Delayed Arteriovenous Malformation Hemorrhage Following Stereotactic Radiosurgery: Case Series

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Learning Objectives

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

1) Describe the major risks and outcomes of stereotactic radiosurgery in the treatment of arteriovenous malformations
2) Discuss, in small groups, the possible factors associated with hemorrhage following stereotactic radiosurgery
3) Identify the importance of follow-up in patients status post stereotactic radiosurgery

Introduction

Hemorrhage, seizures, cerebral edema, and radiation induced changes remain major complications of stereotactic radiosurgery (SRS) treatment for arteriovenous malformations (AVMs). Patients continue to be at risk for intracranial bleeding following treatment during the latency period to obliteration, with an estimated annual post -SRS hemorrhage rate of 1-2%. We present 10 cases of AVM hemorrhage following SRS, of which one case presented with hemorrhage after complete obliteration.

Methods

A retrospective chart review of all AVM patients admitted between 1993 and 2010 at our institution (Johns Hopkins) was performed. We identified 10 patients diagnosed with AVMs by digital subtraction angiography (DSA), treated with SRS, and subsequently found to have developed hemorrhage after treatment. Patient, AVM, and treatment characteristics were collected and analyzed.

Results

Mean age at time of first treatment was 31.9±17.9 years, with 90% of patients being female (n=9). Forty percent (n=4) of patients initially presented with hemorrhage. Spetzler-Martin grades were: I for 10% of patients, II for 20%, III for 30%, IV for 30%, and V for 10%. The mean prescription dose was 15.1±4.5 Gy, with five patients recieving multiple treatments.

Hemorrhagic events were noted after 11 of the 17 treatments. One patient received two treatments of SRS, and developed a hemorrhage after each dose. Two patients hemorrhaged after receiving three courses of SRS. The interval between SRS and subsequent hemorrhage was 44.2±42.8 months.

Of the 10 patients who hemorrhaged after SRS, eventual AVM obliteration was confirmed in only two. Notably, one patient hemorrhaged 54 months after complete AVM obliteration as confirmed by DSA.

Post-SRS hemorrhage: Patient, AVM, and treatment characteristics

Characteristic	n (%)
Sex (n=10)	
Male	1 (10%)
Female	9 (90%)
Age (n=10)	
Mean	31.9±17.9 yrs
Range	11 - 68 yrs
Presentation (n=10)	
Hemorrhagic	4 (40%)
Non-hemorrhagic	6 (60%)
SM grade (n=10)	
I	1 (10%)
II	2 (20%)
III	3 (30%)
IV	3 (30%)
V	1 (10%)
SRS 1 (n=10)	
Mean	15.5±4.5 Gy (n=8)
SRS 2 (n=5)	
Mean	14.4±3.3 Gy (n=5)
SRS 3 (n=2)	
Mean	13.5±6.4 Gy (n=2)
Hemorrhagic events (n=10)	
SRS 1 → Hem 1	83.3±94.3 months (n=10)
SRS → Hem	44.2±42.8 months (n=11)
Multiple hem	4 (40%)
Complete occlusion (n=10)	4 (40%)
W/surgery	2 (20%)
W/o surgery	2 (20%)
SRS→occlusion	70.5±61.5 months (n=2)

Conclusions

The annual hemorrhage rate following SRS for AVM treatment is estimated to be 1-2%. The timing of such hemorrhage is variable.

Arteriovenous malformation obliteration following SRS treatment has been estimated to be 38-76%. However, we note in patients treated with SRS who subsequently hemorrhaged the likelihood of eventual AVM obliteration was low, and observed in only 20%.

Given the possibility of post-SRS AVM hemorrhage, both during the latency period and even after confirmed angiographic obliteration, close follow-up is warranted for AVMs treated with SRS.

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