Evaluating the role of Diffusion Tensor Imaging (DTI) and Dynamic Susceptibility Contrast (DSC) perfusion imaging in comparison to conventional MRI methods in the diagnosis of non-enhancing brain tumours.

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Background: Diagnosis of non-enhancing brain tumors on conventional MRI is challenging as a substantial degree of overlap of over 45% has been reported between low grade and high grade tumours using conventional MRI methods [1]. Diffusion tensor imaging (DTI) and perfusion weighted imaging using dynamic susceptibility contrast (DSC) MRI has been reported to aid in the differential diagnosis of tumours [2]. We therefore tested these quantitative imaging parameters can also be used for diagnosing non-enhancing brain tumours.

Methods: Twenty patients with non-enhancing gliomas, 10 patients with grade II gliomas (4 Astrocytoma, 6 Oligodendroglioma) and 10 patients with grade III gliomas (5 Anaplastic Astrocytoma, 2 Anaplastic Oligoastrocytoma, 3 Anaplastic Oligodendroglioma) were included in this study. Conventional MR sequences included T1, T2 and post contrast T1 weighted images. Analysis of the conventional imaging included measurement of tumor volume using T2 weighted images and the ratio of signal intensity (SI) of tumor to the contralateral brain images usingT2 weighted images and the Amira software (FEL). Pixel-by-pixel DTI maps were generated for computation of Fraction Anisotropy (FA), Mean Diffusivity (MD), Axial Diffusivity (AD) and Radial Diffusivity (RD) using FSL software. DSC maps for cerebral blood volume (CBV) was generated using nordicICE software with automatic arterial input function (AIF) and residue function-based leakage correction method. In order to evaluate the same region of interest for the DTI and DSC maps, image co-registration and resampling of the T2weighted images with DSC and DTI maps was performed using Amira software.

Results: Representative parametric maps from a patient with grade II and grade III tumor are shown in Fig 1. There was no significant difference in the tumor volume and the signal intensity on T2-weighted images between grade II and grade III gliomas (P= 0.82, P=0.12, respectively, Fig 2 A). The median ± SD for CBV, FA, MD, AD and RD for grade II and for grade III are shown in (Fig 2 C-E). None of these parameters were significantly different between grade II and grade III gliomas (P 0.09, 0.28. 0.71. 0.44. 0.99 respectively). However, when the histogram from the ROIs were analyzed, significantly different kurtosis and skewness for CBV values were observed between non-enhancing grade II and grade III gliomas. (P 0.01, 0.02 respectively, Fig 3).

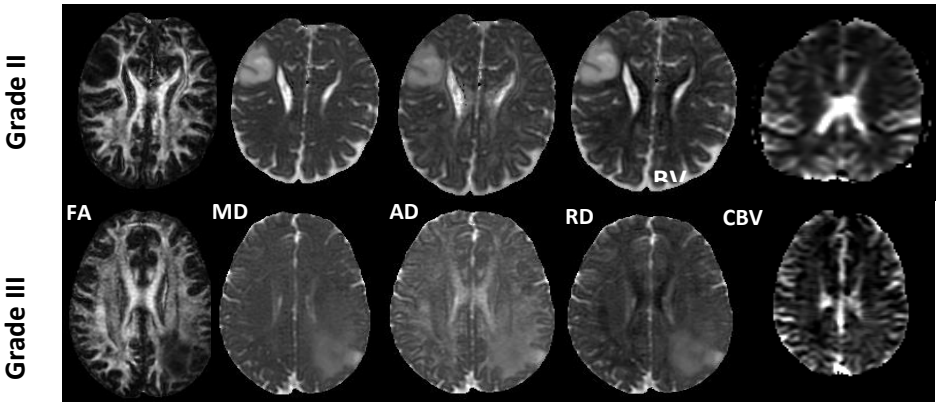

Fig 1: T2 images and DTI and CBV parametric maps from a patient with Diffuse Astrocytoma (II) (top row) and Anaplastic Astrocytoma (III) (bottom row).

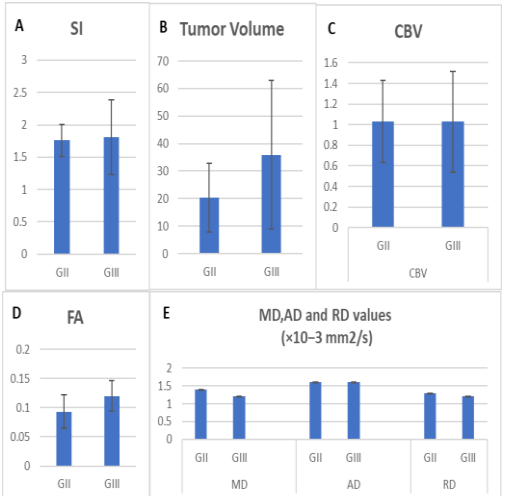

Fig 2: Median ± SD values of the DTI parameters, SI, tumor volume and CBV.

Conclusions:

These preliminary results from a small cohort of patients confirm the literature findings that conventional MRI methods are unable to differentiate grade II and grade III gliomas. Although the median rCBVs weren't different either, the differences in kurtosis and skewness indicates greater heterogeneity in higher grade tumors. While the DTI values were also not significantly different, however, the trend in FA was noted, which indicates that more patients should be evaluated.

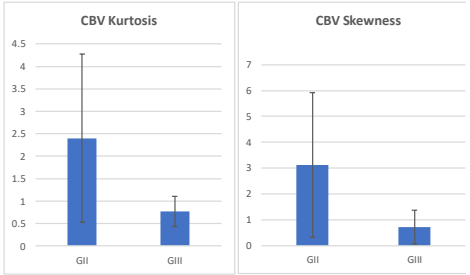

Fig 3: Mean ± SD values of the kurtosis and skewness values for CBV

References:

1. Sahin N et al. The neuroradiology journal, 2013;26(5):531-541.
2. Svolos P et al. Cancer Imaging, 2014;14(1):20.