Accuracy of DSC-pMRI in assigning percentages of high-grade malignant features in masses recurring after surgical and radiation treatment of brain neoplasms

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Background: distinguishing recurrence from radiation necrosis in patients undergoing treatment for brain neoplasms remains a clinically relevant diagnostic dilemma. Several studies have concentrated on defining the significance of not only the presence, but the percentage of high-grade histological features in surgical specimens obtained from masses recurring after surgical and radiation treatment, on the decision to change treatment and on prognosis. Dynamic susceptibility-contrast perfusion MR imaging (DSC-pMRI), which reflects cerebral blood perfusion at the microvascular level, could be used for this purpose.

Objective: the goal of our study was to assess the accuracy of DSC-pMRI in assigning percentages of high-grade malignant features in masses recurring after surgical and radiation treatment of brain neoplasms.

Material and methods: we retrospectively selected 30 patients with high-grade primary or secondary brain neoplasm, who underwent surgical resection and radiation therapy, developed a mass suspicious for recurrent neoplasm on follow up evaluation, subsequently, underwent MRI imaging including DSC-pMRI followed by total gross resection of the recurrent mass. The DSC-pMRI was performed with a contrast-enhanced T2-weighted single-shot spin-echo echo-planar sequence, and the relative cerebral blood volume (rCBV) maps were calculated. The histological specimens were evaluated and defined as grade 1 (less than 20% of high-grade features in the specimen) and grade 2 (≥ 20% of high-grade features in the specimen). The contrast-enhancing mass volume region of interest (ROI) was manually defined. In addition, rCBV of normal white matter was calculated and used in further calculation of intensity thresholds. Lesion volume ROI was used as a mask for registered rCBV map to create rCBV lesion volume. This volume was then thresholded using values obtained on the basis of normal white matter rCBV values. For this analysis, we calculated 31 threshold values from one to four times the white matter rCBV with 0.1 increment. Receiver operating characteristic (ROC) curves were constructed to assess the best performance of all the different thresholds.

Results: thresholds of 1.9, 2.0 and 2.1 times the white matter rCBV values had the best performance in differentiating grade 1 and grade 2 lesions, with sensitivity and specificity of 94.1% and 92.3%, respectively. The thresholds 2.2 and 2.3 also demonstrated good performance, with sensitivity of 88.2% and specificity of 92.3%. The highest sensitivities were seen for thresholds up to 2.1, with decreasing specificity (from 92.3% to 23%) as white matter intensity threshold was decreased. The highest specificities were demonstrated for thresholds higher than 1.9, with decreasing sensitivity (from 94.1% to 41.2%) as white matter intensity threshold was increased.

Conclusion: thresholds between 1.9 and 2.1 times the white matter rCBV values demonstrated high sensitivity and specificity in differentiating lesions with more or less than 20% of malignant histological features. The DSC-pMRI is a promising tool for assigning percentages of high-grade malignant features in masses recurring after surgical and radiation treatment of high-grade brain neoplasms.