Outcomes of Ruptured Intracranial Arteriovenous Malformations Treated with Gamma Knife Radiosurgery

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Introduction

Ruptured intracranial arteriovenous malformations (AVM) are at a significantly greater risk for future hemorrhage than unruptured lesions thereby necessitating treatment in the majority of cases. We describe the radiosurgical outcomes for a large cohort of ruptured AVMs.

Methods

From an institutional AVM radiosurgery database, we identified all patients with a history of AVM rupture. Those with less than 2 years radiologic follow-up were excluded except those with obliteration resulting in 565 ruptured AVM patients for analysis with a median radiologic follow-up of 57 months.

The patients' median age was 29 years, and 21% underwent pre-radiosurgery embolization. The median volume and prescription dose were 2.1 cc and 22 Gy, respectively. The Spetzler-Martin grade was III or higher in 56% of patients, the median radiosurgery-based AVM score was 1.08, and the Virginia Radiosurgery AVM Scale (RAS) was 3 to 4 points in 44%.

Results

The cumulative obliteration rate was 76%, and the actuarial obliteration rates were 41% and 64% at 3 and 5 years, respectively.

Actuarial obliteration rate of ruptured AVMs over time

Ding et al., *JNS* 2014. [Epub ahead of print]
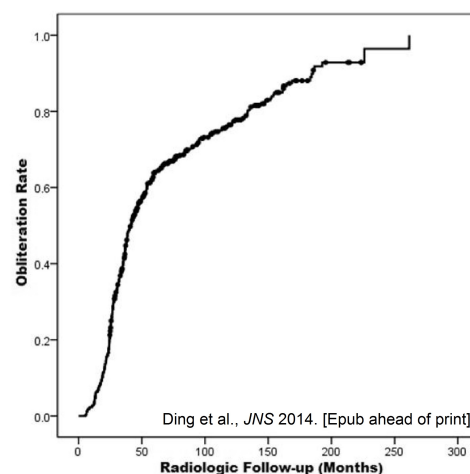
Cohort C Ruptured AVMs	565	212	95	34	6	1	0

Multivariate Cox Proportional Hazards Regression Analysis for Predictors of Obliteration

| Factor | Multivariate | | |
	Hazard Ratio	95% CI	P value
No Pre-radiosurgery Embolization	1.78	1.35-2.35	<0.001*
Increased Prescription Dose	1.05	1.02-1.09	0.001*
Single Draining Vein	1.24	1.00-1.52	0.046*
No Post-radiosurgery Hemorrhage	1.65	1.20-2.45	0.007*
Lower Virginia Radiosurgery AVM Scale	1.19	1.03-1.37	0.020*

The annual risk of latency period hemorrhage was 2.0% with a 1.6% rate of hemorrhage-related morbidity and mortality.

Multivariate Logistic Regression Analysis for Predictors of Post-GKRS Hemorrhage

| Factor | Multivariate | | |
	Odds Ratio	95% CI	P value
Decreased Prescription Dose	1.22	1.10-1.36	<0.001*
Multiple Draining Veins	2.64	1.39-5.01	0.003*

The rates of symptomatic and permanent radiation-induced changes (RIC) were 8% and 2.7%, respectively.

Multivariate Logistic Regression Analysis for Predictors of RIC

| Factor | Multivariate | | |
	Odds Ratio	95% CI	P value
Single Draining Vein	2.53	1.64-3.92	<0.001*
Higher Virginia Radiosurgery AVM Scale	1.34	1.09-1.64	0.005*

Conclusions

Radiosurgery effectively treats ruptured AVMs with an acceptably low risk to benefit ratio. For ruptured AVMs, favorable outcomes are more likely when pre-radiosurgical embolization is avoided and a higher prescription dose can be delivered.

Learning Objectives

By the conclusion of this session, participants should be able to 1) Describe the outcomes of Gamma Knife radiosurgery as a treatment approach for ruptured intracranial arteriovenous malformations, 2) Discuss, in small groups the patient, arteriovenous malformation and treatment characteristics which predict obliteration and radiation-induced changes following radiosurgery, and 3) Identify an effective treatment for ruptured arteriovenous malformations.

References

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