Endoscopic endonasal approach for craniovertebral junction pathology: a review of the literature

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OBJECT The transoral approach is the gold standard for ventral decompression of the brainstem caused by craniovertebral junction (CVJ) pathology. This approach is often associated with significant morbidity, related to swallowing and respiratory complications. The endoscopic endonasal approach was introduced to reduce the rate of these complications. However, the exact role of this approach in the treatment of CVJ pathology is not well defined.

METHODS A comprehensive literature search was performed to identify series of patients with pathology of the CVJ treated via the endoscopic endonasal approach. Data on patient characteristics, indications for treatment, complications, and outcome were obtained and analyzed.

RESULTS Twelve studies involving 72 patients were included. The most common indications for treatment were rheumatoid pannus (38.9%) and basilar invagination (29.2%). Cerebrospinal fluid leak was found in 18% of cases intraoperatively and 4.2% of cases postoperatively. One case of meningitis complicated by sepsis and death represents the procedure-related mortality of 1.4%. Of the patients without preoperative swallowing impairment, 95% returned to oral feeding on the 3rd postoperative day. Ninety-three percent of patients experienced improvement in neurological symptoms after the procedure.

CONCLUSIONS The endonasal endoscopic approach is effective for the treatment of neural compression caused by CVJ pathology. It offers advantages such as lower rates of postoperative dysphagia and respiratory complications when compared with the more traditional transoral approach. However, these 2 approaches should be seen as complementary rather than alternatives. Patient-related factors as well as the surgeon's expertise must be considered when making treatment decisions.

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KEY WORDS craniovertebral junction; endoscopic surgery; odontoidectomy; basilar invagination

THE microsurgical transoral approach is the traditional route and technique used for surgical treatment of ventral compression of the brainstem. Limitations of the transoral approach include the need for a direct oropharyngeal incision to access the odontoid with potential delayed enteral nutrition. In 2002, Alfieri and colleagues performed an anatomical study and demonstrated that the ventral craniovertebral junction (CVJ) could be effectively exposed through an endoscopic endonasal approach.¹

With refinements of endoscopic endonasal techniques, in 2005 Kassam and colleagues reported on a patient with ventral brainstem compression due to a rheumatoid pannus who underwent a successful operation via a completely endoscopic endonasal approach.⁹ Since then, isolated case reports and case series have been reported. However, the exact role of the endoscopic endonasal approach for the treatment of CVJ pathology remains controversial. In the present study, we performed a review of published se-

ABBREVIATION CVJ = craniovertebral junction.

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ries of patients treated through the endoscopic endonasal route and discuss its potential role in the treatment of these challenging lesions.

Methods

A comprehensive literature search of several databases indexing English-language literature published from 1990 to November 13, 2014, was conducted. The databases included Ovid MEDLINE In-Process & Other Non-Indexed Citations, Ovid MEDLINE, Ovid EMBASE, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, Scopus, and Web of Science. The search strategy was designed and conducted by an experienced librarian with input from the authors. Controlled vocabulary supplemented with keywords was used to search for studies of the endoscopic endonasal approach to the CVJ. The actual strategy is available from the corresponding author.

All studies reporting on patients who were treated surgically using an endoscopic endonasal approach were selected. Inclusion criteria were the following: series of 3 or more patients with available data on indications for treatment, procedure-related complications, and clinical outcomes. To avoid duplication of patients, when multiple papers were found from the same authors or the same institution, only the report with the largest relevant cohort was included. Two reviewers (S.F.M.V. and E.S.) independently selected the included studies. A manual search for studies was also conducted by screening references from the identified papers and in major neurosurgical journals.

For each study, we extracted the following information: patients' demographic characteristics, presentation, etiopathology, perioperative complications, time to extubation and oral feeding as well as immediate and long-term neurological outcome. Good neurological outcome was determined if the study used terms such as "no morbidity," "improvement," or "good recovery." The primary objective of this study was to determine the effectiveness as well as the rate of systemic and neurological complications after endonasal endoscopic treatment of pathology involving the CVJ.

