High b-value cerebral DWI and basal nuclei ADC measurements in variant and sporadic Creutzfeldt-Jakob disease

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Introduction: Diffusion weighted imaging (DWI) has emerged as the most sensitive MRI sequence for the diagnosis of human prion diseases, particularly for sporadic CJD (sCJD) where increased sensitivity for signal change in the cortex is observed[1-3]. The diffusion-weighting factors ('b values') used in routine clinical DWI studies are usually b=1000s/mm^2. However, recently higher b value DWI has shown increased sensitivity for detection of signal abnormality in e.g. ischaemic stroke[4] and the grading of cerebral gliomas[5]. The purpose of this study was to investigate whether DWI at b=3000s/mm^2, and ADC measurements in the basal nuclei, improve the diagnosis of variant CJD (vCJD) and sCJD compared to DWI at b=1000s/mm^2.

Methods: Eight patients with vCJD (5 male, mean age 36.1 years) and 9 patients with sCJD (6 male, mean age 59.2 years) referred to the National Prion Clinic, National Hospital for Neurology and Neurosurgery, London, U.K. were included in this study. Five age and sex-matched healthy volunteers were also recruited. All subjects underwent FLAIR MRI (TE 161ms, TI 2473ms, TR 9897ms) and DWI with b values of 0 and 1000 sec/mm^2 (TE 101ms, 1 average) on a clinical 1.5T system (GE Healthcare, Milwaukee, WI). Ten patients (5 with vCJD, 4 with sCJD and 1 with growth hormone-related CJD) had additional DWI with b values of 0 and 3000 sec/mm^2 (TE 136ms, 3 averages). Two independent consultant neuroradiologists performed a qualitative analysis of the diffusion trace-weighted images in a non-blinded fashion. Additionally bilateral ROIs in the caudate (C), putamen (P) and dorsomedial thalamus (DM), and a white matter (WM) region were defined manually (Fig 1A) and signal intensity (SI) ratios between each grey-matter ROI and the WM ROI were calculated for the b =1000 and b 3000 mm^2/s trace-weighted images. Mean ADCs from the same ROIs were also determined. For the vCJD cases, the ADC in the pulvinar nucleus (Pu) of the thalamus were also determined and 2 control ROIs were selected in the right frontal white matter (FWM) and the superior pons (SP).

Results: In the 10 patients that underwent both b=1000 and b=3000 sec/mm^2 acquisitions, we found complete agreement between the 2 observers that in 9 out of the 10 cases, signal change was more conspicuous on the b=3000 sec/mm^2 images, particularly for cortical and thalamic signal changes (Fig 1B and C). The SI ratios where higher in the b=3000 sec/mm^2 images when compared to b=1000 sec/mm^2, particularly in the DM ROI (1.93 ± 0.72 on b=3000 versus 1.39 ± 0.19 on b=1000, p=0.028). At b=1000s/mm^2, we found significantly lower mean ADC in the caudate and putamen ROIs in sCJD patients compared to controls (mean C ADC = 587.3 ± 84.7 mm^2/s in sCJD versus 722.7 ± 16.6 mm^2/s in controls, p=0.007; mean P ADC = 603.3 ± 98.7 mm^2/s in sCJD versus 727.8 ± 24.4 mm^2/s, p = 0.018; Fig 1A). However, at b=3000s/mm^2, we not only found significantly lower mean ADC in the caudate and putamen but also in the dorsomedial thalamic ROIs (mean DM ADC = 485.7 ± 87.4 mm^2/s in sCJD versus 627.3 ± 13.1 mm^2/s in controls, p=0.001; Fig 1B). In the vCJD cases, at b=1000 s/mm^2, we found higher mean ADC in the pulvinar ROIs bilaterally (mean Pu ADC = 837.6±33.0 mm^2/s in vCJD patients compared with 748.0±17.3 mm^2/s in controls, p=<0.001) but at b=3000s/mm^2, no significant differences were found for mean ADC in any of the ROIs comparing vCJD patients and controls.

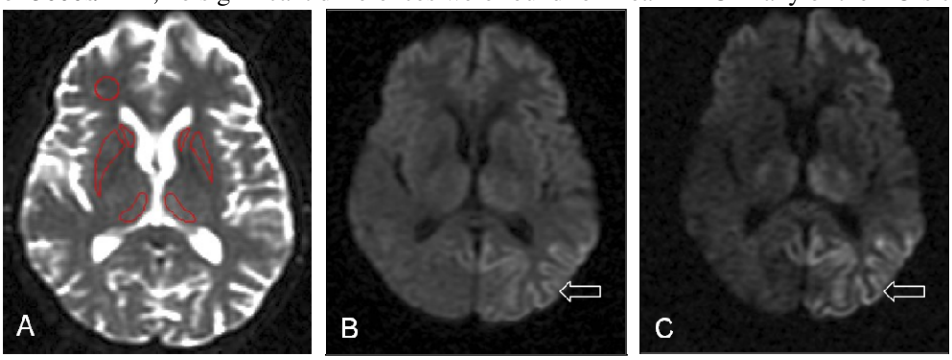

Figure 1: B0 map with ROIs (A), cortical hyperintensity at b=1000 (B) and b=3000 (C)

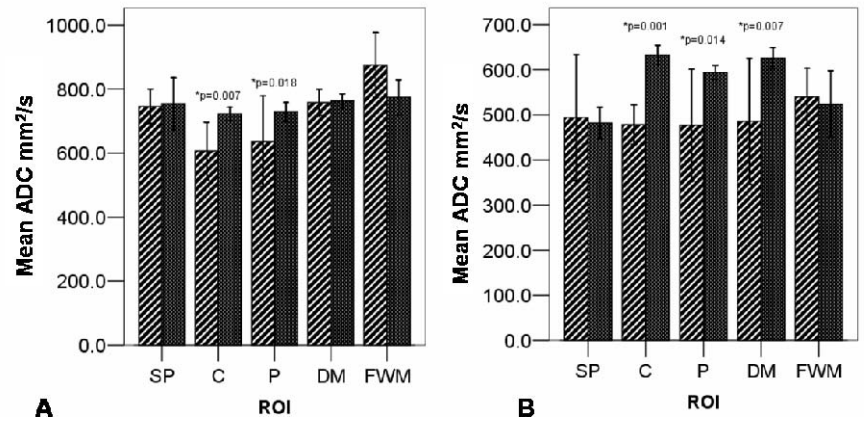

Figure 2: Mean ADCs in sCJD (striped) and controls (block) at (A) b=1000 and (B) b=3000

Conclusion: At high *b* value, signal change is more conspicuous, improving confidence in the radiological diagnosis of human prion disease. Regional cerebral ADC changes in prion disease patients compared to controls were demonstrated, the anatomical ADC patterns being different in sporadic and variant CJD. Future work will clarify the relative contributions of multiple-component tissue-water ADC and T2-effects to these observations. Nevertheless, our results suggest that high-b value DWI provides additional pathological sensitivity in prion diseases.

References:

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