Vestibular Schwannoma Radiosurgery

- Failure of gamma knife radiosurgery for sporadic vestibular schwannomas: a systematic review and meta-analysis
- Producing high quality cranial SRS plans with 4Pi planning technique in a commercial clinical solution
- Tumor-targeted Gamma Knife radiosurgery in patients with trigeminal neuralgia secondary to benign tumors
- Impact of Vestibular Schwannoma Management on Cochlear Implant Programming and Outcomes
- Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines Update for the Role of Imaging in the Management of Patients With Vestibular Schwannomas
- Congress of Neurological Surgeons Systematic Review and Evidence-Based Guideline on Hearing Preservation Outcomes in Patients With Sporadic Vestibular Schwannoma: Update
- Congress of Neurological Surgeons Systematic Review and Evidence-Based Guideline on the Role of Radiosurgery (Stereotactic Radiosurgery) and Radiation Therapy in the Management of Patients With Vestibular Schwannomas: Updates
- Congress of Neurological Surgeons Systematic Review and Evidence-Based Guideline on Surgical Resection for the Treatment of Patients With Vestibular Schwannomas: Update

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Radiosurgery for vestibular schwannoma, often performed using technologies like **Gamma Knife** or **CyberKnife**, is a non-invasive treatment option that delivers targeted radiation to the tumor. This approach aims to stop or slow the growth of the tumor while minimizing damage to surrounding healthy tissue. Radiosurgery is particularly useful for patients who may not be ideal candidates for traditional surgery or who prefer a less invasive option.

In 2017 There are no randomized trials to help guide management of patients with vestibular schwannoma. Within the limitations of the retrospective series, a number of consensus statements were made [1)].

Indications for Radiosurgery in Vestibular Schwannoma

Radiosurgery is typically considered for patients with:

- **Small to medium-sized tumors** (typically less than 3 cm in diameter).
- **Minimal symptoms** or patients who prioritize preservation of hearing and balance.
- Tumors that are **slow-growing** and do not cause significant brainstem compression.
- Patients who have **medical conditions** that make traditional surgery high-risk.
- Patients who have had prior surgery or those with residual tumor after surgical resection.

Procedure Overview

1. Planning and Imaging

1. High-resolution MRI or CT imaging is performed to precisely locate the tumor.
2. The radiosurgery team creates a detailed plan to direct radiation beams accurately to the tumor.

2. Radiation Delivery

1. Radiosurgery involves a single or a few high-dose radiation treatments delivered in an outpatient setting.
2. Technologies like Gamma Knife use multiple radiation beams converging on the tumor, providing a focused dose while sparing nearby tissues.
3. CyberKnife offers flexibility with multiple treatment sessions (fractionated radiosurgery) if needed.

3. Targeted Treatment

1. The radiation damages the DNA of the tumor cells, stopping them from dividing and effectively halting tumor growth.
2. Radiosurgery does not immediately shrink the tumor but prevents it from growing over time.

Benefits of Radiosurgery

- **Minimally Invasive**: Does not require an incision or general anesthesia.
- **Preserves Quality of Life**: Offers a high chance of preserving hearing and facial nerve function, depending on tumor size and location.
- **Outpatient Procedure**: Typically performed on an outpatient basis with minimal recovery time.
- **Effective Growth Control**: Studies show that radiosurgery can control tumor growth in up to 90-95% of cases.

Risks and Side Effects

Although radiosurgery is less invasive than traditional surgery, it does have potential side effects:

- **Hearing Loss**: Some patients may experience progressive hearing loss, depending on tumor size and prior hearing function.
- **Balance Issues**: Some may notice temporary dizziness or balance changes.
- **Facial Nerve Effects**: Rarely, patients may experience facial numbness or weakness.
- **Delayed Effects**: Swelling or radiation necrosis may occur in rare cases months or years after treatment.

Follow-Up and Monitoring

1. After radiosurgery, patients undergo regular MRI scans to monitor the tumor for any changes.
2. Hearing, balance, and facial nerve function are also monitored over time, as delayed effects can still occur.

Outcomes and Prognosis

Radiosurgery has a high rate of success in stabilizing vestibular schwannoma growth, making it an excellent option for patients who prefer a non-invasive approach or cannot undergo surgery. With proper follow-up and monitoring, most patients experience effective tumor control with preserved quality of life.

Vestibular schwannoma radiosurgery is equally effective for younger and older patients. Complications other than hearing deterioration are uncommon. However, malignant transformation is possible, and long-term post-SRS surveillance MRI is important. These data are useful for decision-making involving young adults with VSs [2].

It is an important management option for patients with small- and medium-sized vestibular schwannomas.

Stereotactic radiotherapy techniques aim to control tumor growth with minimal toxicity. Stereotactic radiosurgery (SRS) using either a cobalt unit or a linear accelerator has given high rates of tumor control and of cranial nerve function preservation with marginal doses range of 12-14 Gy. Fractionated stereotactic radiotherapy (FSRT) is optimal for tumors larger than 3 cm. Doses as low as 50.4 Gy provide excellent control rates and low morbidity. Overall, both SRS and FSRT are equally effective and safe options for neuroma patients who do not need immediate surgical decompression [3].

