

Complimentary Role of Brain Dynamic Contrast-Enhanced MR Perfusion for Post-Treatment Evaluation of Brain Tumors: Use of "Stack-of-Stars" Scheme and k-Space Weighted Image Contrast

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Purpose:

In comparison to dynamic susceptibility contrast (DSC), dynamic contrast-enhanced (DCE) is technically a more demanding technique but provides a different prospective of blood-brain barrier and tumor angiogenesis and may be of additional value, where DSC could be affected by susceptibility artifacts. Introduction of imaging tools such as radial k-space sampling 1 and echo-sharing techniques such as k-space weighted image contrast (KWIC) 2 have improved the efficiency of dynamic contrast imaging in terms of coverage, spatial and temporal resolutions. The purpose of this study was to prospectively assess the added value of an improved DCE perfusion technique in evaluation of post-treated brain tumors and compare the result to DSC perfusion and surgical pathology in a subset of patients.

Materials and Methods:

In this prospective study, 20 consecutive patients (12 males, age range: 36-72 years old) who were being treated for brain tumors underwent MR imaging (MRI) on a 3.0 T MR scanner (Siemens Skyra) including DCE and DSC perfusion. The DCE perfusion was acquired by a 3D radial VIBE (volumetric interpolated examination) sequence (TR/TE: 3.6/1.7 ms, voxel size 1.4 x 1.4 x 3mm). A total of 328 radial views were acquired in eight rotations (42 views/rotation) with 'stack-of-stars' scheme. Three measurements were obtained each divided to eight subframes by applying KWIC, resulting in whole brain coverage with three minutes acquisition time and a four sec temporal resolution. Subsequently DSC perfusion was performed using a gradient-EPI sequence (TR/TE: 1450/22 ms, voxel size 1.7 x 1.7 x 4 mm³). A total of 0.2 mmol/kg of gadolinium was used to accomplish both DCE and DSC. The DCE image quality was evaluated independently by two neuroradiologists using a 1-4 grading scale in respect to motion and pulsation artifact, brain edge sharpness and vascular conspicuity. Perfusion datasets were processed using a commercially available FDA approved software (Olea Medical, La Ciotat, France). The arterial input function was selected automatically and multiparametric perfusion maps were calculated using an extended toft model for DCE and block-circulant singular value decomposition technique for DSC. The perfusion maps, FLAIR and T1 postcontrast images for each patient were coregistered using the Olea software. K-trans (minutes⁻¹) and rCBV values were calculated from the region of interests for each patient.

Results:

All DCE studies were rated with diagnostic image quality (median: 3, range: 3-4) by both observers and with excellent interobserver agreement (k=0.82). In 11 patients the k-trans values and perfusion permeability curve pattern were suggestive of tumor recurrence and concordant with rCBV values >1.5 3-4. In six patients the k-trans values and perfusion permeability cure

pattern were suggestive of radiation necrosis and concordant with rCBV < 1. In three patients (15%), DSC maps were nondiagnostic due to blood-product susceptibility artifact within the surgical bed, in whom DCE was able to predict tumor recurrence. In seven patients (35%) the perfusion findings were confirmed subsequently by surgical pathology.

Conclusions:

The described DCE perfusion technique is feasible with acceptable result in comparison to DSC perfusion and can provide additional diagnostic value in a subset of patients with brain tumor in whom DSC may be limited by susceptibility artifact related to post-treatment surgical bed. Radial k-space sampling provides several advantages including lower motion sensitivity, benign undersampling behavior and lack of aliasing artifact, while KWIC helps to maintain the temporal resolution.

Adult Brain:

Neoplasms

Anatomy - Secondary:

Brain

Keywords:

Brain Neoplasms

DCE MR Imaging

Radiation Necrosis

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