

Seizure Control with Intracranial Arteriovenous Malformations is Directly Related to Treatment Modality: A Meta-analysis

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Introduction

Arteriovenous malformations (AVMs) commonly cause seizures. While the most common presenting scenario is hemorrhage (1), 30-61% of patients experience seizures (2,3). Over the past twenty years, while treatment modalities for AVMs have greatly evolved, no study has compared the efficacy of these modalities to control seizures. The purpose of this metaanalysis is to examine the rates of seizurefreedom and improvement in seizure control following AVM treatment with microsurgical resection (MS), stereotactic radiosurgery (SRS), or endovascular embolization (EVE).

Methods

Studies were identified through an extensive search of MEDLINE, COCHRANE, and EMBASE databases for entries from 1/1/1992 -10/31/2012. All studies that described seizure outcomes and met inclusion/exclusion criteria were included (Table 1). The seizure outcomes following MS, SRS, or EVE interventions were compared.

 Table 1. Inclusion/Exclusion Criteria and Outcome Measures

 Inclusion:

 1. Studies reporting on patients with a clinical history of seizures ascribed to cranial AVMs undergoing MS, SRS, or EVE treatment

 2. Published between 1992 and 2012.

 3. Documentation of "seizure-free" results.

 4. Reporting on 25 cases with seizures.

 Exclusion:

 1. Articles not translated into English.

 2. Failure to provide raw data (e.g. data reported as percentages, but actual numbers are ambiguous 3. Studies that included patients who received multimodality treatments without stratification of seizure outcomes.

 4. Studies describing intracranial vascular maformations other than cranial AVMs.

 Outcome Measures:

 • Artiamment of seizure-free status following treatment

 • Secondary:

 • Improvement in seizure control after treatment

 • AVM obliteration following treatment

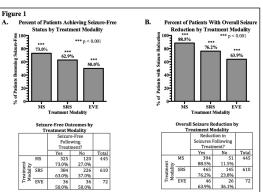
 • AVM obliteration following treatment

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 • AVM nupture status at time of procedure

Results

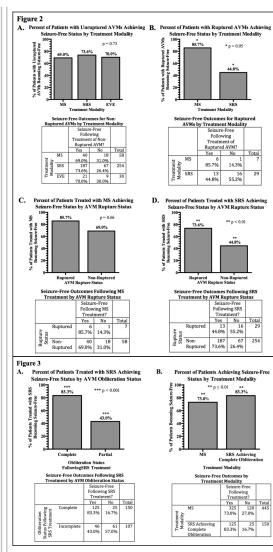
24 studies, with a total 1157 patients, met criteria for inclusion. The MS and SRS groups had significantly higher rates of attainment of seizure-free status than the EVE group: MS 73%, SRS 62.9%, and EVE 50% (p<0.001) (Fig. 1A). MS and SRS treated patients also experienced significantly greater overall reduction in seizure frequency: MS 88.5%, SRS 76.2%, and EVE 63.9% (p<0.001) (Fig. 1B).



Further analysis revealed that the rates of seizure improvement following treatment of unruptured AVMs did not significantly differ among the treatment modalities: MS 69.0%, SRS 73.6%, EVE 70.0% (p=0.73) (Fig. 2A). For ruptured AVMs, despite a limited sample size, our analysis found that the MS group had significantly more seizure-free outcomes compared to SRS group: MS 85.7% and SRS 44.8% (p=0.05) (Fig. 2B).

We also found that while the seizure-free outcomes for MS intervention did not significantly differ depending on the rupture status of the AVM (ruptured: 85.7%; nonruptured: 69.0%; p=0.66), the number of seizure-free outcomes attained following SRS treatment were significantly greater when the AVMs were non-ruptured (ruptured: 44.5%; non-ruptured: 73.6%; p<0.01) (Fig. 2C, D).

Finally, achievement of complete AVM obliteration with SRS therapy correlated with significantly greater rates of attainment of seizure-free status (total obliteration: 83.3%; partial obliteration: 43.0%; p<0.001) (Fig. 3A). This rate of seizure-free attainment surpassed that of the MS treated patients (SRS with total obliteration: 83.3%; MS: 73.0%; p=0.01) (Fig. 3B).



Study Limitations

In addition to the inherent limitations associated with a meta-analysis, our study would have been enhanced by the ability to stratify, evaluate outcomes, and perform multivariate analysis based on patient demographic information, attributes of patient history, or specific qualities of the AVM (size, location, etc.).

Conclusions

1.) This is the first meta-analysis designed to address the relative rates of seizure-free status following MS, SRS, or EVE treatment of AVMs.

2.) Overall, MS and SRS appear to result in greater seizure control following treatment relative to EVE therapy.

3.) Rupture status of the AVM influences the efficacy of the modalities to yield seizure-free results; ruptured AVMs appear best treated by MS while non-ruptured AVMs appear more amendable to all three of the interventions.

4.) The treatment modality that cures the AVM is best correlated with seizure-free outcomes. Microsurgery has the highest rate of achieving this desired outcome initially. However, in patients cured via SRS, rates of seizure-free status were the highest. Thus, complete obliteration of the AVM should be considered a goal of SRS therapy.

5.) Future RCTs are required to further address these issues and would be instrumental in guiding clinical decision making for the treatment of AVMs. Seizure outcomes should be considered an important outcome measure in these studies.

References:

1.) Choi JH, et al., 2005. 2.) Ondra SL, et al., 1990. 3.) Murphy MJ, 1985.

Included Studies: Andrade-Souza et al., 2006; De Los Reyes et al., 2011; Eisenschenk et al., 1998; Englot et al., 2012; Falkson et al., 1997; Gertszten et al., 1996; Hoh et al., 2002; Hyun et al., 2012; Kida et al., 2000; Kurita et al., 1998; Le Feuvre et al., 2007; Lim et al., 2006; Lv et al., 2010; Nagata et al., 2006; Nataf et al., 2003; Piepgras et al., 1993; Schauble et al., 2004; Silander et al., 2004; Steiner et al., 1992; Sutcliffe et al., 1992; Thorpe et al., 2000; Yang et al., 2012; Yeh et al., 1993; Zeller et al., 2011.