Cranial nerve function preservation in surgical resection of tumors with jugular foramen extension: A systematic review

Abigail Salas, BS[1]; Alejandra Rodas, MD[2]; Leonardo Tariciotti, MD[2,3]; Roberto M Soriano,MD[2]; Jackson R Vuncannon, MD[2]; Juan M Revuelta-Barbero, MD, PhD[2]; Edoardo Porto, MD[2]; Biren K Patel, MD[2]; Emily Barrow, MD[2]; Tomas Garzon-Muvdi, MD[2]; Gustavo Pradilla, MD[2]; C. Arturo Solares, MD[2,3]

[1]Boston University Chobanian and Avedisian School of Medicine, Boston, Massachusetts

[2]Department of Otolaryngology - Head and Neck Surgery, Emory University, Atlanta, GA

[3]Department of Neurosurgery, Emory University, Atlanta, GA

EMORY UNIVERSITY SCHOOL OF MEDICINE

Chobanian & Avedisian School of Medicine — BOSTON UNIVERSITY

Abstract

The jugular foramen presents a challenging anatomical region for surgical resection due to its complexity and the high risk of cranial nerve (CN) and vascular injury. Tumors in this region can lead to a spectrum of CN dysfunctions, depending on their extension through the temporal bone, intracranial compartment, and neck. This systematic review aimed to evaluate surgical approaches that prioritize lower cranial nerve (LCN) function preservation while achieving effective tumor resection. A comprehensive literature search across multiple databases identified 26 studies meeting the inclusion criteria, encompassing 265 patients with a mean age of 44.3 years, predominantly female (58.5%). Schwannomas, paragangliomas, and meningiomas were the most common tumor types. Gross total resection (GTR) was achieved in 63.4% of cases, with histology and tumor location influencing the surgical approach. Transmastoid techniques were preferred for paragangliomas, while the petro-occipital trans-sigmoid approach was favored for schwannomas and meningiomas, demonstrating superior CN preservation outcomes. The findings underscore the importance of tailored surgical planning, detailed anatomical understanding, and advanced techniques to minimize morbidity. Achieving GTR while preserving CN function remains a central goal in managing tumors extending to the jugular foramen. This review highlights the need for continued refinement of surgical strategies to balance oncological control and functional outcomes effectively.
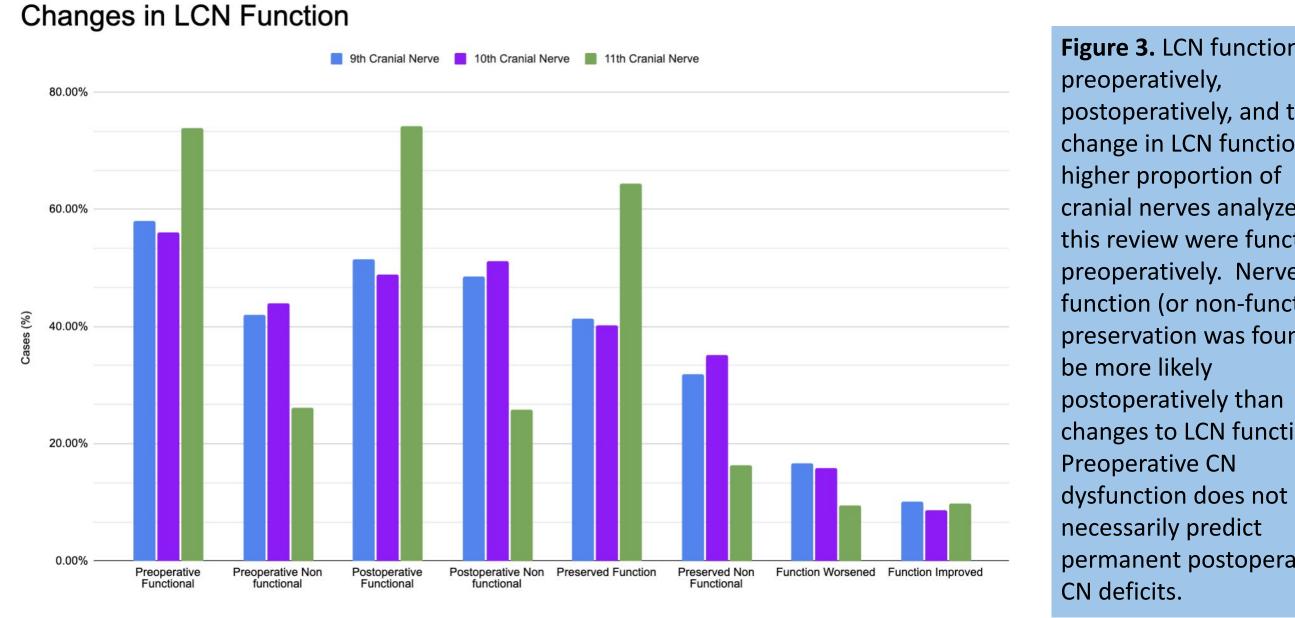
Introduction

