A comparison between Diffusion Tensor Imaging and Q-ball MRI in the study of post-stroke plasticity

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Background: Diffusion tensor imaging (DTI) has been advocated as a valuable non-invasive tool to monitor post-stroke recovery[1,2]. However, its inaccuracy in regions of fibers crossing/kissing could limit its application in studying the complex white matter plasticity characterizing functional recovery after stroke[3,4]. Q-ball imaging has been shown to bypass DTI limitations and it is currently applicable in clinical protocols. **Objective:** To compare DTI to high-angular resolution q-ball imaging in the study of white matter remodelling during stroke recovery. **Methods:** Five patients with ischemic MCA strokes were studied. Magnetic resonance DTI and q-ball were serially performed (within one week of symptoms onset and at 1 and 6 months after the acute event) on 1.5-T scanner (Avanto, Siemens, Erlangen, Germany) using an in-house 23 channel head coil (DTI: EPI, TR 7500 ms, TE 99.3 ms, b values=700 s/mm^2, 30 diffusion gradient directions, slice thickness 2.2 mm, no gap, acquisition time (a.t.): 4:28 min:sec. Q-ball: single-shot spin-echo EPI, TR=8s, TE=110ms, b=3000 s/mm^2, 4 co-registered dataset with 90 diffusion weighted images, 123 diffusion directions, 2.8 mm isotropic resolution, 30 slices, a.t.: 18 min). DTI and Q-ball tractography were performed using trackvis tool [5] and 3D ROI was placed in the periphery of the infarct area to track the functional pathway sub-serving the injured region and involved in the main symptoms (cortico-spinal tract, CST, for 2 patients, arcuate fascicle for 2 patients and insulo-somato-sensory area I connections for 1 patient). Quantitative analysis was performed as following: (fibers solutions tracked by the ROI/ number of tracks in the whole brain) %. **Results:** Qball and DTI acquisition were well tolerated by patients at all time-points after stroke. Applying DTI and q-ball tractography to the white matter tract sub-serving the stroke lesion, we could show that 1. Q-ball always showed more fiber trajectories than DTI, especially if the fiber bundle was crossing regions of multidirectional connectivity (ex Arcuate Fascicle, Figure 1 A and B) 2. Q-ball was showing, better than DTI, longitudinal qualitative and quantitative modulations of the number of fiber tracts (figure 1, B) 3. Only q-ball visualized some fibers which appeared "crossing" the compact structure of the Cortico-spinal tract in one patient (Figure 2). **Conclusions:** For the first time, this study demonstrates the difference and advantages of a clinically compatible q-ball MRI protocol compared to DTI in studying complex connectivity as the result of white matter changes after stroke.

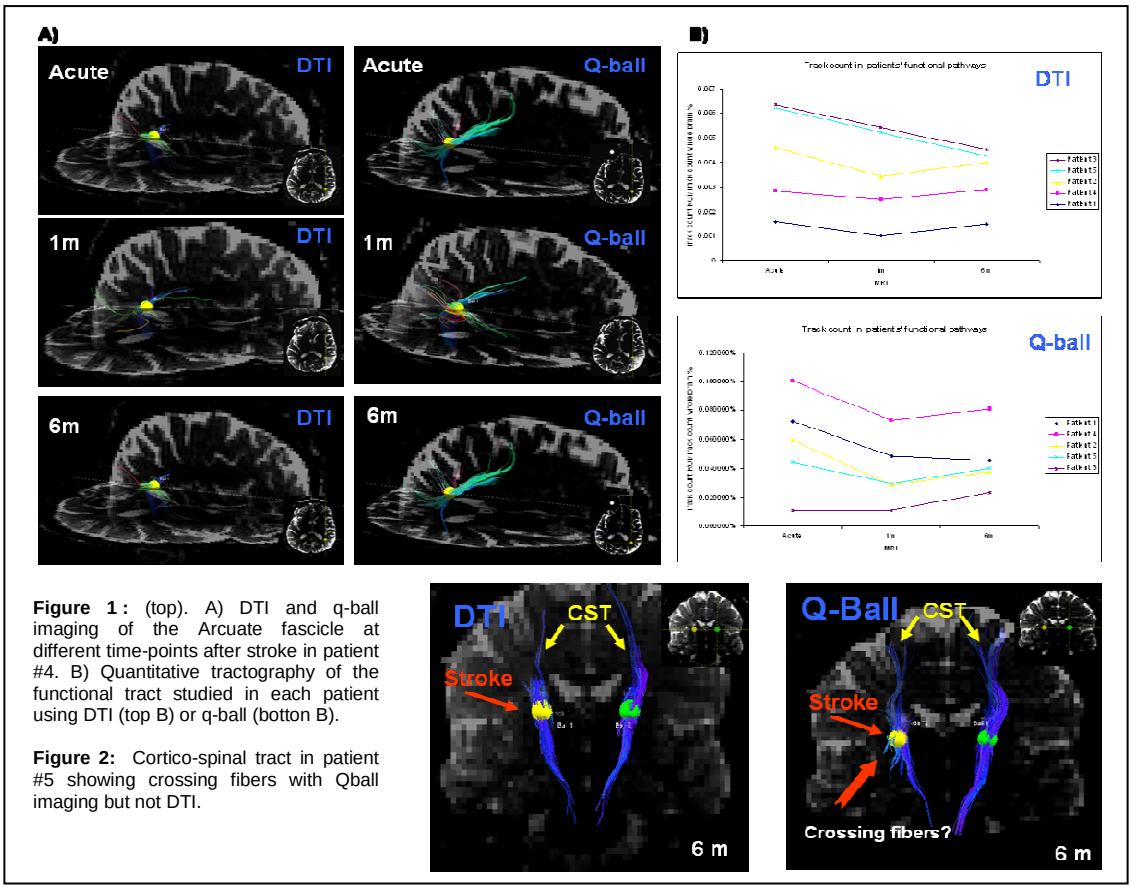

Figure 1 : (top). A) DTI and q-ball imaging of the Arcuate fascicle at different time-points after stroke in patient #4. B) Quantitative tractography of the functional tract studied in each patient using DTI (top B) or q-ball (botton B).

Figure 2: Cortico-spinal tract in patient #5 showing crossing fibers with Qball imaging but not DTI.

References: 1. Buffon F et al. J Cereb Blood Flow Metab. 2005;25:641-650; 2. Berman et al. Neuroimage. 2005; 27:862-871; 3. Carmichael ST. Ann Neurol. 2006; 59:735-742; 4. Nudo RJ. Stroke. 2007; 38:840-845; 5. Wang R and Wedeen V. ISMRM. 2007;15:3720