Hemorrhage Rate of AVMs After Radiosurgery

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Learning Objectives

By the conclusion of this session, participants should be able to:
1) Understand the rate of AVM hemorrhage and rehemorrhage after radiosurgery
2) Understand the natural history of AVM rehemorrhage
3) Better council patients on the effectiveness of radiosurgery of large AVMs

Introduction

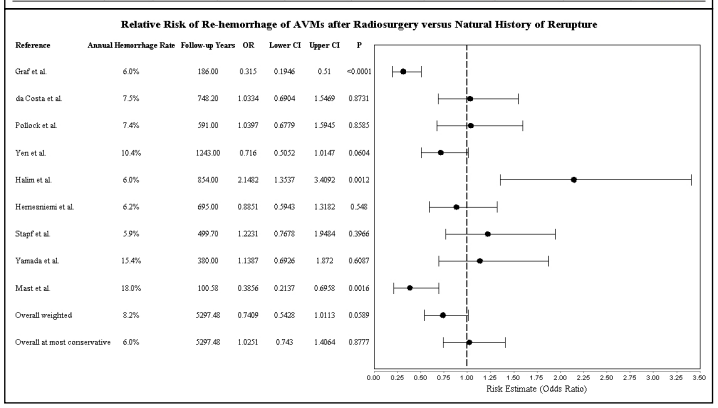
The prognosis of arteriovenous malformations (AVMs) after treatment has been largely predicted by two grading scales: Spetzler-Martin and Pollock-Flickinger. Although there are studies examining hemorrhage rate using the Spetzler-Martin grading scale, there haven't been studies examining hemorrhage rate using the Pollock-Flickinger grading scale. The annual risk of AVM hemorrhage after radiosurgery of Pollock-Flickinger AVM score greater than 2 is analyzed.
AVM score = 0.1*Volume + 0.02*Age + 0.5*Location

Spetzler- Martin Grading Scale			Pollock-Flickinger AVM Score	
Graded Element		Points		Coefficient
Size (diameter)	<3 cm	1	AVM Volume (cm3)	0.1
	3-6 cm	2	Patient Age	0.02
	>6 cm	3	AVM Location	0.5
Location	Non-eloquent	0	Hemispheric/Corpus callosum/Cerebellum	0
	Eloquent	1		
Venous Drainage	Superficial	0	Basal Ganglia/ Thalamus/Brainstem	1
	Deep	1		

Methods

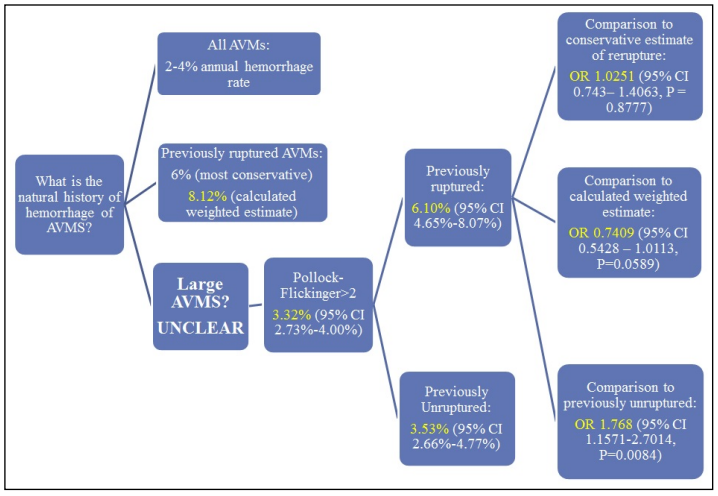
Literature search on PubMed for radiosurgical treatment of AVMs with a score of at least 2 from year 2000-present was conducted. We performed a meta-analysis of the nine papers which reported hemorrhage rate of large AVMs. We then performed a second analysis of six of the papers which separated hemorrhage and rehemorrhage rate. Finally, we compared rehemorrhage rate after radiosurgery through a third analysis to the natural history of rehemorrhage.

Author	Year	Number of Patients	Hemorrhage after treatment	Hemorrhage Rate	Fatalities from hemorrhage (%)	Total Fatalities (%)	Follow up years	Annual Hemorrhage rate	95% CI of annual hemorrhage rate
Kano *et al*	2012	42	9	21.43%	5 (55.56%)	5 (11.90%)	258.3	3.48%	1.85-6.5%
Huang *et al*	2012	18	5	27.78%	1 (20.0%)	1 (5.56%)	108.0	4.63%	1.99%-10.38%
Nagy *et al*	2011	492	69.3	14.09%	35 (50.72%)	35 (7.11%)	2113.0	3.28%	2.59%-4.12%
Amponsah *et al*	2011	5	1	20.00%	0	0	31.9	3.14%	0.56-15.75%
Kim *et al*	2010	44	3	6.82%	0	0	401.1	0.75%	0.26-2.18%
Xiao *et al*	2010	20	1	5.00%	0	0	48.5	2.06%	0.36-10.69%
Chung *et al*	2008	6	1	16.67%	0	0	14.0	7.14%	1.27-3.15%
Bois *et al*	2005	15	3	20.00%	0	0	38.5	7.79%	2.65-20.32%
Pan *et al*	2000	31	10	32.26%	0	1 (3.23%)	67.2	14.89%	8.32-25.35%
Overall		673	102.3	15.20%	41 (40.08%)	42 (6.24%)	3080.5	3.32%	2.73%-4.00%



Results

Annual AVM hemorrhage rate after radiosurgery for all patients (n=673) was 3.32% (95% CI, 2.73%-4.00%). Mortality rate from hemorrhage was 40.08% (41 deaths, 95% CI, 35.54% - 44.62%) and overall mortality rate was 6.24% (42 deaths, 95% CI, 4.65% - 8.33%). Based on information provided, 203 patients presented with hemorrhage and 395 did not. The annual hemorrhage rate of those with hemorrhagic presentation was 6.10% (42.6 re-bleeds, 765.40 follow-up years, 95% CI, 4.65% - 8.07%). In patients who didn't present with hemorrhage, the annual hemorrhage rate was 3.53% (46.7 bleeds, 1205.23 follow-up years, 95% CI, 2.66% - 4.77%). The odds ratio comparing rate of re-hemorrhage versus first-time hemorrhage after radiosurgery is 1.768 (95% CI, 1.1571-2.7014, P = 0.0084). Complete obliteration of AVMs was achieved in 33.27% (95% CI, 29.25%-37.54%).



Conclusions

The annual hemorrhage rate in large AVMs treated with radiosurgery was comparable in this series to the baseline rupture rate reported for untreated AVMs. In addition, separating hemorrhagic versus non-hemorrhagic presentation, subsequent annual hemorrhage rates are similar to respective natural histories. Furthermore, the mortality rate after treatment of large AVMs is significantly higher than that of the natural history.

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