

Multivariate and Volumetric Analysis Indicates Robust Tumor Control Following Radiotherapy for Skull Base Meningiomas

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Introduction

Radiation treatment for skull base meningiomas (SBM) is a well-established therapeutic option for tumor control. Stereotactic radiosurgery (SRS) and intensity modulated radiotherapy (IMRT) are commonly used radiation treatments. Tumor control effectiveness in this population has not been well studied, specifically as it relates to tumor volume.

Objective

This study reports a single-center experience in treating SBMs with SRS and IMRT, providing a detailed multivariate analysis of post-treatment outcomes.

Results

20 patients, received radiation treatment for SBMs as primary or adjuvant treatment:

- Mean age of 57 ± 16 years
- 13 patients (65%) were treated with IMRT
- 7 patients (35%) were treated with SRS
- Tumors were primary in 14 patients (30%) and recurrent in 6 (30%).

Radiotherapy characteristics and outcome:

- In the IMRT cohort, 11 patients (85%) received treatment as adjuvant
- In the SRS cohort. 3 patients (43%) received treatment as adjuvant
- No significant difference for age, sex, pre-treatment tumor volume, or tumor grade across radiotherapy cohorts.
- In the IMRT cohort, radiation dosage was 5040 cGy with 28 fractions.
- In the SRS cohort, 5 patients (63%) were treated with 1400 cGy.
- 4 patients experienced post RT complications in the IMRT cohort compared to 1 in the SRS cohort.

Volumetric analysis:

- Mean pre-treatment tumor volume was 5.71 ± 6.19 mL
- Mean residual tumor volume was 3.82 ± 5.39 mL at latest MRI follow-up
- Tumor volume decreased in 17 patients (85%), remained constant in 1 (5%), and increased in 2 (10%), for a tumor control rate of 90%.
- Mean volume reduction was $16 \pm 42\%$ within six months and $34 \pm 36\%$ at latest follow-up.

WHO grade cohort analysis:

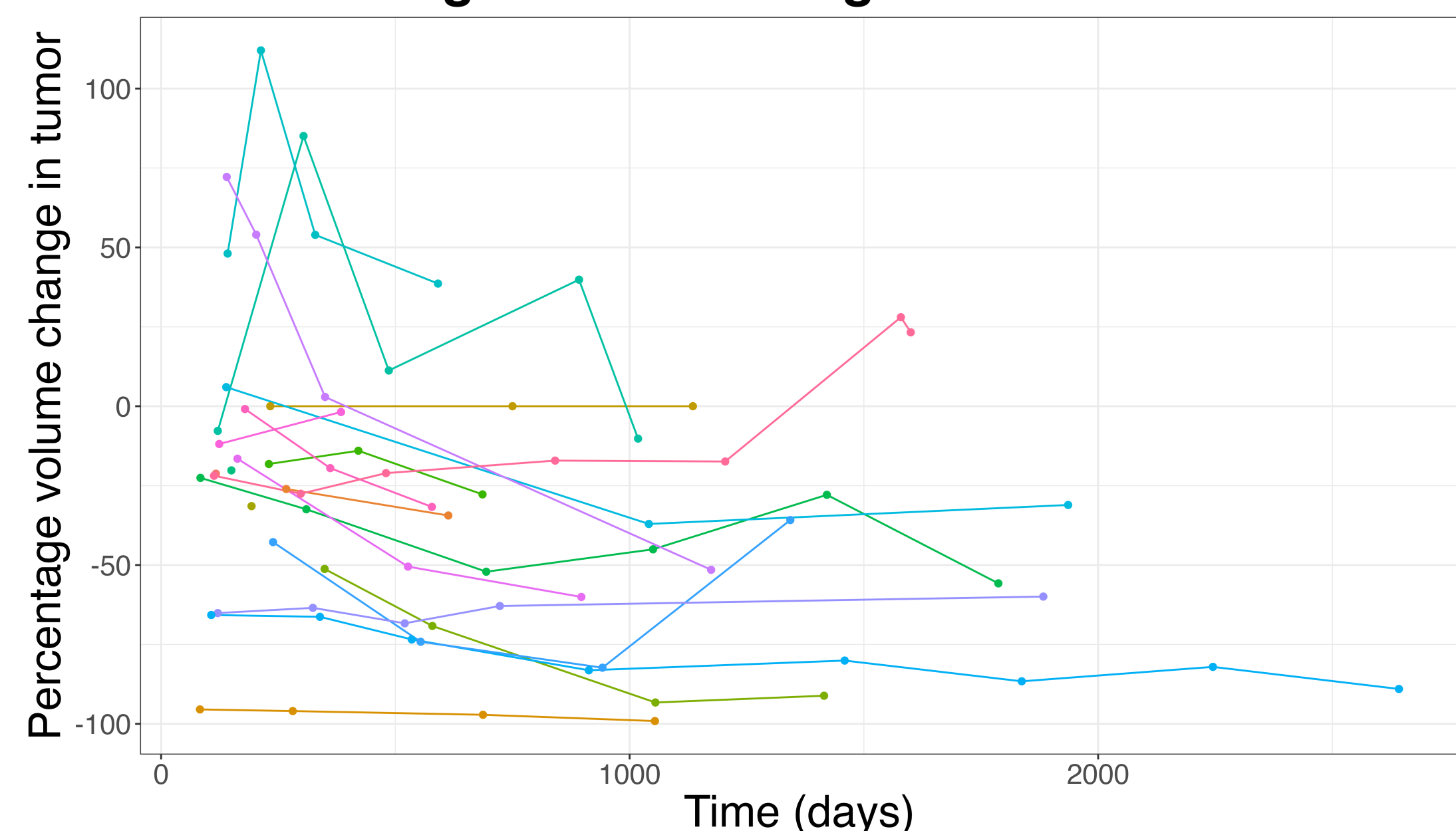
- WHO grade was classified as grade 1 (11 patients) and as grade 2 (2 patients).
- In the grade 1 cohort, tumor size decreased by $40 \pm 32\%$, while grade 2 tumors increased by $31 \pm 11\%$.
- In the grade 1 cohort, 2 patients required resection post radiotherapy for progression of clinical symptoms. In the grade 2 cohort, 1 patient required resection following significant tumor growth and recurrence.

