MR contrast in post-mortem brain remains after 6 decades of storage: imaging in cerebellar agenesis

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Introduction Recent years have seen a rise of interest in post-mortem scanning to take advantages of long scan time available to perform very high resolution imaging of both pathological and healthy tissues, particularly in newer methods such as DTI tractography (see e.g. [2]). Less attention has been paid to the prospects for scanning older specimens, which are usually preserved because they exhibit rare pathology or some other significance.

Cerebellar agenesis (CA) is a rare congenital condition where the cerebellum fails to develop properly [1]. Unlike patients that suffer cerebellar lesions or damage in later life who are left with marked focal deficits, those without proper cerebellar development from birth can appear to be less severely affected, though this is a subject of some debate, hindered in part from the lack of data for this rare condition.

We have performed a series of scans on two particularly important specimens from the Anatomy Department, University of Cambridge, to allow non-destructive high-resolution examination of brain microstructure as well as to preserve the structural information of this rare anatomy in case the specimens succumb to damage in the future. These brains have been preserved since excision in the 1940s and are from patients with different forms of CA. One specimen has 'complete' bilateral agenesis of the cerebellar hemispheres and the other unilateral (hemi-CA), providing the opportunity to investigate structures connected to the cerebellum using contralateral structures for comparison.

Methods We imaged both brains using a Siemens 3T Verio system with a 32-channel head coil. Specimens were scanned with a high-resolution MPRAGE sequence (TR/TE 2.3s/3.59ms FOV 25.6×24.0×8.8cm over 512×480×176 matrix, resolution 0.5mm isotropic, 32 NEX total time 10 hours), routine clinical diffusion scan (12 dir, 6 b-values, EPI 2mm resolution) and a high-resolution SE diffusion scan (130 dirs, 16 bvals, resolution 1.2mm isotropic). We also obtained high-resolution SWI images (TR/TE 28/20ms 0.5×0.5×1.2mm^3 resolution).

Results The preserving fluid did not give any imaging artefacts and excellent structural contrast was seen between grey and white matter (GM/WM) in both specimens. Figure 1. More sophisticated imaging techniques such as the SWI image shown in Figure 1B were less useful, revealing only microstructural damage to the brain tissues. The FA map is shown in figure 1E, showing that routine diffusion methods cannot be straightforwardly applied to these specimens.

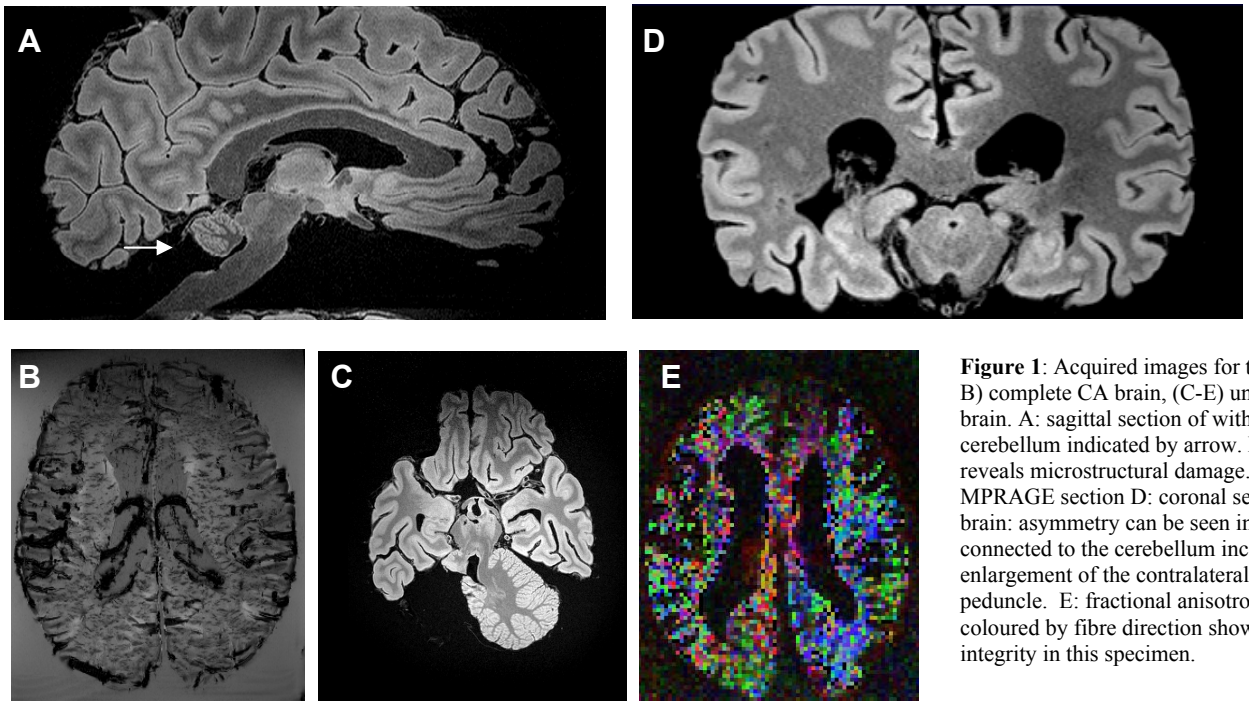

Figure 1: Acquired images for two samples (A-B) complete CA brain, (C-E) unilateral agenesis brain. A: sagittal section of with rudimentary cerebellum indicated by arrow. B: SWI image, reveals microstructural damage. C: axial MPRAGE section D: coronal section of same brain: asymmetry can be seen in nuclei connected to the cerebellum including enlargement of the contralateral cerebral peduncle. E: fractional anisotropy (FA) image coloured by fibre direction shows poor tract integrity in this specimen.

Conclusions

Structural contrast remains excellent in aged specimens which can be scanned using standard clinical systems without much optimisation of scan parameters required. Applications such as DTI however may not be viable using standard diffusion sequences (EPI, SE) though perhaps other methods (SSFP-based acquisitions) could be adapted.

Figure 1A shows that a small midline vermis is in fact present in the 'complete' CA specimen, although no nuclei could be identified.. In the 'hemi CA' specimen one hemisphere and a clear dentate nucleus is present, without the vermis of the other hemisphere. More specimens will have to be scanned for a conclusive answer to the pathology involved in these cases.

[1] Glickstein (1994) Brain 117 1209-1212 [2] Behrens (2003) Nat. Neuroscience vol 6 (7) pp 750-757