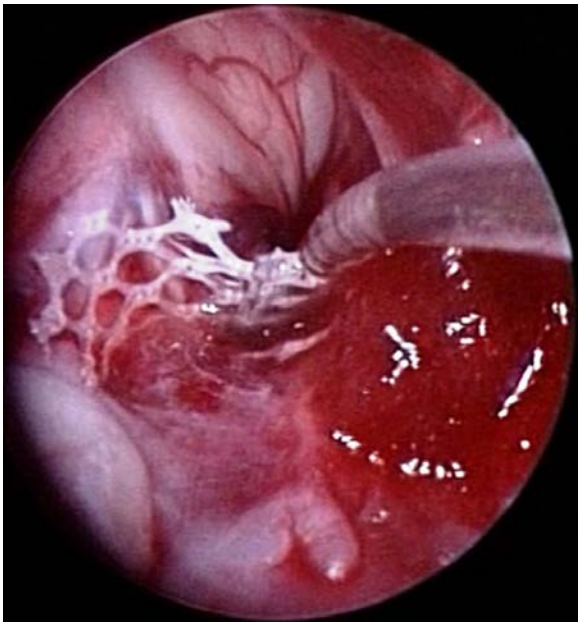

Figure 7. CPA endoscopy assisted ABI electrode placement in the lateral recess of the fourth ventricle

Conclusion

Advances in technology like neuro-navigation with image guidance have been the catalyst for making minimally invasive surgery popular worldwide. The less invasive endoscopic skull base approach has quicker recovery, less morbidity, and shorter hospital stay than traditional external approaches. CPA endoscopy has evolved from a diagnostic to a therapeutic tool, since the endoscope allows near and clear visualization of the CPA with in-depth view of the various nerve roots arising from the brainstem and their exit foramina. This panoramic view helps with identification of critical anatomical landmarks with minimal trauma, excellent illumination and magnification, and has decreased complications. The drawbacks include lack of binocular vision, poor depth perception in the operating field, and inability to use both hands for surgery, areas where the operating microscope scores over the endoscope. There is therefore a learning curve for surgeons to optimally perform endoscopic skull base surgery, which calls for years of practice. Endoscopic surgeons must be familiar with handling endoscopes as well as CPA anatomy before attempting diagnostic or therapeutic procedures in this intricately positioned vital region of the cranial base.

Conflicts of interest: None.

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