The jugular foramen is an area of anatomical complexity and represents a surgical challenge with potential complications related to cranial nerve or vascular injury. Lesions involving this region can produce varied cranial nerve (CN) symptomatology based on their extension through the temporal bone, intracranial compartment, and neck. Nonetheless, approach selection must aim for anatomical and functional preservation of uninvolved nerves. The infratemporal fossa type A approach was the first to allow access to the jugular foramen. Morbidity related to facial and vestibulocochlear nerve dysfunction urged the development of new approaches. These novel techniques along with other intraoperative practices such as nerve monitoring have favored functional preservation.
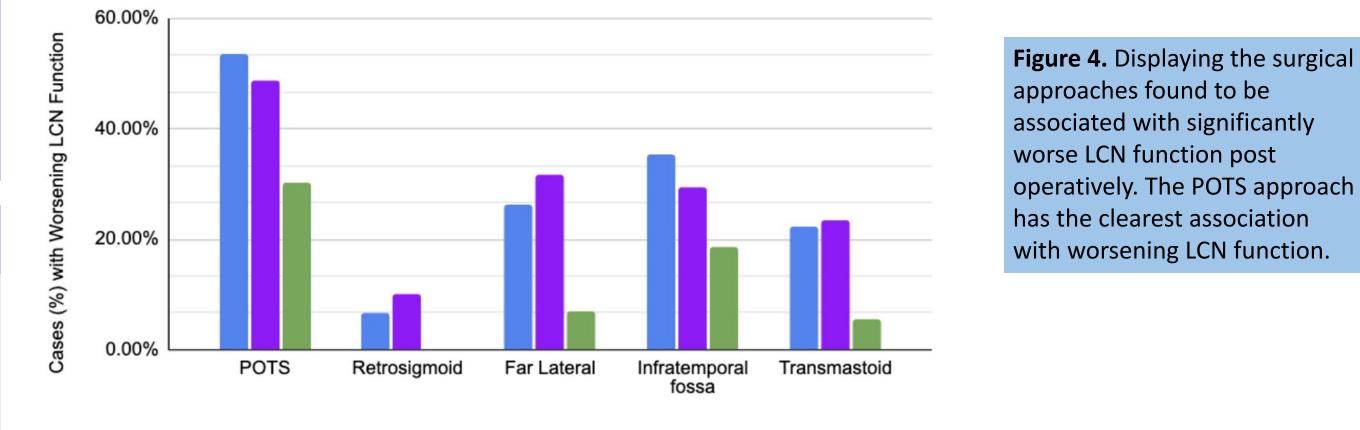
Methods and Materials

Methods

A literature search was conducted in PubMed, Cochrane, Google Scholar, and Embase using the terms "jugular foramen" AND "surgery" AND "nerve function". Inclusion criteria were the following: (1) Presents history of lesion involving the jugular foramen, (2) Surgical resection was the primary treatment (3) Includes description of CN function pre- and post-operatively, and (4) Includes description of the surgical approach.

Figure 1. Identification of Studies via Databases showing papers and patients included in the database after screening for inclusion criteria. The initial search provided 423 articles, from which 26 were ultimately included after duplicate removal then abstract and full-text analysis.

Figure 2. Contributions of Each Paper to the Database showing how many patients each first author contributed to the database. For example, we extracted 61 patients from Mazzoni A. et al case series which constitutes 17.3% of the patients in the database. Notably, there are 9 case reports in our database each contributing a single patient.

Materials

Of the 264 cases reviewed, 154 (58.3%) were female, 102 (38.6%) were male, and 8 (3%) were unspecified. The median age was 44.41 (±13.52). 136 (51.5%) tumors were schwannomas 28 (10.6%) were meningiomas, 84 (31.8%) were paragangliomas, 6 (2.3%) were chondrosarcomas, 5 (1.9%) were chordomas, 3 (1.1%) were papillary adenomas, 1 (0.4%) was a hemangioma, and 1 (0.4%) was a teratoma.

