



Contralesional pyramidal tract neuroaxonal integrity predicts functional status in chronic stroke patients with mild primary infarction

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INTRODUCTION

There are subtle functional deficits in chronic stroke patients despite small volume primary infarction. These are difficult to characterize with standard neurological scales and conventional MRI. Often NIHSS and mRS do not capture the overall functional deficits that patients experience and routine MRI demonstrates little to no significant abnormalities. In this study, we used walking speed as a comprehensive tool for gait evaluation and a more sensitive marker for functional assessment. For assessment of structural deficits, we used DTI-3D tractography as a sensitive quantitative MR based marker enabling targeted assessment of corticospinal tracts in patients with small volume anterior circulation infarcts that are either silent or have little stigmata of tissue damage on conventional MRI techniques.

METHODS

Chronic stroke patients (SS) (NIHSS<4) without significant gliosis or encephalomalacia in primary infarct territory and mild functional deficit, (mRS≤2) were compared with healthy age and gender matched controls [Age (yrs): SS, 66±9 (n=11) versus controls, 63±7 (n=8), p=0.5]. Diffusion Tensor Imaging based tractographic reconstruction of corticospinal tracts was performed. Trace constrained diffusion metrics were compared across groups. Walking speed, (m/s) was used for assessment of comprehensive functional status.

RESULTS

Even though the patients had only mild functional deficits, mRS ≤ 2, We found the walking speed to be significantly lower in the stroke group, (mean±sd, stroke vs.controls: 0.99±0.2 vs 1.2±0.08, p value= 0.02). However, the walking speed did not correlate with NIHSS or mRS, (p>0.1).

Fore comparison the tracts were grouped as contralesional and ipsilesional to the infarct side. For controls, these values were replaced with average of the two sides.

Despite lack of overt abnormalities on conventional MRI. We detected significant abnormalities in DTI parameters within the corticospinal tracts. The ipsilesional and contralesional corticospinal tracts had significantly elevated tract constrained diffusivity estimates compared to average CST control estimates, (p=0.001 and p=0.01).

In whole group, (n=18) we found that the best predictor of walking speed was contralesional CST FA, p=0.07, (Figure 1, note for controls this value was replaced with average CST FA). The results were significant after adjusting for height, with contralesional CST FA, beta coefficient=4.3, p=0.01. In the stroke group alone, (n=10), there was significant association between walking speed and contralesional CST FA, r= 0.67, p=0.03 and a trend with average CST FA, r=0.58, p=0.07. The ipsilesional CST FA was not significantly associated with walking speed in our stroke group, r=0.43, p=0.2. There was no correlation with NIHSS or mRS, (p>0.1).

