Spetzler-Martin Grade III arteriovenous malformations

To The Editor: We read with interest the recent article by Koltz et al. (Koltz MT, Polifka AJ, Saitos A, et al: Long-term outcome of Gamma Knife stereotactic radiosurgery for arteriovenous malformations graded by the Spetzler-Martin classification. Clinical article. J Neurosurg 118:74–83, January 2013). The authors reported their experience of using Gamma Knife stereotactic radiosurgery (SRS) in treating Spetzler-Martin Grade III arteriovenous malformations (AVMs), which pose different surgical risks due to their heterogeneity. The authors concluded that, for patients with Grade III AVMs, SRS offers favorable outcomes that may be comparable with conventional microsurgery.

Grade III AVMs are categorized into 4 types using Spetzler-Martin classification as follows: S1E1V1 (small AVMs < 3 cm in eloquent cortex with deep venous drainage, S2E1V0 (AVMs ranging from 3 to 6 cm in eloquent cortex with superficial drainage), S2E0V1 (AVMs ranging from 3 to 6 cm in noneloquent cortex with deep venous drainage), and S3E0V0 (large AVMs > 6 cm in noneloquent cortex with superficial drainage). Lawton et al. reported that the surgical risks were 2.9% for small AVMs (Type S1E1V1), 7.1% for medium/deep AVMs (S2E0V1), and 14.8% for medium/eloquent AVMs (S2E1V0). They concluded that small Grade III AVMs (S1E1V1) have the lowest surgical risk and can be safely treated with microsurgical resection. Medium/eloquent Grade III AVMs (S2E0V1) have an intermediate surgical risk and require judicious selection for surgery. Medium/eloquent Grade III AVMs (S2E1V0) have a higher surgical risk and are best managed conservatively or with SRS. Davidson and Morgan reported that the risk of adverse outcome due to surgery was as follows: S1E1V1 in 9%, S2E1V0 in 15%, S2E0V1 in 15%, and S3E0V0 in 17%. Pandey et al. recently demonstrated that multimodality management of Grade III AVMs resulted in a high rate of obliteration. They also showed that AVM size correlated with new neurological deficits, whereas an eloquent brain region and venous drainage did not influence this. Therefore, they proposed subclassifying the Grade III AVMs according to their size (< 3 cm and ≥ 3 cm) to account for treatment risk.

In the series by Koltz et al., the obliteration rate following SRS for small (< 3-cm) Grade III AVMs (S1E1V1) was 96%. Of 15 patients with nonhemorrhagic small Grade III AVMs (S1E1V1), SRS yielded an obliteration rate of 100% and morbidity rate of 0%. Therefore, SRS is a reasonable alternative to surgical treatment for unruptured small Grade III AVMs (S1E1V1). Although SRS for the hemorrhagic group of lesions also yielded favorable outcomes, we recommend microsurgical resection for ruptured small Grade III AVMs (S1E1V1). Curative embolization is the therapeutic goal in some centers, but it is considered for selected small Grade III AVMs with specific angioarchitecture.

The authors also described the obliteration rate following SRS for large (≥ 3-cm) Grade III AVMs. However, the obliteration rate in nonhemorrhagic large Grade III AVMs is incorrect. There were 5 survivors with incomplete obliteration in the Grade III group, including 1 patient with hemorrhagic small AVMs, 1 patient with hemorrhagic large AVMs, and 3 patients with nonhemorrhagic large AVMs. Since there was 1 death in this group, the obliteration rate of nonhemorrhagic large AVMs should be 71.4% (10 of 14), not 64% in Table 6. As shown in Table 6, the majority of large (≥ 3-cm) Grade III AVMs in their series were Type S2E1V0. Is the percentage of the nonhemorrhagic group of large Grade III AVMs in eloquent cortex (94%) also in error? Since the role of preradiosurgical embolization continues to be controversial, the authors might provide data for preradiosurgical embolization of large (≥ 3-cm) Grade III AVMs. Some studies have suggested that preradiosurgical nidus embolization is associated with lower obliteration rates compared with SRS alone. This discrepancy might result from several factors. First, residual nidus volume after embolization is significantly correlated to obliteration rate after SRS. In large AVMs, partial embolization is not helpful if the AVM size is not reduced sufficiently. Izawa et al. have reported that the obliteration rate was significantly better if nidus volume after embolization but before SRS was less than 12 ml compared with a nidus volume more than 12 ml. Blackburn et al. have recently suggested that staged embolization sessions are required to achieve a residual AVM volume ≤ 10 ml. Second, embolization might be helpful for SRS only if specific anatomical compartments of the lesion are obliterated. Diffuse embolization of the nidus without reducing the volume does not improve the outcomes. Third, varied embolic agents might affect SRS targeting. In our experience, for large Grade III AVMs in accessible regions, we prefer preoperative embolization to decrease the blood supply to the malformation, thereby enhancing the safety of the operation. For large Grade III AVMs in eloquent regions, we recommend staged embolization to reduce large AVMs to a manageable size that is amenable to radiosurgical ablation. For large Grade III AVMs with a diffuse nidus, or "en passage" feeders, we recommend staged SRS.

