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## Long-term Outcomes and Patterns of Tumor Progression After Gamma Knife Radiosurgery for Benign Meningiomas.

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### Abstract

**OBJECT:** To characterize the timing and patterns of long-term treatment failure after Gamma Knife radiosurgery (GKRS) for benign intracranial meningiomas. **METHODS:** Data were retrospectively reviewed in 116 patients who underwent 136 GKRS treatments for benign intracranial meningiomas from 1996 to 2004. Patients with atypical or malignant meningiomas were excluded. Surgical resection preceded GKRS in 72 patients (62%). The median tumor volume was 3.4 cm, and the median prescription dose to the 50% isodose line was 16 Gy. **RESULTS:** The median follow-up time was 75 months (range, 4-146 months). Overall tumor control was achieved in 128 of 136 lesions (94%), of which tumor size was stable in 68% and decreased in 26%. Seven patients experienced disease progression in 8 tumors, occurring at a mean time of 90 months. The overall 5-year and 10-year actuarial tumor control rate was 98.9% and 84%, respectively. Characteristics corresponding to tumor progression included insufficient tumor coverage (98% vs 93%,  $P = .007$ ), cavernous sinus lesions, and meningiomatosis. Complications after GKRS developed in 8% of patients, in whom the mean tumor volume was nearly double that in patients with no adverse effects (11 vs 5.7 cm,  $P = .003$ ). **CONCLUSIONS:** GKRS demonstrates excellent long-term tumor control in the management of benign meningiomas. Tumor progression occurred at a mean time of 7.5 years after GKRS, reinforcing the need for long-term surveillance despite initial tumor control. Treatment failure was related to undercoverage of lesions in the majority of cases, with the remainder demonstrating evidence of abnormal tumor biology.

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