Intraarterial MR Perfusion Imaging of Meningiomas: Comparison to Digital Subtraction Angiography

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Purpose

Meningiomas are highly vascular tumors of the dura that often benefit from preoperative endovascular embolization in order to reduce operative blood loss and associated morbidity. Intraarterial (IA) administration of contrast directly into the external carotid artery (ECA) and internal carotid artery (ICA) branches supplying the tumor during the embolization procedure maps out the blood vessels supplying the tumor as well as evaluating which portions of the tumor are successfully devascularized prior to surgery. Whereas IA digital subtraction x-ray angiography (DSA) is the gold standard for embolization guidance, IA perfusion MRI may offer increased sensitivity to residual areas of vascularized tumor.

Materials and Methods

Studies were performed in a combined "XMR" suite wherein a single-plane x-ray angiography unit (Integris V5000, Philips Medical Systems) is coupled in-line to a 1.5 T MR scanner (Intera, Philips Medical Systems), allowing relatively easy patient movement between the two imaging modalities during endovascular interventional procedures. We evaluated 14 patients with selective intra-arterial (IA) T2* dynamic susceptibility contrast (DSC) perfusion MR during preoperative DSA and embolization procedures. Eight of these patients were also evaluated with intraprocedural IA T1 weighted perfusion MR. IA perfusion was performed with dilute Gd (5mM) and was injected initially into the external carotid (injection rate = 1 cc/s, volume = 5 ml) and subsequently into the common carotid (injection rate = 3 cc/s, volume = 15 ml). The selected carotid artery was confirmed to be providing vascular supply to the tumor by prior angiographic evaluation. The portion of the tumor demonstrated to be associated with external or internal carotid supply, based on IA MR perfusion measures, were correlated with DSA obtained during each procedure. IA perfusion assessments were additionally compared to preoperative conventional MRI and IV T2* perfusion MR studies.

Results

Both T2* and T1 IA perfusion MR techniques were more sensitive than DSA at detecting vascularized tumor prior to or following embolization (Figure 1). The T1 technique was subject to less susceptibility artifact, and thus performed better than the T2* technique at the skull base and near aerated paranasal sinuses. Both IA MR perfusion techniques demonstrated tighter arterial input functions (AIF) than the IV MRI perfusion technique due to contrast administration directly into cervicocerebral arteries. Similarly, time enhancement curves for the IA MR perfusion methods demonstrated reduced mean transit time (MTT) and lack of a recirculation peak as comparted to the IV MR perfusion method. IA MR perfusion methods were good at differentiating ECA from ICA supply to individual tumors. However, vascular variants such as anterior falx artery or ethmoidal artery tumor supply arising from the ophthalmic artery (ICA branches outside the blood brain barrier) presented interpretive challenges for MRI but were readily apparent on DSA.

Conclusion

IA MR perfusion techniques appear to be a useful adjunct to DSA in determining tumor vascularity and the source of that blood supply during DSA guided preoperative embolization procedures. Further correlations with intraoperative observations and pathologic specimens are warranted to better assess the overall sensitivity and specificity of IA MR perfusion and to determine its overall utility in comparison to DSA and IV perfusion methods.

Figure 1. Intraarterial MR perfusion is more sensitive than DSA in detecting vascularized tumor. Right external carotid artery (ECA) T2* DSC perfusion MRI prior to (A) and at the peak of (B) injection of IA dilute Gd contrast into the right ECA demonstrates that the lateral aspect of a recurrent meningioma (arrows) is perfused by branches of the right ECA. However, DSA in the AP (C) and lateral (D) projections during right ECA iodinated contrast injections demonstrates no discernable vascularized tumor.