Vestibular schwannoma Gamma Knife radiosurgery

see Vestibular schwannoma Gamma Knife radiosurgery

Fractionated stereotactic radiotherapy for vestibular schwannoma

see Fractionated stereotactic radiotherapy for vestibular schwannoma (FSRT).

A study provides a valuable investigation into how microvascular risk factors might influence outcomes following vestibular schwannoma radiosurgery. By assessing a large cohort of 749 patients

treated between 2000 and 2022, the study explores the connections between microvascular risk factors—like hypertension, smoking, obesity, and coronary bypass history—and the efficacy and side effects of SRS [4)]

Strengths

1. **Large Sample Size and Cohort Design**: The authors reviewed a substantial cohort of 749 patients across two decades. This sample size enhances the reliability and generalizability of findings, especially when considering the rare nature of VS.

2. **Specific Risk Factors Analysis**: The study dives into specific microvascular risk factors, evaluating how each may impact tumor control and adverse outcomes such as facial nerve paresis and hearing loss. This approach allows for a nuanced understanding of the multifactorial risks associated with SRS in VS treatment.

3. **Clinical Relevance for Patient Counseling**: The findings offer practical implications for clinical counseling. For example, identifying smoking as a risk factor for accelerated hearing loss and hypertension as a predictor for facial nerve weakness can help clinicians guide patients more effectively regarding the potential risks of SRS based on individual health backgrounds.

4. **Statistical Approach**: The use of Cox proportional hazards regression to assess associations and the adjustment for variables like age and ipsilateral hearing status in hearing loss analysis provide a robust statistical foundation, increasing the validity of the results.

Limitations

1. **Lack of Mechanistic Insight**: While the study identifies correlations between microvascular risk factors and SRS outcomes, it does not provide insights into the biological mechanisms. The authors hypothesize that microvascular hyalinization and ischemia could play a role in VS tumor control, yet no direct evidence is presented.

2. **Limited Data on Tumor Control**: Despite a detailed investigation of complications, the study lacks significant findings regarding tumor control in relation to microvascular risk factors. This could be due to limited follow-up on tumor growth or insufficient sensitivity of the study to detect such associations, limiting the applicability of the findings to tumor management.

3. **Potential Confounding Factors**: Although the study adjusts for age and ipsilateral hearing status, other potential confounding factors such as overall health status, treatment modalities prior to SRS, and specific lifestyle factors were not discussed in detail, which might influence outcomes like hearing loss or facial nerve complications.

4. **Limited Generalizability Beyond the Study Setting**: Conducted within a single tertiary academic center, results might not fully represent diverse patient populations, especially those managed in non-academic or smaller medical centers where treatment protocols may differ.

Conclusion

This study makes a notable contribution to understanding how microvascular risk factors may affect specific outcomes following SRS for sporadic VS. The association of hypertension and coronary artery bypass surgery history with facial nerve paresis, as well as smoking history with accelerated hearing loss, provides valuable insights for clinical decision-making and patient counseling. However, limitations in mechanistic insight and generalizability, as well as the lack of significant findings on

tumor control, suggest the need for further research. Future studies could benefit from exploring the biological mechanisms at play and expanding data collection across multiple centers for broader applicability.

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Tsao MN, Sahgal A, Xu W, De Salles A, Hayashi M, Levivier M, Ma L, Martinez R, Régis J, Ryu S, Slotman BJ, Paddick I. Stereotactic radiosurgery for vestibular schwannoma: International Stereotactic Radiosurgery Society (ISRS) Practice Guideline. J Radiosurg SBRT. 2017;5(1):5-24. PMID: 29296459; PMCID: PMC5675503.
2)
Kawashima M, Hasegawa H, Shin M, Shinya Y, Katano A, Saito N. Outcomes of stereotactic radiosurgery in young adults with vestibular schwannomas. J Neurooncol. 2021 Jul 9. doi: 10.1007/s11060-021-03803-w. Epub ahead of print. PMID: 34241770.
3)
Kalogeridi MA, Kougioumtzopoulou A, Zygogianni A, Kouloulias V. Stereotactic radiosurgery and radiotherapy for acoustic neuromas. Neurosurg Rev. 2019 Apr 13. doi: 10.1007/s10143-019-01103-6. [Epub ahead of print] Review. PubMed PMID: 30982152.
4)
Dornhoffer JR, Babajanian EE, Khandalavala KR, Marinelli JP, Daher GS, Lohse CM, Link MJ, Carlson ML. Associations of Microvascular Risk Factors with Sporadic Vestibular Schwannoma Outcomes Following Stereotactic Radiosurgery. Otolaryngol Head Neck Surg. 2024 Nov 7. doi: 10.1002/ohn.1038. Epub ahead of print. PMID: 39506614.