

# Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines on the Role of Radiosurgery and Radiation Therapy in the Management of Patients With Vestibular Schwannomas

Isabelle M. Germano, MD\*  
 Jason Sheehan, MD, PhD‡  
 Johnathan Parish, MD§  
 Tyler Atkins, MD¶  
 Anthony Asher, MD¶  
 Constantinos G. Hadjipanayis, MD, PhD\*  
 Stuart H. Burri, MD||  
 Sheryl Green, MBCh#  
 Jeffrey J. Olson, MD\*\*

\*Department of Neurological Surgery, Icahn School of Medicine at Mount Sinai, New York, New York; ‡Department of Neurological Surgery, University of Virginia, Charlottesville, Virginia; §Department of Neurosurgery and Spine, Carolinas Medical Center, Charlotte, North Carolina; ¶Carolina Neurosurgery & Spine Associates, Charlotte, North Carolina; ||Department of Radiation Oncology, Levine Cancer Institute, Charlotte, North Carolina; #Department of Radiation Oncology, Icahn School of Medicine at Mount Sinai, New York, New York; \*\*Department of Neurosurgery, Emory University School of Medicine, Atlanta, Georgia

Sponsored by: Congress of Neurological Surgeons (CNS) and the Section on Tumors.

Endorsed by: Joint Guidelines Committee of the American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons (CNS).

No part of this article has been published or submitted for publication elsewhere.

**Correspondence:**

Isabelle M. Germano, MD,  
 Department of Neurological Surgery Box 1136,  
 Icahn School of Medicine at Mount Sinai,  
 One G. Levy Place,  
 New York, NY 10029.  
 E-mail: [isabelle.germano@mountsinai.org](mailto:isabelle.germano@mountsinai.org)

Received, August 10, 2017.

Accepted, October 2, 2017.

Copyright © 2017 by the Congress of Neurological Surgeons

## RADIOSURGERY VS OBSERVATION

**Question:** What are the indications for stereotactic radiosurgery (SRS) treatment vs observation for patients with intracanalicular vestibular schwannomas without evidence of radiographic progression?

**Recommendation:** Level 3: If tinnitus is not observed at presentation, it is recommended that intracanalicular vestibular schwannomas and small tumors (<2 cm) without tinnitus be observed as observation does not have a negative impact on tumor growth or hearing preservation compared to treatment.

## RADIOSURGERY TECHNOLOGY

**Question:** Is there a difference in outcome based on radiosurgery equipment used: Gamma Knife (Elekta, Stockholm, Sweden) vs linear accelerator-based radiosurgery vs proton beam?

**Recommendation:** There are no studies that compare 2 or all 3 modalities. Thus, recommendations on outcome based on modality cannot be made.

## RADIOSURGERY TECHNIQUE

**Question:** Is there a difference in outcome based on the dose delivered?

**Recommendation:** Level 3: As there is no difference in radiographic control using different doses, it is recommended that for single fraction SRS doses, <13 Gy be used to facilitate hearing preservation and minimize new onset or worsening of preexisting cranial nerve deficits.

**Question:** Is there a difference in outcome based on the number of fractions?

**Recommendation:** As there is no difference in radiographic control and clinical outcome using single or multiple fractions, no recommendations can be given.

## RADIOGRAPHIC FOLLOW-UP, RETREATMENT, AND TUMORIGENESIS AFTER RADIOSURGERY

**Question:** What is the best time sequence for follow-up images after SRS?

**Recommendation:** Level 3: Follow-up imaging should be obtained at intervals after SRS based on clinical indications, a patient's personal circumstances, or institutional protocols. Long-term follow-up with serial magnetic resonance imagings to evaluate for recurrence is recommended. No recommendations can be given regarding the interval of these studies.

**Question:** Is there a role for retreatment?

**Recommendation:** Level 3: When there has been progression of tumor after SRS, SRS can be safely and effectively performed as a retreatment.

**Question:** What is the risk of radiation-induced malignant transformation of vestibular schwannomas treated with SRS?

**Recommendation:** Level 3: Patients should be informed that there is minimal risk of malignant transformation of vestibular schwannomas after SRS.