In summary, management of Grade III AVMs should be determined on an individual basis, based on size, location, angioarchitecture, and rupture status.

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The authors report no conflict of interest.

References

RESPONSE: We wish to thank Dr. Xu and colleagues for their insightful review of our case series. We wholeheartedly agree that the clinical management of Spetzler-Martin Grade III AVMs remains challenging and that the literature supporting current practices is incomplete. Indeed, a major stimulus prompting our review of outcomes for AVMs treated with Gamma Knife radiosurgery, stratified by the Spetzler-Martin classification, was to better elucidate the role of radiosurgery specifically for Grade III lesions. The microsurgical contribution to the literature, as referenced by Dr. Xu and colleagues, is well respected by us. We hope that our experience will help clinicians to better manage this complex patient population.

In Table 1 we provide the long-term outcomes of our 5 patients who had preradiosurgical embolization of large (> 3-cm) Grade III AVMs. Twenty-percent of these patients (n = 1) presented with hemorrhagic stroke. The average nidus diameter was 5 cm. Each patient had an average follow-up of 8.8 years. Over this period, the obliteration rate was 60% (n = 3) with a mean time to obliteration of 2.7 years; in the other 2 patients there was a substantial although subtotal reduction in lesion volume. There was a 0% rebleed rate after embolization-radiosurgery treatment. The morbidity rate after embolization alone was 20% (n = 1), the result of a retained microcatheter after N-butyl cyanoacrylate injection. The morbidity (seizures, which we consider to be a minor morbidity) after radiosurgery in patients who underwent embolization prior to treatment was 20% (n = 1). This compares favorably to Lawton’s microsurgical morbidity of S2VOE1 lesions of 14.8%. The mortality rate was 0%.

We acknowledge that the number of patients in our series with this specific subtype of AVM and this specific management was low (n = 5). To date, our outcomes have been excellent with correspondingly high patient satisfaction, despite the complex pathology (large lesion located in eloquent cortex). In our experience, patients with Grade III lesions, both hemorrhagic and nonhemorrhagic,

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Nidus Diameter (cm)</th>
<th>AVM Grade (S-V-E)</th>
<th>Treatment Course</th>
<th>Follow-Up (yrs)</th>
<th>Time to Obliteration If Attained (mos)</th>
<th>Overall Clinical Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>nonhemorrhagic</td>
<td>4</td>
<td>2.0-1</td>
<td>E-E-GKRS</td>
<td>5</td>
<td>27</td>
<td>seizures</td>
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<tr>
<td>nonhemorrhagic</td>
<td>3.6</td>
<td>2.0-1</td>
<td>E-GKRS</td>
<td>9</td>
<td>52</td>
<td>intact</td>
</tr>
<tr>
<td>nonhemorrhagic</td>
<td>5</td>
<td>2.0-1</td>
<td>E-E-GKRS-GKRS</td>
<td>5</td>
<td>98% obliteration</td>
<td>intact</td>
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<tr>
<td>nonhemorrhagic</td>
<td>5.5</td>
<td>2.0-1</td>
<td>E-E-GKRS-GKRS-GKRS</td>
<td>16</td>
<td>90% obliteration</td>
<td>intact</td>
</tr>
<tr>
<td>hemorrhagic</td>
<td>7</td>
<td>2.0-1</td>
<td>E-E-E-GKRS</td>
<td>9</td>
<td>21</td>
<td>intact</td>
</tr>
</tbody>
</table>

* E = embolization; GKRS = Gamma Knife radiosurgery; S-V-E = Size of nidus, Venous drainage, and Elocution of adjacent brain.