

Characterizing Rates of Post-Radiotherapy Seizure Control in Patients with Arteriovenous Malformations: A Systematic Review and Meta-Analysis

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Abstract

Objectives:

Cerebral arteriovenous malformations (AVMs) are rare, congenital vascular abnormalities with complex angioarchitecture characterized by a nidus and direct arteriovenous shunt that is devoid of capillary beds. These low resistance, high flow lesions can present with hemorrhage or seizures. For small (< 3.5cm), unruptured lesions located in eloquent brain, stereotactic radiosurgery (SRS) is considered an option for treatment as it has been shown to induce AVM obliteration in 60% of cases. However, its potential to induce epileptogenic activity and its effect on AVM-associated seizures are factors that remain less clear. As such, the objective of the present review is to evaluate seizure outcomes following SRS for cerebral AVMs.

Methods:

The PubMed, Scopus, and Web of Science databases were systematically queried according to PRISMA guidelines for primary studies describing new onset seizure, seizure progression and/or seizure freedom following SRS for treatment of patients with AVMs. Gamma Knife (GKRS), linear accelerator (LINAC)-based systems such as CyberKnife, and proton beam therapy (PBT) were considered. Meta-analysis was performed with random effects modeling and p-values < 0.05 were considered statistically significant.

Results:

Of 196 unique articles, 33 studies comprising 4,381 patients were included. Seventy-seven percent (n=3,391) underwent GKRS and 10% (n=411) received hypofractionated radiotherapy delivered via LINAC. The remaining 13% underwent proton beam therapy (PBT). Forty-one percent presented with seizures while 26% experienced seizures post-treatment. Additionally, there were 108 instances of new onset seizure following treatment with SRS. Seizure control – defined as stability, improvement, or complete relief of seizures – was seen in 94.7% of patients. Across all modalities, complete obliteration was described in 65% of patients (1,240/1,909). SRS was not associated with likelihood for seizure freedom post-intervention (p=0.06), though this could have been the result of high reported effect heterogeneity (I²=95%). Among the 1,711 patients with available follow-up data, 730 (42.7%) were seizure-free at last follow-up. Furthermore, seizure frequency remained at pre-intervention levels for 357 (20.9%) patients, and seizure status worsened for 91 (5.3%) patients. Finally, 533 patients (29.6%) exhibited partial improvement.

Conclusion(s):

SRS is a common therapeutic option for the obliteration of small cerebral AVMs presenting in eloquent brain. Prior studies have shown radiographic obliteration in 60% of cases, but seizure outcomes have heretofore been understudied. The present meta-analysis finds that while SRS treatment of AVMs is associated with increased seizure freedom, the correlation is not statistically significant due to significant heterogeneity in the reported literature. Additional, multicenter studies are merited to clarify this effect.