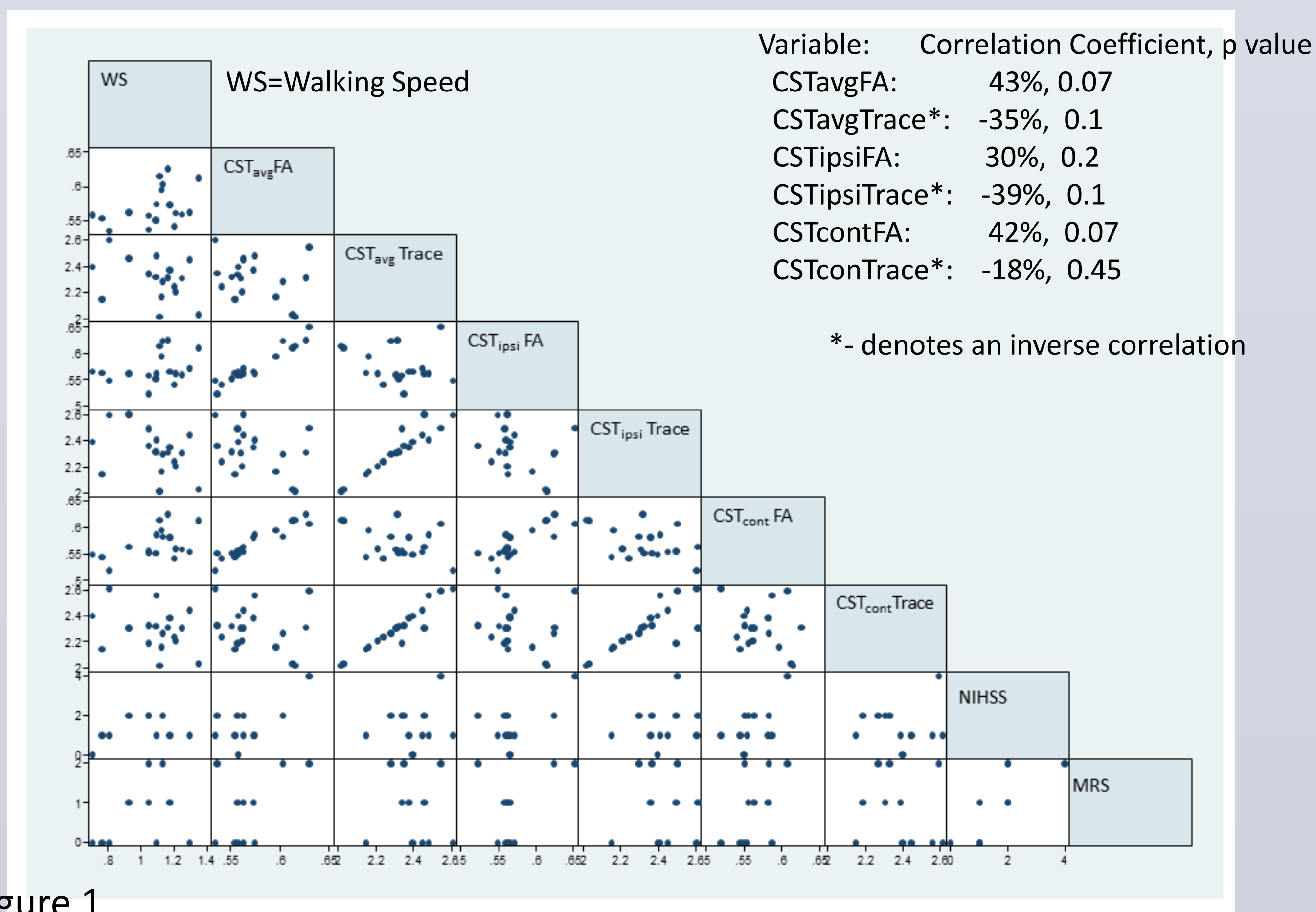


Figure 1

RESULTS

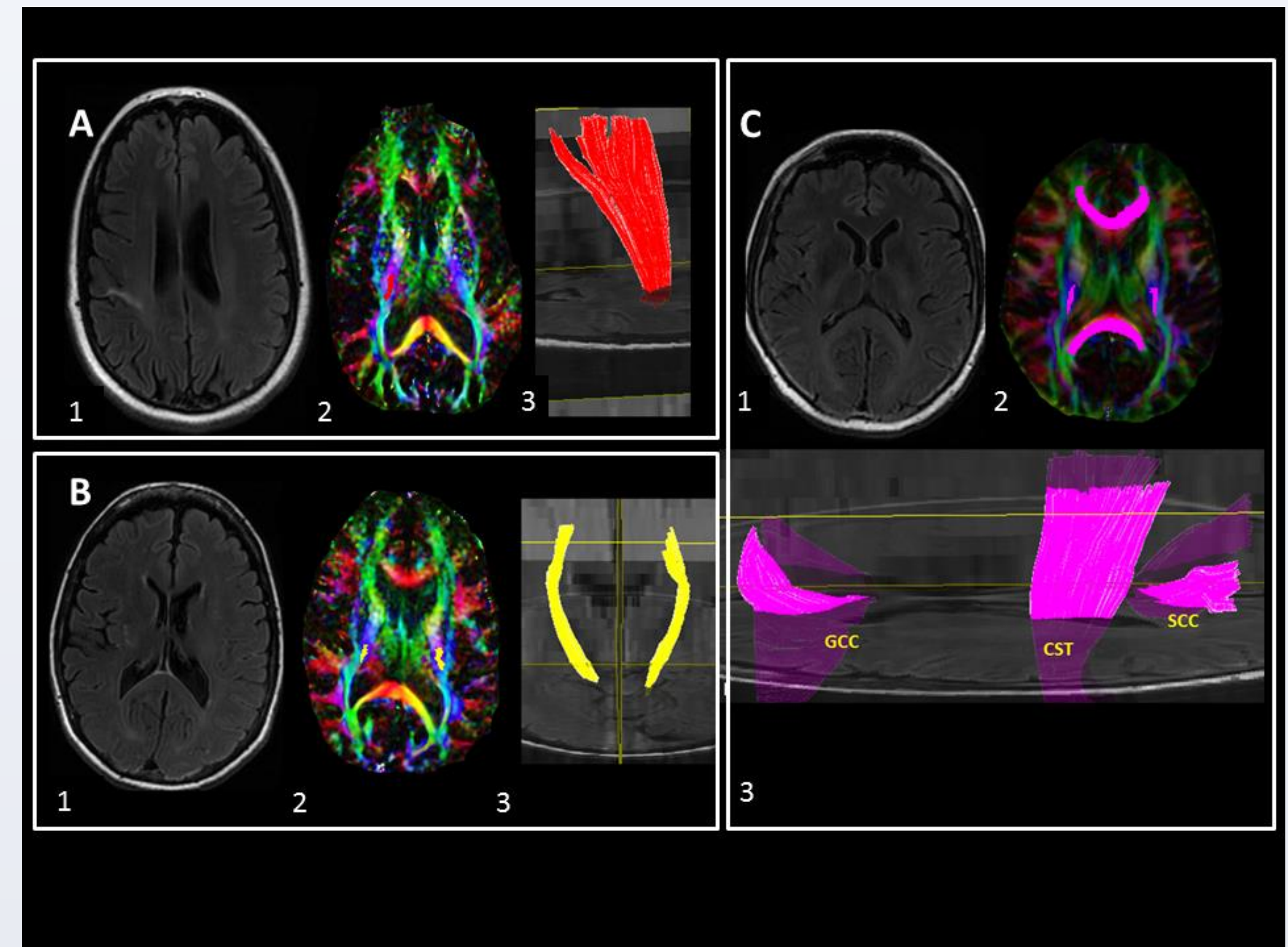


Figure 2

Above are provided two examples for typical patient targeted for this study. A: A 50 yr old female, with mRS and NIHSS of 2 in the setting of a small right parietal infarct seen on FLAIR (1). A normal appearing corticospinal tract seen on color map (2) and 3D reconstructions (3). B: Another 54 yr old female, with an mRS of 1, NIHSS of 2 in the setting of a small right corona radiate/internal capsule infarct seen on FLAIR (1) with no visible abnormalities in the corticospinal tracts on color maps (2) or 3D reconstructions (3). C: A control subject, a healthy 66 year old female, normal FLAIR (1), normal appearing color map, (2), depicting the 3D-reconstructions of three major fiber bundles chosen for analyses (3), GCC: Genu of Corpus Callosum, SCC: Splenium of corpus callosum and CST: Corticospinal Tracts.

CONCLUSIONS

There are conventional MRI occult abnormalities in the contralesional and ipsilesional CST in chronic stroke patients despite small volume primary infarcts. Walking speed was significantly abnormal despite negligible abnormalities on MRI and mRS≤2. The CST diffusivity was more sensitive to detect these changes. However the CST FA was a more significant predictor of walking speed. Both average CST and contralesional CST FA predict motor function measured as walking speed.

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