No patients experienced radiation necrosis or mortality at follow-up. Average follow-up was 3.25 ± 1.98 years.

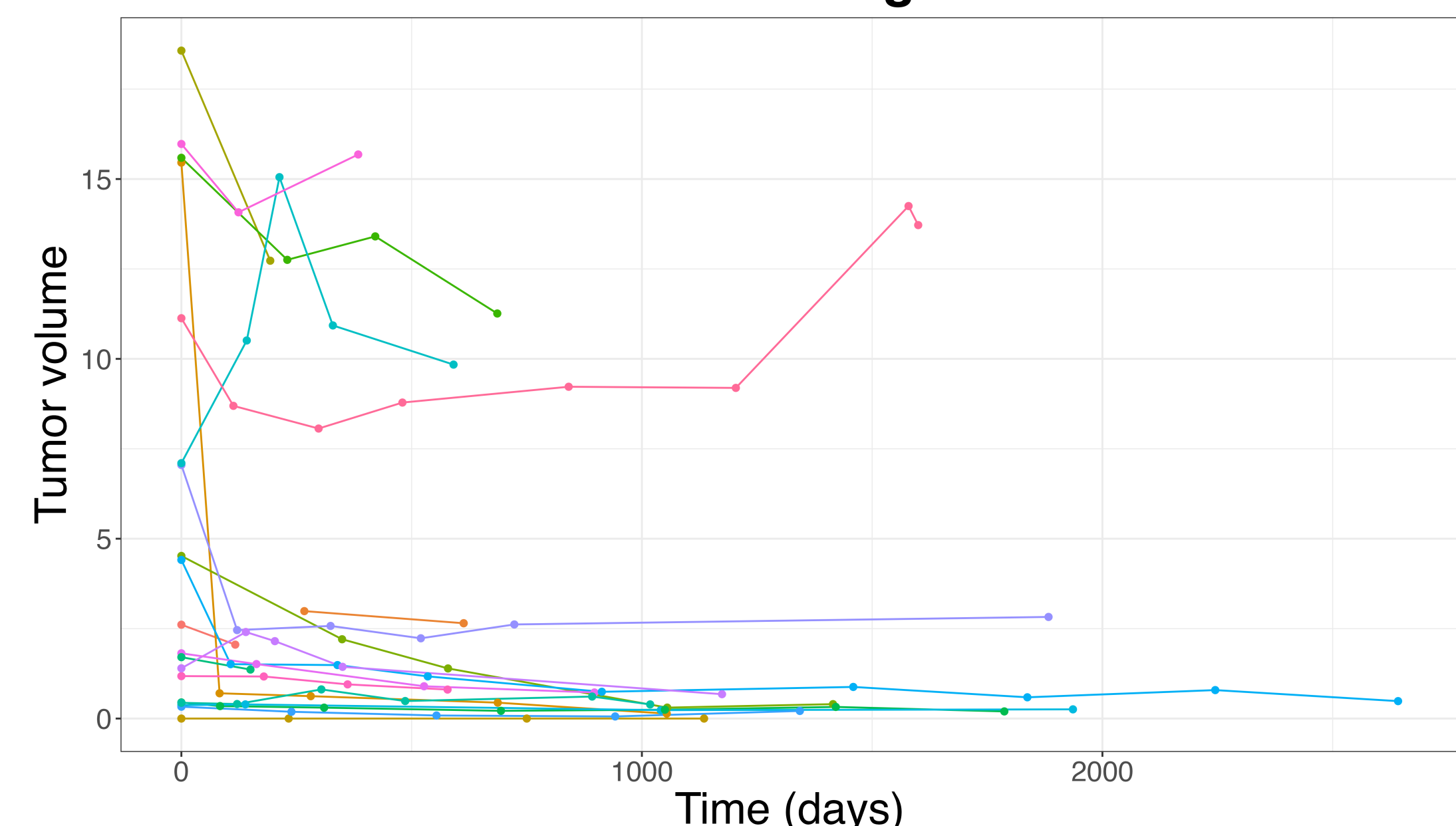
Methods

- Retrospective review queried from a comprehensive high-volume center's institutional database of meningiomas
- Identified 20 patients who underwent radiotherapy for SBMs between 2016 and 2023
- Patient demographics, tumor grading, radiation treatment modality and outcomes were analyzed across long-term follow-up and outcomes.
- Baseline and follow-up tumor volumes were calculated through volumetric 3D rendered semi-automatic segmentation.

Percentage volume change in tumor over time



Tumor volume change over time



Conclusion

- This pilot study examines early trends in SBM to multimodal radiotherapy and provides a detailed volumetric analysis of tumor control. Specifically, we noted that radiotherapy results in initial decrease of tumor size for SBMs, independent of patient demographics, tumor characteristics, treatment type, or dosage.
- Our results support the efficacy and high degree of tumor control achievable with radiotherapy for SBMs, in both primary and adjuvant treatment.
- Grade 2 SBMs, although initially quiescent, grew over time, indicating the need for surveillance and long-term follow-up.
- While these early correlations implicate a role of radiotherapy as providing robust tumor control in SBMs, larger studies are needed to validate this study's analysis and findings.