Subject-Specific Approach for Detecting Corticospinal Tract Abnormalities in Stroke Patients

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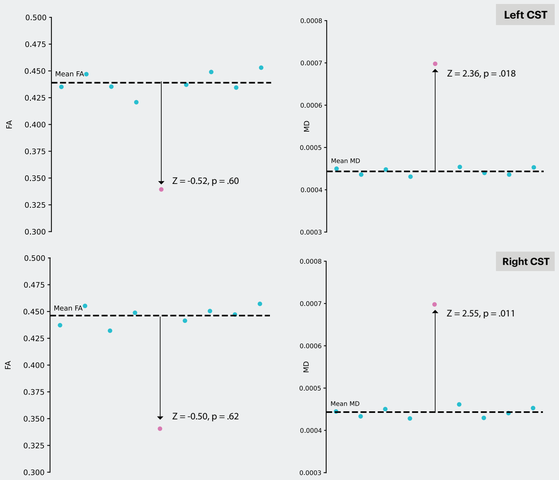
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Introduction

Stroke can result in significant damage to the corticospinal tract (CST), which is associated with motor functioning[1]. This can impair motor execution and hinder an individual's functional independence in daily life. Diffusion MRI (dMRI) is often used to detect changes in the white matter diffusion metrics, such as fractional anisotropy (FA) and mean diffusivity (MD). However, analyses of such nature only provide group comparison and do not account for individual variations. In this study, we developed a framework to detect white matter changes at the individual level.

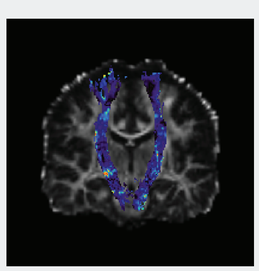
Results



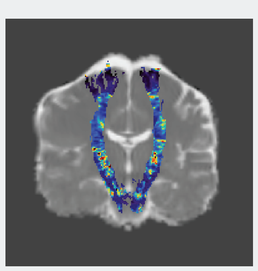
Tract-based

There was no statistically significant difference between fractional anisotropy (FA) of the patient and the healthy subjects on both left and right CST.

Mean diffusivity (MD) of the patient in both left and right CST was significantly lower compared to the health subjects



FA Z-score color map

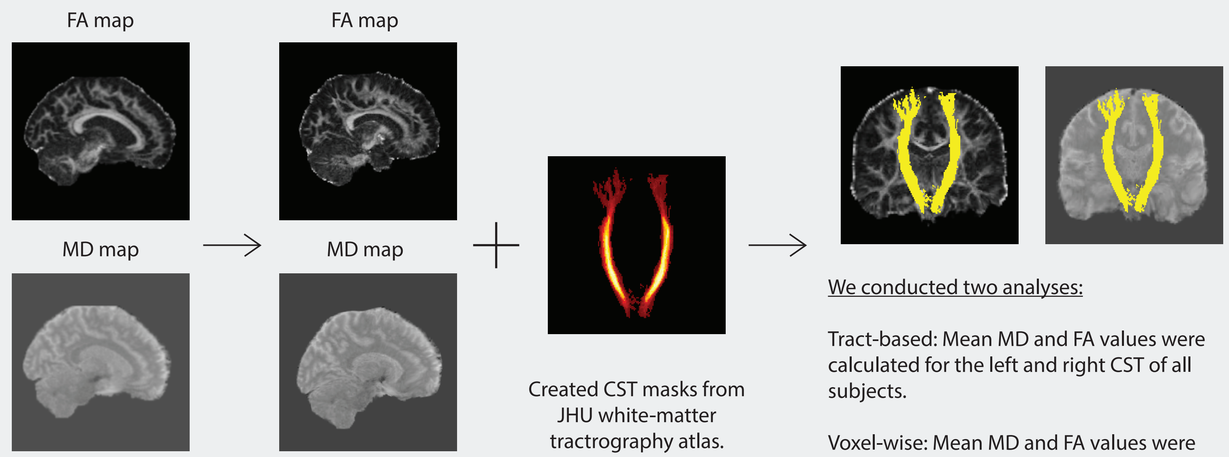


MD Z-score color map

Voxel-wise

We plotted the patient's Z-score in the tract space as a color-coded map to display how the patient's DTI matrices deviate from those of healthy subjects.

Method



We generated FA and MD maps (8 Healthy, 1 Patient).

Warped patient space into standard space.

Created CST masks from JHU white-matter tractrography atlas.

<u>We conducted two analyses:</u>

Tract-based: Mean MD and FA values were calculated for the left and right CST of all subjects.

Voxel-wise: Mean MD and FA values were calculated for all voxels in the left and right CST across all subjects.

Conclusions

- The subject-specific approach in our study allowed us to examine the deviation of the diffusion matrices of a stroke patient from the healthy brains.
- Stroke disrupts the axonal structure, leading to a reduction in the FA of voxels. At the same time, the stroke also disrupts the structural barriers, leading to an increase in MD.
- Across all voxels, MD values deviated more from the healthy brains compared to FA. This can be attributed to factors such as oedema and inflammation that increase water diffusion in the brain.
- Future work could involve increasing the healthy subjects sample size as well as including additional white-matter tracts.

Acknowledgement

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References

1 Maraka, S., Jiang, Q., Jafari-Khouzani, K., Li, L., Malik, S., Hamidian, H., Zhang, T., Lu, M., Soltanian-Zadeh, H., Chopp, M., & Mitsias, P. D. (2014). Degree of corticospinal tract damage correlates with motor function after stroke. Annals of Clinical and Translational Neurology, 1(11), 891–899. https://doi.org/10.1002/acn3.132