

# Dosimetric Thresholds Predicting High Risk of Radionecrosis in Gamma Knife Radiosurgery for Cerebral Metastases

Steven L Gogela MD; Yair M. Gozal MD, PhD; John Thaman; Bryan Matthew Krueger MD; Ronald E. Warnick MD

[Institution]



## Introduction

Although Gamma Knife radiosurgery is widely utilized for treatment of cerebral metastases, no study has quantified the risk of RN at higher dose volumes or established thresholds above which the risk of RN is prohibitive.

## Methods

Patients having cerebral metastases treated with stereotactic radiosurgery using the Gamma Knife Perfexion at a single institution who had at least 6 months imaging follow-up were analyzed. RN was diagnosed based on imaging characteristics of serial MRIs, MR spectroscopy and perfusion, and/or histological diagnosis. Multiple clinical and dosimetric variables were analyzed, including V8-V28 Gy dose volumes. The midpoint of the first of two consecutive distributional quantiles with a significant rise in RN was calculated as the threshold volume for increased RN risk.

## Results

Of 92 included patients, 290 lesions were treated to a mean dose of 20 Gy. Mean time of survival or last follow up was 14.8 months. RN was diagnosed in 23 lesions (7.9%); 20 (6.9%) were symptomatic. There was a statistically significant increase in RN risk as the dose volume rose for each measured level (V8-V28). Threshold volumes for significant increase in RN risk were established for all dose volumes. Notable thresholds for total dose volume included: 6.6 cm<sup>3</sup> for V10; 4.8 cm<sup>3</sup> for V12; 1.9 cm<sup>3</sup> for V20; and 0.9 cm<sup>3</sup> for V24. A 20% increase in RN risk was noted for every additional 0.6 cm<sup>3</sup> of V10; 0.4 cm<sup>3</sup> of V12; 0.09 cm<sup>3</sup> of V20; and 0.04 cm<sup>3</sup> of V24.

## Conclusions

While V10 and V12 are commonly monitored during Gamma Knife treatment of cerebral metastases, we have shown that higher dose volumes can be highly predictive of RN. We propose that radiosurgeons avoid exceeding a V12 of 5 cm<sup>3</sup> or V24 of 1 cm<sup>3</sup>, which predict significant risk of RN. Multi-session radiosurgery may be a safer option when these thresholds are reached.

## Learning Objectives

By the conclusion of this session, participants should be able to:

- 1) Recognize the importance of monitoring high dose volumes when assessing a Gamma Knife plan for radionecrosis risk.
- 2) Appreciate the thresholds for V12 and V24 Gy dose volumes, above which the risk of radionecrosis is prohibitive.