Results

Search Results and Study Characteristics

The search criteria led to 265 citations, and 1 recently published study was identified through our manual search.⁷ After screening the titles and abstracts, we identified 45 articles about endoscopic approaches to the CVJ, and the full texts were reviewed carefully. Of these 45 articles, 32 did not meet the inclusion criteria: 7 were anatomical studies, 4 were imaging studies, 7 studies dealt with the endoscopic transoral approach, 2 were review articles, 10 were individual case reports, and 2 included 2 patients only. A total of 13 studies included patients with CVJ pathology treated using an endoscopic endonasal approach and met our inclusion criteria. Two publications corresponded to the same group,^{6,8} and only the most recent was included. A total of 12 studies comprising 72 patients were included in our analysis^{2,4–7,10–13,17,19,20} (Fig. 1 and Table 1). All studies provided data on patient demographics, clinical presentation, indications for treatment, perioperative complications, and neurological outcome.

Patient Characteristics

Patient characteristics are summarized in Table 2. The mean patient age was 55.8 years (range 6–96 years), and 57.1% of patients were female. The most common indications for treatment were rheumatoid pannus (38.9%) and basilar invagination (29.2%) causing compression of the cervicomedullary junction. The most common presenting symptoms were myelopathy, present in 77.8% of patients and neck pain, reported in 30.6%. Swallowing disturbance was seen in 15.3% of cases preoperatively.

Complications and Outcome

Intraoperative CSF leak was reported in 13 cases (18%). However, it was present in only 3 patients (4.2%) postoperatively. One patient developed meningitis that was complicated by sepsis and death, resulting in a procedure-related mortality of 1.4%. Transient velopharyngeal insufficiency was seen in 3 cases (4.2%), and 2 patients had respiratory failure in the perioperative period.

FIG. 1. Flow diagram showing the review process.

TABLE 1. Characteristics of studies included in the literature review

Authors & Year	Study Design	No. of Patients	No. of Females	Mean Age (yrs)	Mean Follow-Up (mos)
Goldschlager et al., 2015	Retrospective	9	5	45	42.9
Mazzatenta et al., 2014	Retrospective	5	3	30	34.2
Ponce-Gómez et al., 2014	Retrospective	5	4	42.6	6
Duntze et al., 2014	Retrospective	9	4	63.7	6
Choudhri et al., 2014	Retrospective	5	4	67.4	18.8
Yen et al., 2014	Retrospective	13	7	52.7	55.5
Yu et al., 2013	Retrospective	3	2	51.3	26.7
Gladi et al., 2012	Retrospective	4	3	74.3	22
Gempt et al., 2011	Retrospective	3	3	64.3	6.3
Lee et al., 2010	Retrospective	4	1	48.8	4.7
Wu et al., 2008	Retrospective	3	0	44.3	1
Nayak et al., 2007	Retrospective	9	NA	75.8	3

NA = not available.

Data on time to extubation were available for 49 patients; 1 patient was ventilator dependent preoperatively and remained intubated after the surgical procedure. Of the remaining 48 patients, 27 were extubated the day of the procedure and 20 on the 1st postoperative day. One patient with severe quadriparesis remained intubated for 1 week until posterior fixation was performed due to the high risk of respiratory failure. A total of 63 patients had available data on time to oral feeding. Three patients had significant preoperative dysphagia requiring nasogastric

tube feeding, which was continued postoperatively. Of the 60 patients with adequate swallowing preoperatively, 54 (90%) were swallowing the on 1st postoperative day, 57 (95%) by postoperative Day 3, and all of them by Day 6.

The majority of patients (67 patients, 93%) experienced improvement of symptoms shortly after the surgical procedure. Five patients continued to be symptomatic but did not develop new deficits. On long-term follow-up, all patients continued to show improvement, and no delayed procedure-related complications were reported.

TABLE 2. Patient characteristics*

Variable	Value
Demographic characteristics	
Age in yrs	
Mean $\pm$ SD	55.8 $\pm$ 20.8
Range	6–96
% female	57.1
Presenting symptoms	
Myelopathy	56 (77.8)
Neck pain	22 (30.6)
Swallowing disturbance	11 (15.3)
Bulbar involvement	1 (1.4)
Asymptomatic	1 (1.4)
Pathological condition	
Rheumatoid pannus	28 (38.9)
Basilar invagination	21 (29.2)
Os odontoideum	5 (6.9)
Tumor	6 (6.9)
Atlantoaxial subluxation	4 (5.6)
Trauma	4 (5.6)
Skull base osteomyelitis	2 (2.8)
Atlas assimilation	1 (1.4)
Ganglion cyst	1 (1.4)
Gout	1 (1.4)

* Values are reported as the number of patients (%) unless otherwise indicated.

