

Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines on Intraoperative Cranial Nerve Monitoring in Vestibular Schwannoma Surgery

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FACIAL NERVE MONITORING

Question 1: Does intraoperative facial nerve monitoring during vestibular schwannoma surgery lead to better long-term facial nerve function?

Target Population: This recommendation applies to adult patients undergoing vestibular schwannoma surgery regardless of tumor characteristics.

Recommendation: Level 3: It is recommended that intraoperative facial nerve monitoring be routinely utilized during vestibular schwannoma surgery to improve long-term facial nerve function.

Question 2: Can intraoperative facial nerve monitoring be used to accurately predict favorable long-term facial nerve function after vestibular schwannoma surgery?

Target Population: This recommendation applies to adult patients undergoing vestibular schwannoma surgery.

Recommendation: Level 3: Intraoperative facial nerve can be used to accurately predict favorable long-term facial nerve function after vestibular schwannoma surgery. Specifically, the presence of favorable testing reliably portends a good long-term facial nerve outcome. However, the absence of favorable testing in the setting of an anatomically intact facial nerve does not reliably predict poor long-term function and therefore cannot be used to direct decision-making regarding the need for early reinnervation procedures.

Question 3: Does an anatomically intact facial nerve with poor electromyogram (EMG) electrical responses during intraoperative testing reliably predict poor long-term facial nerve function?

Target Population: This recommendation applies to adult patients undergoing vestibular schwannoma surgery.

Recommendation: Level 3: Poor intraoperative EMG electrical response of the facial nerve should not be used as a reliable predictor of poor long-term facial nerve function.

COCHLEAR NERVE MONITORING

Question 4: Should intraoperative eighth cranial nerve monitoring be used during vestibular schwannoma surgery?

Target Population: This recommendation applies to adult patients undergoing vestibular schwannoma surgery with measurable preoperative hearing levels and tumors smaller than 1.5 cm.

Recommendation: Level 3: Intraoperative eighth cranial nerve monitoring should be used during vestibular schwannoma surgery when hearing preservation is attempted.

Question 5: Is direct monitoring of the eighth cranial nerve superior to the use of far-field auditory brain stem responses?

Target Population: This recommendation applies to adult patients undergoing vestibular schwannoma surgery with measurable preoperative hearing levels and tumors smaller than 1.5 cm.

Recommendation: Level 3: There is insufficient evidence to make a definitive recommendation.

The full guideline can be found at: https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4.

KEY WORDS: Auditory brainstem response, Acoustic neuroma, Cranial nerve monitoring, Electrophysiology, EMG, Intraoperative cranial nerve monitoring, Vestibular schwannoma

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The goals of vestibular schwannoma (VS) surgery have shifted over the years. The safety profile of these surgeries has continued to improve, and modern-day mortality is at an all-time low. As a result, a great deal of focus is now placed on minimizing morbidity, including hearing loss and facial paresis. The current expectation is that complete tumor resection is to be undertaken with a serious intent to achieve good postoperative facial function. A similar concept has been adopted in patients with existing preoperative hearing. Whereas the initial role of intraoperative cranial nerve monitoring (ICNM) was for identification and intraoperative mapping of the facial nerve, there is a new focus on intraoperative electrical factors that could potentially serve as electroprognostic indicators of long-term facial function. The utility of testing in this manner may have a profound impact on how to counsel patients with immediate postoperative paresis and an anatomically preserved facial nerve. In contrast to facial nerve monitoring, the role of ICNM for hearing preservation is less well defined and is not uniformly used. This may be the result of a more technically challenging and cumbersome process than what is required with facial nerve monitoring. There is a need to assess the existing literature for VS surgery outcomes, specifically as it relates to the use of ICNM and its impact on postoperative facial nerve function and hearing preservation.

METHODS

The PubMed, Embase, and Web of Science databases were queried. The keywords used during our search of the medical literature databases cited above are documented in Table 1 (https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4/table1) and Table 2 (https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4/table2).

ABBREVIATIONS: **CMAP**, compound muscle action potential; **DENM**, direct eighth cranial nerve monitoring; **EMG**, electromyogram; **ICNM**, intraoperative cranial nerve monitoring; **SMS**, supramaximal stimulation; **VS**, vestibular schwannoma

Facial Nerve Monitoring

The search of 3 databases yielded a total of 2853 candidate articles. A total of 1984 remained after duplicates were removed and date range criteria were applied. The abstracts were reviewed, and after the general and specific inclusion/exclusion criteria were applied, 21 articles remained and were included in the final analysis (Table 1 [https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4/table1] and Figure 1 [https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4/figure1]).