**NEUROFIBROMATOSIS TYPE 2****Question:** What are the indications for SRS in patients with neurofibromatosis type 2?**Recommendation:** Level 3: Radiosurgery is a treatment option for patients with neurofibromatosis type 2 whose vestibular schwannomas are enlarging and/or causing hearing loss.The full guideline can be found at: [https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter\\_7](https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_7).**KEY WORDS:** Fractionated radiotherapy, Gamma Knife, LINAC, Proton beam, Radiation, Radiosurgery, Vestibular schwannoma*Neurosurgery* 00:1–3, 2018

DOI:10.1093/neuros/nyx515

www.neurosurgery-online.com

There is a growing body of evidence that vestibular schwannomas (VSs) can be controlled by radiosurgery. However, the appropriate time of treatment, the treatment modality (Gamma Knife [GK; Elekta, Stockholm, Sweden], linear accelerator [LINAC]-based, and proton beam), scheme (single fraction [SRS], hypo- or hyperfractionation [SRT], or conventional fractionation), dose, and post-treatment follow-up is still a matter of debate. This guideline was created to provide guidance on the use of radiation therapy for these tumors based on the data present in the literature. As for most topics, the soundness and usefulness of this data varies, depending on study design and how the data were collected. The aim of this study is to generate evidence-based guidelines for the use of radiation therapy and radiosurgery for patients with VSs.

**METHODS**

Details of the systematic literature review are provided in the full text of this guideline ([https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter\\_7](https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_7)) and within the methodology article ([https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter\\_1](https://www.cns.org/guidelines/guidelines-management-patients-vestibular-schwannoma/chapter_1)) of this guideline series. The task force collaborated with a medical librarian to search for articles published from January 1, 1990 to December 31, 2014. Two electronic databases, PubMed and the Cochrane Library, were searched. Strategies for searching electronic databases were constructed by the evidence-based clinical practice guideline task force members and the medical librarian using previously published search strategies to identify relevant studies. The selected studies were classified according to criteria for evidence on therapeutic effectiveness as detailed in the Joint Guidelines Committee

**ABBREVIATIONS:** CT, computed tomography; GK, Gamma Knife; GR, Gardner–Robertson hearing scale; LINAC, linear accelerator; MRI, magnetic resonance imaging; NF2, neurofibromatosis type 2; PTA, pure tone average; SRS, stereotactic radiosurgery; SRT, stereotactic radiotherapy; VSs, vestibular schwannomas

guideline development methodology (<https://www.cns.org/guidelines/guideline-procedures-policies/guideline-development-methodology>).

**RESULTS**

The primary search identified 956 articles. Duplicates and non-English studies were removed (n = 22). Abstracts were excluded based on predefined study criteria and subject relevance (n = 15). Full-text articles were excluded based on predefined study criteria and subject relevance (n = 762). In total, 137 articles met the inclusion criteria, which resulted in 6 level 3 recommendations.

**CONCLUSIONS**

SRS and SRT play a role in the management of patients with VS and in patients with neurofibromatosis 2 and VS. Only class III evidence studies are currently available to formulate our guidelines. National and international prospective quality registries and clinical trials are currently ongoing and such efforts have the potential to define national patterns of care in radiosurgery, with a focus toward improving health care outcomes, supporting informed decision making, and potentially lowering the cost-of-care delivery to patients.

**Disclosure**

These evidence-based clinical practice guidelines were funded exclusively by the Congress of Neurological Surgeons and the Tumor Section of the Congress of 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](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.

### Acknowledgments

The authors acknowledge the Congress of Neurological Surgeons Guidelines Committee for its contributions throughout the development of the guideline and the American Association of Neurological Surgeons/Congress of Neurological Surgeons Joint Guidelines Committee for its review, comments, and suggestions throughout peer review, as well as Trish Rehring, MPH, CNS Guidelines Senior Manager, and Mary Bodach, MLIS, for her assistance with the literature searches. Throughout the review process, the reviewers and authors were blinded from one another. At this time, the guidelines task force would like to acknowledge the following individual peer reviewers for their contributions: Sepideh Amin-Hanjani, MD, D. Ryan Ormond, MD, Andrew P. Carlson, MD, Kimon Bekelis, MD, Stacey Quintero Wolfe, MD, Chad W. Washington, MD, Cheerag Dipakkumar Upadhyaya, MD, and Mateo Ziu, MD.