

## Long-Term Volumetric Response of Koos Grade 3 and 4 Vestibular Schwannomas Treated with Gamma Knife Stereotactic Radiosurgery

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Abstract

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### Abstract

#### Objectives:

The management of vestibular schwannomas (VS) is undergoing significant changes. Stereotactic Radiosurgery (SRS) has demonstrated effective disease control with a low complication rate, particularly for tumors smaller than 3 cm. However, increasing interest surrounds the potential of SRS to induce tumor shrinkage in larger lesions. The objectives of this study are: 1) to evaluate the volumetric response of Koos grade 3 and 4 VS at 6, 18, and 24 months post-Gamma Knife SRS (GKRS); and 2) to compare the efficacy of upfront GKRS versus adjuvant GKRS after surgical resection.

#### Methods:

We retrospectively analyzed demographic, clinical, and volumetric data from patients with Koos grade 3 and 4 VS treated consecutively at a single institution between March 2014 and December 2021, with a minimum follow-up of 2 years. Both definitive (upfront GKRS) and adjuvant (post-surgical) cases were included. All treatment was delivered by Gamma Knife platform—Gamma Knife Perfexion (Elekta Solutions AB, Stockholm, Sweden) before May 2018 and Gamma Knife Icon subsequently. Tumor volumes were measured at pretreatment, and during the 6, 18, 24 and last follow-up MRIs. Tumor volumes were measured using GammaPlan software (Elekta Solutions AB). Descriptive and univariate statistical analyses were performed.

Normality of continuous variables was tested using the Shapiro-Wilks test. Continuous variables are displayed as the mean  $\pm$  SD if the variable follows a normal distribution, otherwise they are displayed as the median [interquartile range]. Statistical significance was considered at  $p < 0.05$ . All analyses were performed with R statistical software (version 4.1.2).

#### Results:

In total, 40 patients with Koos grade 3 and 4 vestibular schwannomas were treated in the selected period, of which 26 met the inclusion criteria. The median age was 56.5 years (interquartile range [IQR], 49.8–65.0 years) and the median GKRS dose was 12.0 Gy [12.0–12.5 Gy]. The median pre-GKRS volume was 2.60cc [1.45–4.81cc].

At the 6-month follow-up, a median volume increase of 1.97% [-16.71–25.0%] was observed. Interestingly, there was a non-significant statistical difference in volume between the upfront GKRS and adjuvant GKRS groups (-9.4% vs 16.1%,  $p=0.205$ ), likely due to larger initial tumor volumes in the adjuvant group (2.47 cc vs 4.34 cc,  $p = 0.726$ ).

At 18 months, the mean tumor volume reduction was -6.75% (SD 34.2), and by 24 months, the reduction reached -27.76% (SD 38.7). At the last follow-up, the mean volume reduction was -57.78% [-74.29– -6.27%], with a median follow-up of 72.0 months [46.6–84.1 months].

Interestingly, the most substantial tumor shrinkage occurred after 24 months, with a median reduction of -33.33% [-55.05 – -10.00%] between the 24-month mark and the last follow-up. Notably, the mean tumor reduction between 18 and 24 months post-treatment was -31.21% (SD, 27.2).

Four patients (15.26%) exhibited a tumor volume increase at the last follow up. None of them required

rescue surgery. There was no statistically significant difference between the upfront and adjuvant treated tumors regarding the volume reduction at the latest follow-up.

Regarding the Koos grades, there was a marginally but not significantly increased reduction of the mean percentage volume reduction at 24 months in Koos grade 4 tumors compared to grade 3 ( $-35.25 \pm 36.3\%$  vs  $-4.40 \pm 35.7\%$ ,  $p=0.144$ ). There were no significant differences in outcomes for cystic tumors.

Conclusion(s):

GKRS provides effective long-term volumetric control for Koos grade 3 and 4 vestibular schwannomas, with over 80% of patients experiencing tumor volume reduction. The most significant reduction occurs after 24 months post-treatment, with notable shrinkage beginning around 18 months. In asymptomatic or paucisymptomatic patients with Koos grade 3 and 4 VS, definitive GKRS should be considered a viable alternative to surgery, offering promising disease control and tumor shrinkage.