Discussion

The endonasal route takes advantage of a natural anatomical corridor to approach a deep-seated area such as the CVJ. Reporting the current review of the literature and combining the results of the available studies, we provide an overview of the current role of endoscopic endonasal surgery in the treatment of congenital or acquired pathology of the CVJ. According to our results, this approach is effective in relieving neural compression and improving neurological function in the majority of patients (Fig. 2). Procedure-related complications are observed in a small number of patients and are within the accepted range for this type of pathology. In particular, meningitis, which is one of the more feared complications of the transoral approach and is likely related to surgical field contamination with saliva and oral bacterial flora, has been found to be a minor risk in transnasal surgery. Only 1 case of meningitis in 72 patients was recorded. Of note, although this procedure is typically thought of as extradural, there was an 18% observation of intraoperative CSF leak. However, this approach allows the surgeon to perform an effective dural repair, as demonstrated by the small incidence of postoperative CSF leak (4.2%).

Our results highlight one of the main advantages of the endonasal route, which is the lower rate of postoperative dysphagia and respiratory complications. Most patients were extubated in the immediate postoperative period, and 95% were swallowing by the 3rd postoperative day. These findings compare favorably to those of studies evaluating the transoral approach, which have reported a need

FIG. 2. Preoperative (**A** and **C**) and postoperative (**B** and **D**) axial T2-weighted MR images (**A** and **B**) and sagittal CT reconstructions (**C** and **D**) of an endonasal odontoid resection in an 8-year-old girl with medullary compression (arrow).

of enteral feeding in 90%–100% of patients.^{16,18} According to a recent anatomical study, the lower incidence of postoperative dysphagia with the endonasal approach is likely related to the lower density of neuronal elements from the pharyngeal plexus above the palatal plane.¹⁵

The cumulative experience with the endoscopic endonasal approach allows a direct comparison with the traditionally used transoral-transpharyngeal approach and the recently introduced transcervical approach for the treatment of CVJ pathology.³ Few studies have compared directly the different approaches. Raper et al. found no difference in the rate of successful complete odontoidectomy between the transoral and endonasal approaches.¹⁴ However, the time to extubation and oral feeding was significantly shorter in the endonasal group. Similarly, Ponce-Gómez and colleagues reported their own series of patients treated using both approaches and found comparable rates of neurological improvement after odontoidectomy, with less time to extubation and oral feeding, as well as shorter hospital stay in the endonasal group.¹³

However, the direct comparison of transoral and endonasal endoscopic approaches should be looked at carefully. The studies reporting both approaches may be affected by selection bias, due to a different patient population and indications. In our opinion and in agreement with other authors, the endoscopic endonasal approach, rather than an alternative, should be considered a complementary approach to the standard transoral-transpharyngeal route.¹¹ Some patient-related factors can help determine the most suitable approach. For instance, in patients with micrognathia, macroglossia, or limited oral aperture (< 3 cm), the transoral approach is more challenging.^{2,11} The experience of the surgical team should also be considered, and the endoscopic endonasal approach should be used in carefully selected cases only by operators with extensive experience with this technique.

Our study has some limitations. There is a potential publication bias, as studies reporting good outcomes are more likely to be published. In addition, the study heterogeneity was considerable, as we included series from different centers and different patient populations. The quality of the evidence presented here depends on the quality of the included studies, which is affected by the small number of patients and their retrospective nature. Nevertheless, this literature review provides useful data and a starting point to further define the role of endoscopic endonasal surgery in the treatment of CVJ pathology.

Conclusions

The endonasal endoscopic approach for the treatment of pathology of the CVJ is an effective treatment option for carefully selected patients. In general, it constitutes a safe approach in experienced hands. This approach should be considered as complementary rather than an alternative to the traditional transoral-transpharyngeal approach.

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Author Contributions

Conception and design: all authors. Acquisition of data: Morales-Valero, Serchi. Analysis and interpretation of data: all authors. Drafting the article: Van Gompel, Morales-Valero, Serchi. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Van Gompel. Study supervision: Van Gompel, Zoli, Mazzatenta.

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