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Editorial

Radiosurgery for Cerebral Arteriovenous Malformations

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Arteriovenous malformations (AVMs) are the most common intracranial vascular malformation that we encounter in our clinical practice. Patients may present with either headaches, seizures, or bleed. There are several classification systems described in literature to aid in management. Most of them look into the size of the nidus and the status of the draining veins. Any nidus which is compact, superficial, and in a surgically safe area are offered surgery. Most of the other AVMs are managed by radiosurgery or embolization either as a single treatment modality or in combination.

The largest series of 258 cases with histopathology of the vascular malformations including AVMs were studied in detail and published by Karanth et al.[1] It is well documented that AVMs form a conglomerate of arteries, veins, and arterialized veins. The vessel wall has varying degree of hyalinization and calcification with the intervening parenchyma showing gliotic changes and signs of hemosiderin and inflammation.

This issue of the journal has interesting read on AVM. Hunugundmath et al[2] documented the outcome of linear accelerator (LINAC)-based single fraction radiosurgery of AVMs on 35 patients with a median follow-up of 7 years. The median modified AVM score was 1.47. Nearly 40% of the patients had undergone embolization pre-radiosurgery. Obliteration rate observed was around 71%, and 6% of the patients had bleed post-radiosurgery. At our institute we use gamma knife radiosurgery (GKRS) for appropriate sized AVMs since 1997. The new Gamma knife ICON model enables us to use frameless stereotactic radiosurgery for indicated cases. The protocol is similar to what authors have described in their paper for LINAC, but it is a daycare procedure. The patient comes on the day of GKRS and undergoes contrast-enhanced magnetic resonance imaging (MRI) brain along with time of flight sequence imaging of brain and digital subtraction angiography (DSA). The planning is done on the GammaPlan software. The most crucial part of the planning, I believe, is delineating the nidus. We generally prefer to deliver 22 Gy (18–25 Gy) to the nidus. We may opt for volume staging or dose staging of the nidus depending on the volume and location and both have shown good results. The single fraction definitely gives a better result but may be associated with radiation-induced changes (RICs) depending on the nidus angio-architectural complexity. The patients are called for follow-up MRI brain annually for the first 2 years and then once in 2 years. The follow-up DSA is done in the 4th year of treatment. DSA is essential in case MRI shows residual nidus but may not necessarily be done when MRI reveals complete obliteration.

It is good to see that in their series the authors observed only three patients developing transient neurological deficits and no mortality. I would like to remind my authors that at times radiation complications can be life threatening. The RICs usually sets in first 6 months and may be clinically symptomatic in some (►**Fig. 1**). Most of the time it presents as radiation necrosis, in few cases we have seen malignant edema as well. The first line of treatment is steroids which we give in tapering dose along with some cerebral decongestants. We have also tried injection bevacizumab for some of our patients and most of them have done well but some refractory edemas have to be subjected to decompressive craniectomy. Papers suggesting the role of biomarkers in early identification of patients likely to develop RIC are also there in literature.

The obliteration rates are more or less the same irrespective of the radiosurgery system used. In our previous series we have shown 69% obliteration rates with GKRS.[3] These residuals are usually out of field nidus and suggests hidden areas because of dilated veins. For the patients with residual nidus, we offer them repeat GKRS and the results are good.

Paper by Baek et al[4] covers another crucial factor that we look at when deciding the line of treatment of these AVMs. The intra- and peri-nidal aneurysms associated with AVMs may prompt us to go for embolization prior to radiosurgery. The authors have described six patients with four intranidal and two peri-nidal aneurysms. Only one of them underwent