Results

Changes in LCN Function

Figure 3. LCN function preoperatively, postoperatively, and the change in LCN function. A higher proportion of cranial nerves analyzed in this review were functional preoperatively. Nerve function (or non-function) preservation was found to be more likely postoperatively than changes to LCN function. Preoperative CN dysfunction does not necessarily predict permanent postoperative CN deficits.

Worsening LCN Function by Approach

Figure 4. Displaying the surgical approaches found to be associated with significantly worse LCN function post operatively. The POTS approach has the clearest association with worsening LCN function.

Worsening LCN Function by Tumor Type

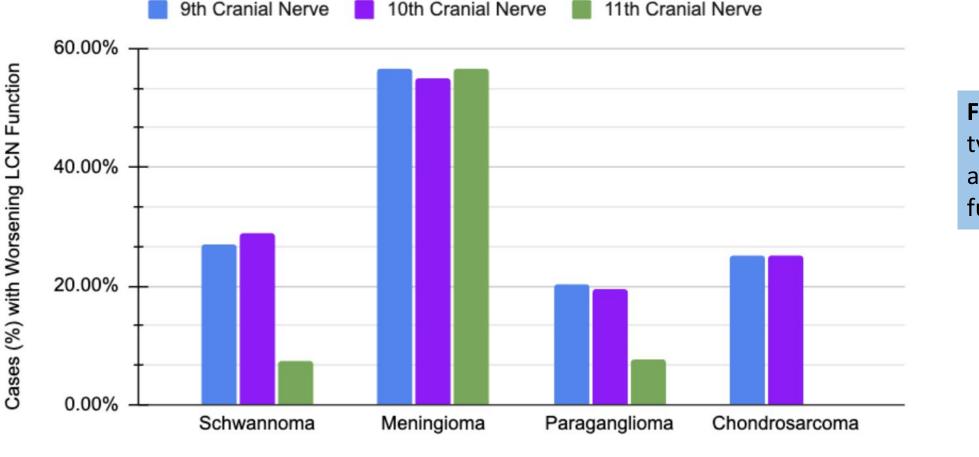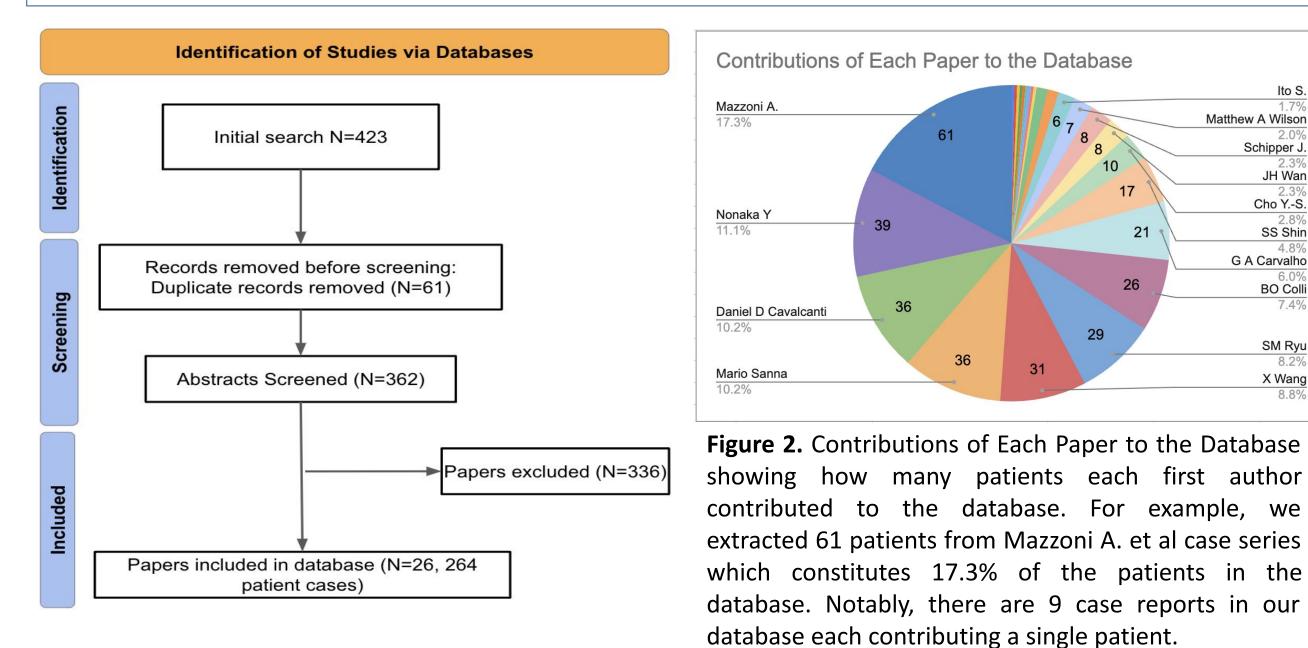**Figure 5.** Displaying the tumor types found to have a significant association with worsening LCN function postoperatively.

