Prospective Glioma Grading Using Single Dose Dynamic Contrast Enhanced MRI Perfusion

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Target Audience: Radiologist, Neuro-surgeon, Radiation-Oncologist.

Introduction: Conventional MR techniques are routinely used in the preoperative evaluation of gliomas. However, it provides limited information on tumor physiology and grading. Perfusion MR imaging performed better in comparison to other available MR techniques, like conventional imaging, spectroscopy and diffusion tensor imaging in differentiating low from high grade gliomas. The purpose of this study was to evaluate the relative sensitivity and specificity of single dose contrast Dynamic Contrast Enhanced (DCE) MR perfusion in prospective evaluation of glioma grading and to correlate the relative cerebral blood volume (rCBV) values with mitotic index and Ki -67 index obtained on histopathology.

Materials and methods: Total 53 patients with histopathologically proven gliomas who presented with symptoms related to space occupying intracranial mass lesion underwent single dose contrast DCE perfusion study. Prospective grading of glioma into low and high grade was done based on rCBV cut-off value of 3.0 which has been reported previously. We also compared the hemodynamic parameters obtained on single dose with double dose perfusion study for normal brain parenchyma and brain tumors.

Statistical analysis: - The sensitivity and specificity of the single dose perfusion study in differentiating high and low grade gliomas were calculated using ROC (receiver operating characteristic) analysis. Spearman rank correlation coefficient was computed and tested for significance to study the relationship of rCBV with mitotic index and tumor proliferation activity (Ki-67 index). Mean rCBV value of high grade(figure2) and low grade(figure2)tumors on double dose and single dose perfusion studies were compared separately for any differences using student independent t test. $P<0.05$ was considered to be significant.

Results: On prospective evaluation, 36 out of 53 patients were diagnosed as high grade and remaining 17 patients were labeled as low grade on the basis of pre-defined rCBV cut off value. Based on the above mentioned threshold value of rCBV, prospective grading of glioma in low and high grade was achieved with a sensitivity and specificity of 97.4% and 100% respectively. No significant difference was observed in rCBV values on single and double dose perfusion study for both high (p=0.993) and low grade (p=0.946) gliomas separately. Positive correlation was observed in between rCBV and mitotic index in all gliomas but no correlation was found when assessed independently (figure 1).

Discussion: We observed high sensitivity and specificity of single dose perfusion study in differentiating low and high grade gliomas. Our results are comparable with previously published double dose DCE perfusion and standard dose prospective Dynamic Susceptibility Contrast (DSC) perfusion studies[2,3]. It can be explained with the fact that, there is decrease in contrast dosage requirement with availability of higher relaxivity contrast agents and we have used Leaky Tracer Kinetic Model(LTKM) model for perfusion data processing in this study, which provides better leakage correction and better accuracy in correctly classifying the gliomas in low and high grade gliomas than Generalised Tracer Kinetic Model (GTKM) model, as shown previously by Sahoo et al.[1] We conclude that single dose DCE-MRI provides information as good as double-dose to differentiate high grade from low grade gliomas on a 3.0T MRI and could be added to the routine brain tumor imaging protocol.

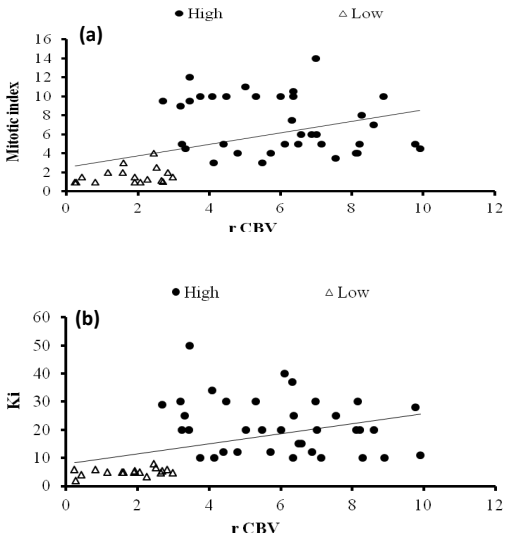

Figure 1: *Scatter plot shows significant positive correlation of rCBV with mitotic index (r=0.589) (a) and Ki-67 index (r=0.580) (b) in all gliomas.*

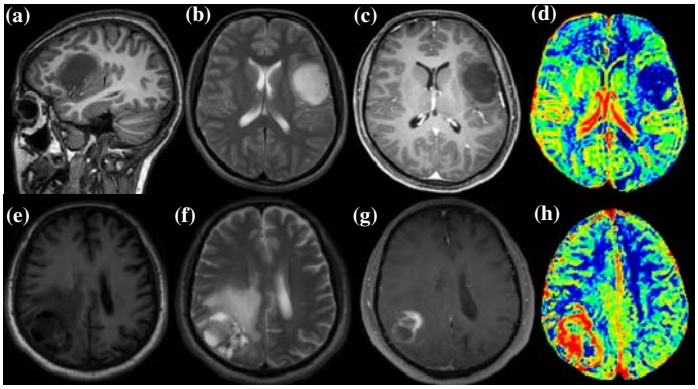

Figure 2: *Mixed signal intensity lesion on T1(a) and T2(b) in left temporal lobe with minimal enhancement on post contrast study(c) and low perfusion on CBV map(d) Histopatholgy was consistent with the diagnosis of low grade tumour. Heterogenous signal intensity lesion on T1(e) and T2(f)in right parietal lobe with irregular peripheral enhancement on post contrast study(g) and showing high perfusion on CBV map (h).Histopatholgy was consistent with the diagnosis of high grade tumour.*

References:1. Sahoo et al. JMRI 2013 Sep;38(3):677-88 2. Neuro Oncol. 2014 Jul;16(7):1010-21 3. George A. Alexiou, Clin Neurol Neurosurg. 2014 Jan;116:41-5.