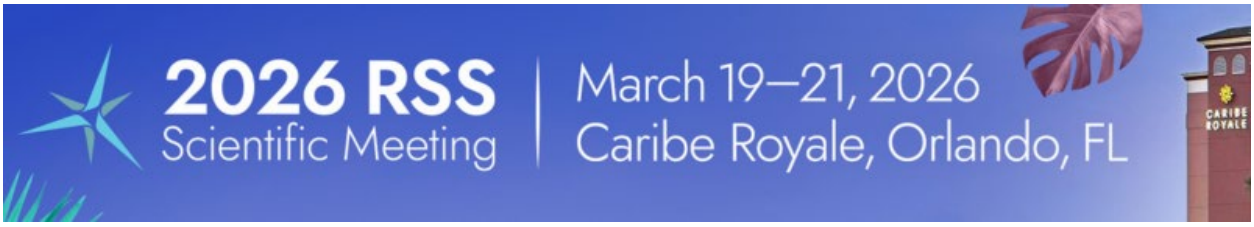

Volumetric Outcomes of Hypofractionated Gamma Knife Stereotactic Radiosurgery for Koos Grade III and IV Vestibular Schwannomas: A Comparative Analysis

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Objectives: The management of vestibular schwannomas (VS) is evolving with improvements in stereotactic radiosurgery (SRS). Hypofractionated SRS offers a radiobiologically advantageous approach compared to single-fraction SRS, potentially enhancing tumor control while minimizing treatment-related toxicity. This study aims to evaluate volumetric and clinical outcomes following hypofractionated Gamma Knife SRS (GKRS) for Koos grade III and IV VS and to compare them with single-fraction GKRS in a consecutive cohort.

Methods: A retrospective analysis of all patients with Koos grade III–IV VS treated with hypofractionated or single-fraction GKRS between 2014 and 2024 was performed. Minimum follow-up was 6 months. Hypofractionated regimens included 18 Gy/3 fractions or 25 Gy/5 fractions, while single-fraction patients predominantly received 12 Gy. Tumor volumes were measured pre-treatment and at 6, 18, 24 months, and last follow-up using Brainlab Elements. Statistical analyses were performed with a significance threshold of $p < 0.05$.

Results: Among 77 treated patients, 64 met inclusion criteria (32 per group). Median age was 60 years (IQR 49.0–66.2 years) , with median follow-up of 17.6 months (IQR 6.9–51.5). A transient mean volumetric increase was observed at 6 months (+3.45%), followed by consistent regression at 18 months (–7.14%) and 24 months (–28.13%). At the final follow-up (median 66.5 months), tumors had a mean reduction of –57.97%. Tumor control was 100%, as no patient required further intervention. Volumetric evolution and control rates remained comparable between hypofractionated and single-fraction groups. Symptomatic improvement was significantly greater in the hypofractionated cohort (37.5% vs 12.5%, $p = 0.043$), particularly among patients with larger baseline volumes. No significant differences in adverse effects were detected; 3 patients (4.7%) required CSF shunt placement.

Subgroup analysis showed small tumors (< 2 cc) exhibited transient growth at early follow-up, while larger tumors demonstrated greater long-term regression. Cystic and solid tumors displayed similar volumetric and functional outcomes. Patients with prior microsurgical resection (37.5%) achieved equivalent tumor control and symptom relief, despite having larger tumors and higher Koos grades at baseline.

Conclusion(s): Hypofractionated GKRS achieves comparable volumetric reduction and tumor control to single-fraction GKRS in Koos grade III–IV vestibular schwannomas, with improved symptom relief and no increase in complications. These findings support hypofractionated GKRS as an effective and safe treatment modality for these type of tumors.