Cochlear Nerve Monitoring

The search of 3 databases yielded a total of 1849 articles. A total of 803 remained after duplicates were removed and date range criteria applied. The abstracts were reviewed, and after the general and specific exclusion criteria were applied, 7 articles remained and were included in the final analysis (Table 2 [https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4/table2] and Figure 2 [https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_4/figure2]).

Refer to full text for comprehensive list of the inclusion and exclusion criteria applied.

RESULTS

Facial Nerve Monitoring

Level 3 data suggest the use of ICNM of the facial nerve during VS surgery leads to better facial function outcomes. Level 3 data do not support the use of specific electroprognostic criteria to reliably predict *poor* facial function after VS surgery. Although a handful of parameters were presented as potential predictors, none had strong predictive value or were powered to do so. The strongest argument against using electrical markers as predictors for *poor* function was based on the observation that patients with electrical silence, or absent responses at the end of surgery, did not necessarily develop a permanent facial paralysis. Whereas several markers can be reliably used to predict *good* facial function, the ability to predict poor function is still limited. Since we cannot reliably predict poor long-term facial nerve function, early facial reanimation should not be employed unless nerve transection is certain.

Cochlear Nerve Monitoring

Level 3 evidence supports the use of intraoperative cochlear nerve monitoring in hearing preservation VS surgery. The most common method employed was auditory brainstem response. The presence or characteristics of Wave I and V, as well as the cochlear compound action potential (CAP), were the most useful parameters discussed. The biggest challenge with neuromonitoring of the cochlear nerve involves the technical aspects and delayed feedback. Auditory brainstem response is plagued by delay issues due to the data averaging that is required to assess changes in function. To circumvent this, direct cochlear nerve monitoring has been used instead. The technical requirements and challenges of performing direct cochlear nerve monitoring, however, were made apparent in various reports. They range from the inability to place electrodes at the nerve root exit zone prior to tumor resection, to the difficulty in keeping the probes in place throughout the duration of surgery or securing the probe without causing iatrogenic damage to the nerve. Finally, factors such as the presence of excess cerebrospinal fluid or blood, the stimulation voltage used to elicit responses, or the interference of electrocautery stimuli have all been reported to alter responses and the interpretation of results.

DISCUSSION AND CONCLUSION

The benefit of using ICNM in VS surgery is supported in this analysis. Despite the best of surgical techniques and electrophysiology equipment, surgical outcomes are still bound by tumor characteristics, such as size. Large tumors are more likely to result in facial paralysis and hearing loss when compared to small tumors. As technology continues to evolve and the comfort level of surgical teams continues to improve, clinicians will hopefully learn more about specific parameters that will help as reliable prognosticators of function. Although several factors were discussed in this review, the sensitivity and specificity profile of each will need to be validated and reproduced in future studies. More prospective analyses will be needed to help with this endeavor.

Disclosure

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Neurological Surgeons, and the American Association of Neurological Surgeons, which received no funding from outside commercial sources to support the development of this document.

Conflict of Interest

The Vestibular Schwannoma Guidelines Task Force members were required to report all possible COIs prior to beginning work on the guideline, using the COI disclosure form of the AANS/CNS Joint Guidelines Committee, including potential COIs that are unrelated to the topic of the guideline. The CNS Guidelines Committee and Guideline Task Force Chair reviewed the disclosures and either approved or disapproved the nomination. The CNS Guidelines Committee and Guideline Task Force Chair are given latitude to approve nominations of Task Force members with possible conflicts and address this by restricting the writing and reviewing privileges of that person to topics unrelated to the possible COIs. The conflict of interest findings are provided in detail in the full-text introduction and methods manuscript (https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_1).

Disclaimer of Liability

This clinical systematic review and evidence-based guideline was developed by a multidisciplinary physician volunteer task force and serves as an educational tool designed to provide an accurate review of the subject matter covered. These guidelines are disseminated with the understanding that the recommendations by the authors and consultants who have collaborated in their development are not meant to replace the individualized care and treatment advice from a patient's physician(s). If medical advice or assistance is required, the services of a competent physician should be sought. The proposals contained in these guidelines may not be suitable for use in all circumstances. The choice to implement any particular recommendation contained in these guidelines must be made by a managing physician in light of the situation in each particular patient and on the basis of existing resources.

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