Dynamic susceptibility-weighted contrast-enhanced MR imaging of meningiomas before and after transarterial embolization

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Background and Purpose:

Preoperative transarterial embolization of meningiomas is widely accepted as a standard of care to reduce intraoperative blood loss and perioperative bleeding complication. Patients with meningioma have benefited a great deal with the increasing knowledge of experienced interventional neuroradiologists and technological progress in imaging, microcatheter equipment and embolic materials. However, embolization can only be done safely in vessels supplied by the external carotid artery (ECA) or dural branches of intracranial vessels [1]. It is not uncommon to subject a patient to catheter angiography only to find that embolization cannot be safely performed due to the predominant vascular supply being pial vessels. Additionally, when embolization is successfully carried out, the exact topographic distribution of embolic material can be difficult to fully assess using angiography or anatomic MR imaging alone. Dynamic susceptibility contrast-enhanced (DSC) perfusion MR imaging has been shown to correlate with tumor vascularity and sensitive to changes in microvascular environment of the brain [2,3,4]. The purpose of our study was to use perfusion maps derived from DSC imaging to characterize meningiomas before and after embolization.

Methods:

Three patients with previously untreated meningioma were recruited for MR imaging prior to embolization. Each patient underwent anatomic and DSC perfusion MR (DSC pMRI) imaging on a 1.5T scanner within 48 hours before and after embolization. All patients had gross total resection of their tumor within 24 hours of completion of embolization. In addition to pre- and post-contrast T1-weighted imaging, DSC pMRI was performed using 0.1mmole/kg of Gd-DTPA. In one patient, a selective DSC pMRI was done with direct injection of Gd-DTPA into a catheter placed within external carotid artery (ECA) and common carotid artery (CCA). After a diagnostic arteriogram to identify blood supply and to assess safety and feasibility of embolization, a transarterial embolization was performed using acrylic microspheres in external carotid artery branches. Following embolization, all patient underwent MR imaging similar to that prior to embolization. The anatomic T1-weighted images were evaluated for areas of nonenhancement following embolization. DSC pMRI data was processed to yield relative cerebral blood volume (rCBV), mean transit time (MTT), and permeability maps. Pre- and post-embolization DSC perfusion maps were analyzed for changes in 1) overall blood volume, 2) transit time, 3) permeability, and 3) topographic distribution of perfusion abnormalities between the two studies.

Results:

Histopathologic analysis revealed grade I meningioma in all patients. There were no intra- or peri-operative bleeding complications. The anatomic T1-weighted images did not show any difference between pre- and post-embolization nor did the T2-weighted images. There were, however, profound differences in DSC perfusion imaging in that there were overall increase in mean MTT but decrease in permeability of the entire tumor between pre- and post-embolization studies. The maximum tumor rCBV increased following embolization. In one patient with selective DSC perfusion MR imaging of external carotid artery (ECA) and common carotid artery (CCA) (Figure 1), similar changes in increase in mean MTT and maximum rCBV were noted.

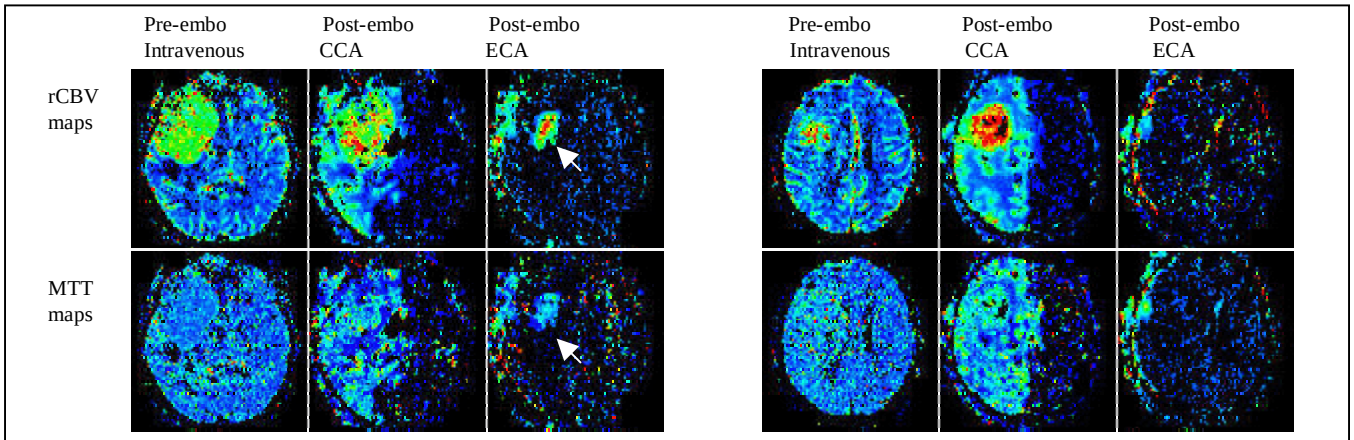

Figure 1. 59-year-old woman with right frontal grade I meningioma. Relative cerebral blood volume (rCBV) and mean transit time (MTT) maps at two different slice location pre- and post-embolization (embo). Pre-embo DSC perfusion imaging was performed by injected Gd-DTPA intravenously and in post-embo, directly into ECA and CCA. The pre-embo perfusion maps show increased blood volume within the tumor. Post-embo CCA rCBV map shows increased blood volume in a heterogeneous pattern. Post-embo ECA rCBV map shows similar increase in blood volume but delayed in MTT in residual tumor supplied by ECA (arrows).

Discussion & Conclusion:

Our preliminary data suggest that DSC perfusion MR imaging can depict hemodynamic changes in meningiomas before and after transarterial embolization. We found that relative cerebral blood volume and mean transit time maps were helpful in depicting the residual tumor blood supply and the effectiveness of ECA embolization. Meanwhile, the standard T1-weighted images did not display changes following ECA embolization. As preoperative transarterial embolization becomes more widely available, a means of noninvasive and quantitative imaging to monitor the extent and effectiveness of the result will be critical. Further study with larger sample size and direct correlation between DSC perfusion MR imaging and intraoperative and histopathologic analysis are necessary.

References:

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