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Endoscopic-assisted microsurgical techniques at the craniovertebral junction: 4 illustrative cases and literature review

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ABSTRACT

Background: Endoscopic-assisted microsurgery (EAM) techniques are employed to improve visualization of the surgical field while minimizing brain retraction and trauma to neurovascular structures. There have been several reports in the literature on the indications and advantages of endoscopic-assisted techniques when operating at the craniovertebral junction (CVJ). The purpose of this study was to present illustrative cases and to perform a literature review of endoscopic-assisted microsurgical techniques at the CVJ.
Methods: A review of the literature was compiled through MEDLINE/OVID and using cross-references of articles on Pubmed. Illustrative cases from the senior author's clinical series are presented to highlight indications and the utility of EAM at the CVJ.
Results: Our literature review supports the utility of the endoscope in the transoral, transcervical, lateral, far lateral and posterolateral approaches. In particular EAM can be used in the transoral approach to increase surgical exposure of the clivus and minimize the need to split the soft palate while in the far lateral and posterolateral approaches, EAM can improve visualization down narrow or deep surgical corridors to help identify critical neurovascular structures and minimize the need for extensive bony removal. In general, the endoscope can be used to look around bony, vascular, or neoplastic lesions to visualize the surgical space behind these structures as well as to assess for tumor remnants after microsurgical resection.
Conclusion: EAM techniques can improve illumination and visualization of the surgical field at the CVJ. In addition, the EAM techniques can help to minimize the need for brain retraction or extensive exposures. Utilization of both the endoscope and the microscope allows the surgeon to benefit from the advantages of each modality.

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1. Introduction

A urologist in Chicago, V.L. L'Espinasse, provided the first published description of the use of an endoscope in a neurosurgical procedure in 1917, when he used a cystoscope to perform an endoscopic choroid plexus coagulation [1,2]. This first attempt highlighted a new innovation in neurosurgery – the ability to obtain a panoramic view of the surgical field with good illumination in a narrow surgical corridor using the endoscope. Despite this discovery, endoscopes were not widely adapted in neurosurgery until the invention of the Hopkins rigid rod lens in the 1960s that provided superior optics suitable for neurosurgical use [3]. Shortly thereafter, Perneczky was one of the first to popularize the use of the endoscope as an adjunctive tool for visualization and surgical manipulations while performing intracranial microsurgical procedures [4–7]. He coined the term "endoscopic-controlled" surgery to indicate when surgical manipulations are performed under sole endoscopic visualization. This is opposed to "endoscopic-assisted" microsurgery (EAM), in which the endoscope is used as a visualization adjunct, but primary surgical manipulations are performed under microscopic visualization. Since then several neurosurgeons have incorporated endoscopic-assisted microsurgery (EAM) for various skull base pathologies. The use of endoscopes to visualize pertinent anatomical features during microsurgery has been described for a wide array of neurosurgical procedures including for inspection of the suprasellar cistern after transcranial resection of craniopharyngioma [8,9], inspection of the trigeminal or facial nerve during microvascular decompression [10,11], to visualize the posterior third ventricle and pineal gland during a supracerebellar infratentorial approach for pineal tumors [12,13], and to visualize the seventh nerve during the surgical resection of vestibular schwannomas and other cerebellopontine angle tumors [14–18].

Endoscopic-assisted techniques are employed to improve visualization of the surgical field while minimizing brain retraction and trauma to neurovascular structures. The endoscope can provide increased illumination and higher magnification with a wider view angle and increased depth of field. The benefit can be particularly seen in narrow surgical corridors, angled spaces, and regions with multiple neurovascular structures that need to be identified and preserved while working in the space around and beyond them. In this way, the potential benefit of EAM while operating at the craniovertebral junction (CVJ) is evident. There have been several reports in the literature on the indications and advantages of endoscopic-assisted techniques when operating at the CVJ [19–24]. The purpose of this study was to present illustrative cases and to perform a literature review of endoscopic-assisted microsurgical techniques at the CVJ.

2. Methods

A review of the literature was compiled through MEDLINE/OVID and we searched reference section of articles for additional references on Pubmed, using the terms "endoscope," "endoscopic," or "endoscopic-assisted" in combination with either "craniovertebral junction," "transoral," "transcervical," "far lateral," "suboccipital," "retrocondylar," "transatlantal," or "extreme lateral." Search result abstracts were reviewed for pertinent papers including reviews, clinical series, and laboratory investigations.

3. Results

A number of surgical approaches to the CVJ have been developed over the last several decades. These approaches can be divided into anterior, lateral, and posterior approaches. Within the anterior approaches are the transoral and endoscopic endonasal transclival [22,24–30]. The lateral approaches include the extreme lateral, transatlantal or direct lateral, and anterolateral approaches [31–36]. Finally, the posterior approaches include the far lateral, posterolateral, and midline suboccipital approaches [31,33,37–43]. The endoscope has been incorporated as an adjunct in several of these approaches.

3.1. Transoral approach

The transoral approach provides direct exposure of anterior pathology at the CVJ. Several cadaveric studies have demonstrated the utility of endoscopic-assisted techniques to complement the standard microsurgical transoral approach [22,26,44]. In a cadaveric quantitative study, the surgical area exposed over the posterior pharyngeal wall was significantly greater with the endoscope compared to the microscope without any compromise of surgical freedom. More importantly, the extent of the clivus exposed without splitting the soft palate was significantly greater with the endoscope (9.5 ± 0.7 mm) compared to the microscope (2.0 ± 0.4 mm) ($P < 0.05$) [22]. A 30° endoscope can significantly increase the surgical working area.

In a clinical series of seven patients that underwent the transoral approach with EAM, the authors qualitatively concluded that the use of the endoscope allowed for a more radical decompression as demonstrated by post-decompression contrasted fluoroscopy compared to their microsurgical transoral technique alone [44]. Another clinical study utilized endoscopic transoral (2), endonasal (2), and combined (4) approaches in 8 patients. Compared to a cohort undergoing a transoral transpalatal approach, the endoscopic cohort had significantly reduced length of hospital stay and reduced need for prolonged intubation or tracheostomy [26]. Incision of the palate and posterior pharyngeal wall as well as prolonged retraction of the tongue can result in increased oropharyngeal edema and postoperative airway obstruction.

3.2. Transcervical approach

The transcervical approach has been used as an alternative approach to the anterior mid-lower clivus and foramen magnum. A cadaveric study demonstrated that the high anterior transcervical approach with anterior far-lateral clivectomy and inferior petrosectomy extends the exposure to include the cerebellopontine angle