



# Quantitative Volumetric Response After Gamma Knife Radiosurgery For Meningiomas

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## Background

~ Meningioma response to Gamma Knife stereotactic radiosurgery (SRS) mainly assessed visually on serial magnetic resonance imaging (MRI) and described as "Larger," "Stable," or "Smaller," which provides little information about the true nature of tumor response.

~ Analysis of actual volume measurements may reflect tumor response more effectively.

## Objective

1. Quantitatively define the early radiobiologic response of meningioma following SRS.
2. Evaluate volumetric response as predictor of long-term tumor control.

## Methods

~ Retrospective chart review of all patients treated with Gamma Knife SRS for meningioma and at least one follow-up image (T1-weighted gadolinium-enhanced MRI) in the electronic record at the University of Pittsburgh from 2002-2010.

~ Volume calculated using the sum of surface areas multiplied by the slice thickness.

~ Primary outcome: progressed (>+15% change), regressed (<-15% change) and stable.

~ Primary predictors: volume percent change from baseline, rate of change, and rate of percent change (below).

~ Statistical analysis: Kruskal-Wallis and Fisher Exact hypothesis tests and multivariate logistic regression to evaluate volume statistics as predictors of progression after adjusting for covariables.

### Calculated Volume Statistics

$$\% \Delta = \left( \frac{vol2 - vol1}{vol1} \right) + 100\%$$

$$Rate = \frac{vol2 - vol1}{time} = \frac{cm^3}{month}$$

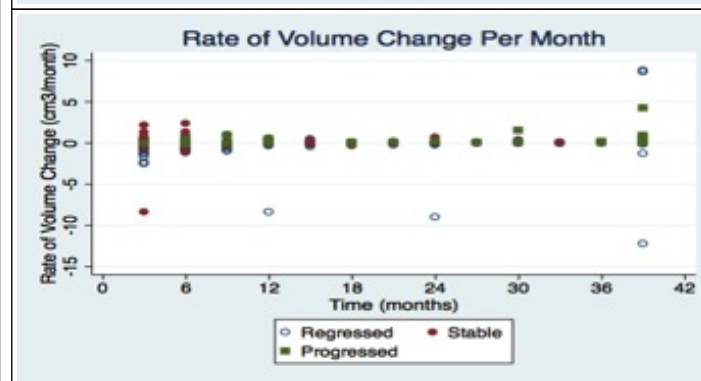
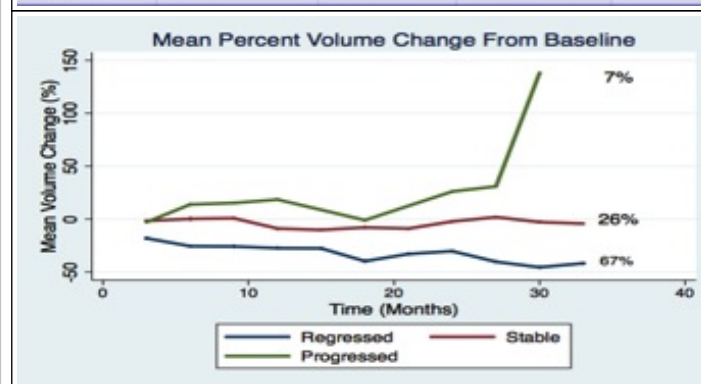
$$\% Rate = \frac{\% \Delta}{time} = \frac{\%}{month}$$

Percent Change (%), Rate of change (cm<sup>3</sup>/month), and rate of % change (%/month)

## Results



	Regress	Stable	Progress	P-value
Age (years)	55.6 ± 15.0	56.6 ± 14.8	62.7 ± 15.6	0.263
Base Volume (cm <sup>3</sup> )	5.24 ± 5.18	6.79 ± 6.84	7.45 ± 8.60	0.482
Final Volume (cm <sup>3</sup> )	3.27 ± 3.65	6.65 ± 6.94	13.88 ± 17.18	<0.001
Final %ΔV	-40.19 ± 16.16	-2.66 ± 8.15	104.23 ± 105.62	<0.001
Follow-up Length (months)	31.0 ± 24.6	18.0 ± 17.4	40.0 ± 25.0	<0.001



## Results

	3 months OR (p-value)	6 months OR (p-value)	12 months OR (p-value)
Base volume (cm <sup>3</sup> )	1.19 (0.221)	1.11 (0.051)	1.29 (0.149)
%ΔV	1.00 (0.993)	1.04 (0.007)	1.20 (0.062)
Absolute Slope (cm <sup>3</sup> /month)	2.35 (0.689)	2.55 (0.227)	460.5 (0.049)
%ΔV Slope (%/month)	0.982 (0.880)	1.18 (0.012)	1.57 (0.118)

## Conclusions

~ Meningioma volume response after SRS is dynamic.  
-Early response may not predict eventual tumor control.

~ Quantitative analysis of tumor response in the first 6-12 months post-SRS may help predict long-term tumor control.

## Limitations

- ~ Retrospective nature limits analysis due to variable follow-up lengths and quality of images
- ~ Selection bias in type of cases referred for SRS
- ~ Intra-rater reliability may be variable

## Implications

~ Quantitative analysis of actual tumor volumes and rates of change following SRS may improve ability to identify early tumor progression or possibility for poor long-term control.

~ Trends in response to SRS may assist in choice of appropriate therapy for meningioma and future management.

## Acknowledgements

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