Brain Arteriovenous Malformations: Follow Up Of Nidal Volume Using MR Angiographic Techniques One Year After Stereotactic Radiosurgery

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Introduction: Arteriovenous malformations (AVM) of the brain are a major cause of haemorrhagic stroke in the young adult population. They may also present with seizures, fixed or progressive neurological deficits, and headache, or may be found incidentally [1]. In the treatment of intracranial AVM with Stereotactic Radiosurgery (STRS), one of the main aims is the obliteration of the nidus, a process which usually takes up to 2 years or more. Nidus volume is best measured using conventional catheter angiography (CCA) with a stereotactic frame, which due to its very high temporal and spatial resolution has remained the reference standard [2]; but this is an invasive procedure which carries clinical risks, and observing AVMs post-treatment might involve at least 3 CCAs. Hence there is a definite role for relatively non-invasive Magnetic Resonance Angiography (MRA) techniques in the management of these patients. In this study we report the combined use of two MRA techniques: contrast-enhanced Sliding Interleaved Ky (CE-SLINKY) and MR digital subtraction angiography (MRDSA), in the follow up of patients with AVM after treatment.

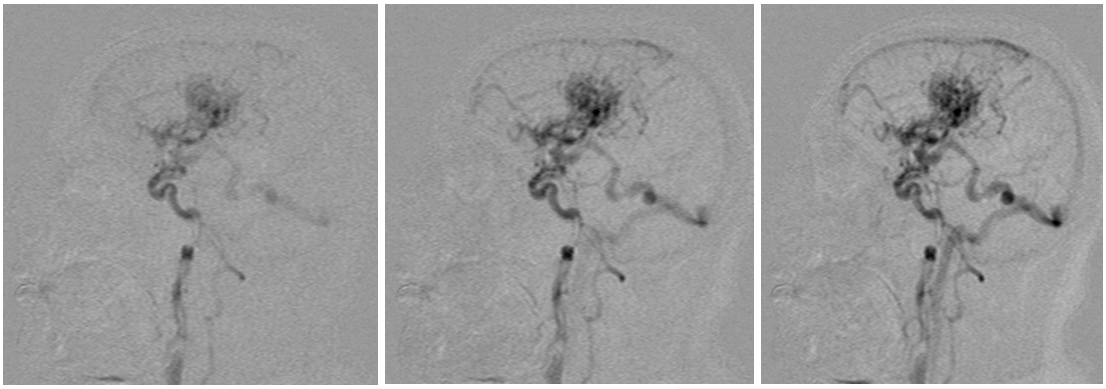
Methods: Thirty-nine patients with an average age of 41 years with cerebral AVM participated in this prospective study after informed consent and local ethics approval. Ten to 18 months after the treatment with STRS, a standard MRI protocol was performed for all patients on a 1.5T system with a bird-cage head coil (Eclipse; Philips Medical Systems). MRDSA was performed after administration of 10ml bolus of 0.5 mol/L gadolinium DTPA (Gd-DTPA) (Magnevist) using a technique described previously [3]. Three-dimensional CE-SLINKY data were acquired after the administration of a second bolus of 10 ml of Gd-DTPA. The CE-SLINKY imaging parameters were as follows: TR 29 ms; TE 6.7 ms; flip angle 33 degrees; field of view 22.0 cm; slice thickness 1.0 mm; no gap; 113 images; resolution 512 × 256 (resolution increased acquired matrix factor × 2); phase sampling ratio 0.809; bandwidth 15.6 kHz. In patients where the AVM was found not to be obliterated, nidus volumes were measured using CE-SLINKY data, in conjunction with the MRDSA data. Nidus volumes obtained by CE-SLINKY were then converted to CCA volumes using a previously validated regression equation [4], and compared to volumes measured with pre-treatment CCAs.

Results: Eight patients (19%) showed complete obliteration of their nidus. Twenty-four patients (59%) obliterated their nidus by greater than 50%, and 9 patients (22%) obliterated their nidus by less than 50%.

Discussion:. Calculation of AVM nidus volume with CCA is not only invasive; it is a complex process which can only be done with a stereotactic frame secured to the patient's head using local anaesthetic at four sites of pin insertion. An advantage of our method is the calculation of volumes without the need for a stereotactic frame. However, one of the limitations of the 3D time-of-flight techniques like CE-SLINKY is the lack of temporal resolution. Conversely, a limitation of MRDSA is the lack of spatial resolution. In our study we have used the two MRA techniques in combination: MRDSA to provide vital information on the nidus anatomy and flow of the larger, more complex and irregularly shaped AVM with multiple draining veins, while CE-SLINKY was used to provide excellent anatomical depiction of the AVM and measurement of nidus volume, thus circumventing the need for CCA.

Conclusion: We conclude that the progress of AVM obliteration can be monitored quantitatively without the need of an invasive CCA by combining MRDSA with quantitative CE-SLINKY.

(a)



(b)

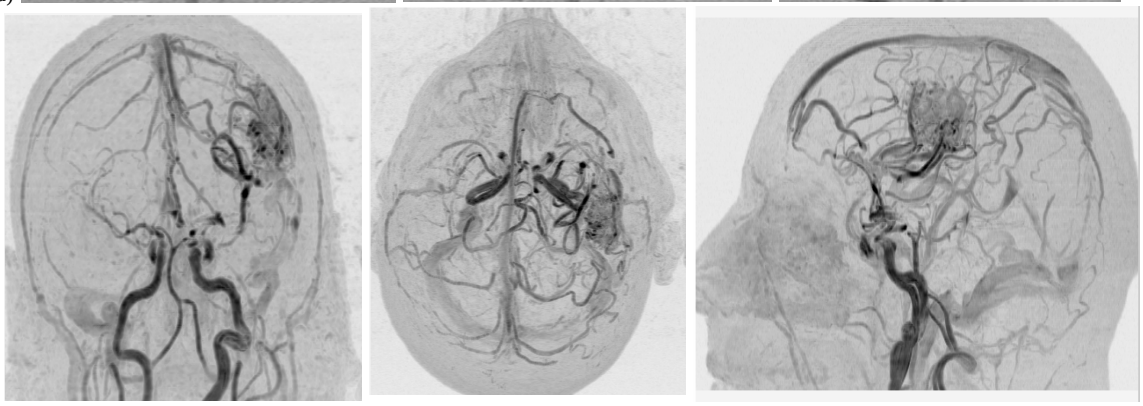


Figure 1: (a) MRDSA showing early arterial, late arterial and early venous phase during the passage of bolus (b) CE-SLINKY maximum intensity projection (MIP) images on a patient with a cerebral AVM.

References:

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