Discussion

The surgical management of tumors extending to the jugular foramen demands extensive anatomical knowledge and technical expertise. Careful surgical planning is critical to selecting the appropriate approach and minimizing cranial nerve (CN) morbidity. Schwannomas were identified as the most prevalent tumor type invading the jugular foramen, with this tumor type notably associated with a higher risk of lower cranial nerve (LCN) dysfunction postoperatively. Meningiomas, paragangliomas, and chondrosarcomas were also found to be associated with worsening LCN function postoperatively with meningiomas showing clearest association with worsening LCN function - most likely due to the invasive nature of this tumor type. Among surgical approaches, the POTS, approach demonstrated the strongest association with postoperative LCN dysfunction most likely because this surgical approach allows for a broad intraoperative view with the potential to damage cranial nerves and other structures. Furthermore, intradural extension and gross total resection (GTR) were correlated with an increased risk of LCN morbidity. However, preoperative CN dysfunction does not necessarily predict permanent postoperative CN deficits.

Conclusions

Physical examination and imaging remain central to guiding surgical decision-making. This study represents a comprehensive systematic review encompassing multiple tumor types, surgical approaches, and surgeons. To enhance our understanding, future studies should focus on more targeted retrospective analyses of specific tumor types and surgical approaches to better elucidate the outcomes associated with each. Additionally, investigating surgical outcomes from a single surgeon's cases could provide valuable insights, as surgical techniques often vary between practitioners.

Contact

Abbey Salas

Boston University Chobanian and Avedisian School of Medicine

72 E Concord St Boston, MA 02118

asalas@bu.edu

6789772772

References

1. Fayad, Jose N.; Keles, Bahar; Brackmann, Derald E. (2010). Jugular Foramen Tumors: Clinical Characteristics and Treatment Outcomes. Otology & Neurotology 31(2):p 299-305. https://doi.org/10.1097/MAO.0b013e3181be6495
2. Fisch U. (1978). Infratemporal fossa approach to tumours of the temporal bone and base of the skull. The Journal of laryngology and otology, 92(11), 949–967. https://doi.org/10.1017/s0022215100086382
3. Gilbert, M. E., Shelton, C., McDonald, A., Salzman, K. L., Harnsberger, H. R., Sharma, P. K., & Jensen, R. L. (2004). Meningioma of the jugular foramen: glomus jugulare mimic and surgical challenge. The Laryngoscope, 114(1), 25–32. https://doi.org/10.1097/00005537-200401000-00004
4. JUGULAR FORAMEN. Neurosurgery 61(4):p S4-229-S4-250, October 2007. | DOI: 10.1227/01.NEU.0000296227.70319.6E
5. Ramina, R., Maniglia, J. J., Fernandes, Y. B., Paschoal, J. R., Pfeilsticker, L. N., Neto, M. C., & Borges, G. (2004). Jugular foramen tumors: diagnosis and treatment. Neurosurgical focus, 17(2), E5. https://doi.org/10.3171/foc.2004.17.2.5
6. Sanna, M., Bacciu, A., Pasanisi, E., Taibah, A., & Piazza, P. (2007). Posterior petrous face meningiomas: an algorithm for surgical management. Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology, 28(7), 942–950. https://doi.org/10.1097/MAO.0b013e31814b23f0
7. Song, M. H., Lee, H. Y., Jeon, J. S., Lee, J. D., Lee, H. K., & Lee, W. S. (2008). Jugular foramen schwannoma: analysis on its origin and location. Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology, 29(3), 387–391. https://doi.org/10.1097/MAO.0b013e318164cb83