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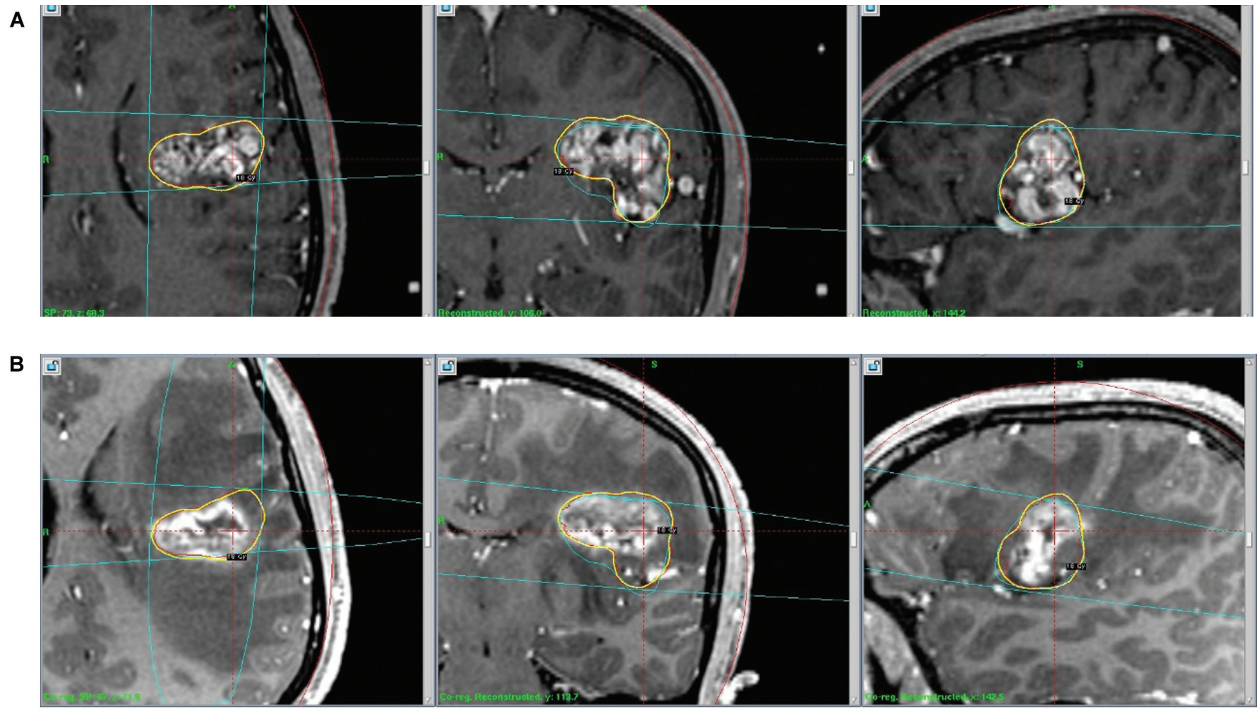

Fig. 1 (**A**) Axial, coronal, and sagittal contrast-enhanced magnetic resonance imaging (CEMRI) brain of 8 years old child presented with headache and underwent gamma knife radiosurgery (GKRS) with margin dose of 18 Gy and volume of nidus 9 mL. (**B**) The follow-up scan at 1 year shows significant edema with radiation-induced change (RIC) and was managed with steroids.

coil embolization before GKRS. Others were subjected to primary GKRS. The AVMs associated with aneurysms is not a rare phenomenon with incidence reaching to almost 16% in literature. It is generally suggested that these aneurysms may be first secured by embolization. It is not appropriate to generalize the treatment and as suggested by the authors, the aneurysms located at distal branches of posterior or middle cerebral arteries have less turbulent flow and can be treated with primary GKRS. Proximal pedicular aneurysms do not get obliterated with GKRS and may need to be addressed by embolization to avoid bleeding postradiation. In our experience too we have observed similar findings and in a compact suitable nidus we go for single modality of treatment and prefer primary GKRS. The sample size is small and a continued analysis of this subset of patients will guide us in choosing appropriate treatment modalities.

AVMs are intriguing intracranial lesions which pose a challenge to neurosurgeons, radiosurgeons and vascular surgeons. The surgery offers 100% obliteration but has a steep learning curve. Wherever feasible, surgery should be the first line of treatment for AVMs. Role of endovascular intervention in AVMs is mostly as a support for surgery or radiosurgery. Radiosurgery is an established modality of treatment for AVMs located in deep and eloquent areas but one should be aware of RICs.

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