

Tracking Recovery of the White Matter following Ischemic Stroke

Authors: Reed S Geisler, M.Eng.¹; Yousef Hannawi, M.D.²
Institutions: 1: MD Program, 2: Department of Neurology

Background

Constraint-induced movement therapy (CIMT) is a physical rehabilitation technique that can be used to facilitate motor recovery following stroke. Integrity of white matter motor fibers measured through Diffusion Tensor Imaging (DTI) has been shown as a predictive marker for motor recovery following acute ischemic stroke. DTI and CIMT both have established utilization in the measure of white matter destruction and rehabilitation following stroke. Early work has been conducted to evaluate DTI as a prognostic indicator of stroke recovery, but direct evaluation of the techniques in a paired manner, where conducted, have been limited.

Hypothesis

Our objective is to determine factors associated with functional recovery following stroke. We aim to investigate the temporal relationship of white matter tract recovery as measured by fractional anisotropy (FA) through DTI and improvement of motor scores following CIMT in chronic stroke patients. We hypothesize that FA of the white matter tracts can be a biomarker for recovery following chronic stroke in patients undergoing CIMT.

Methods

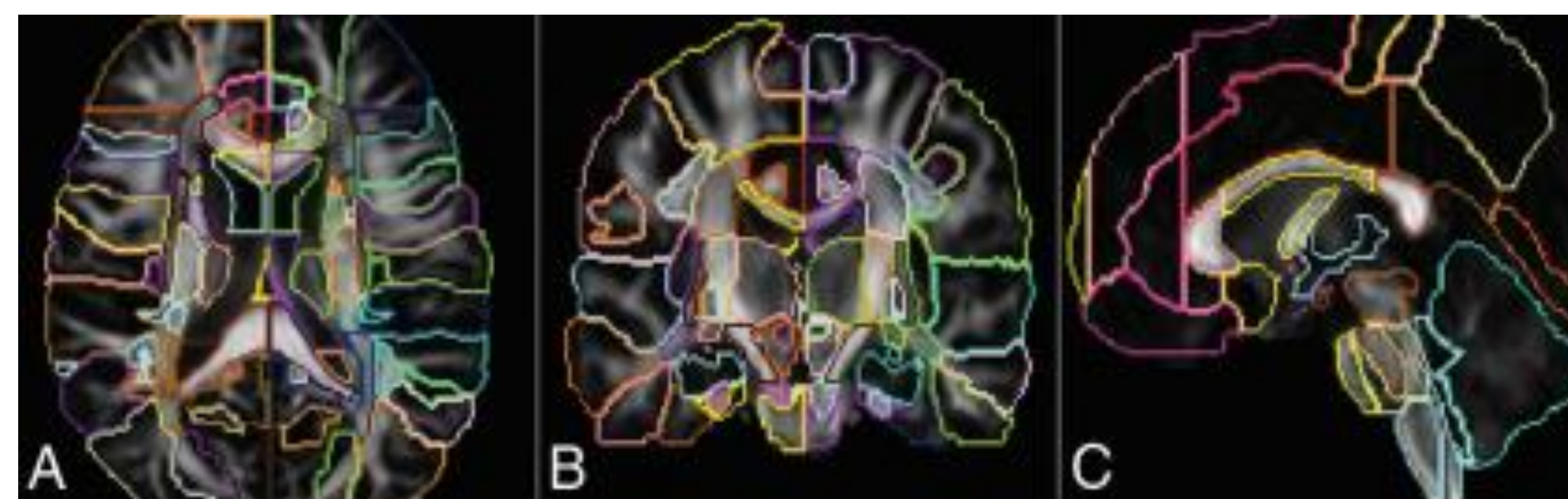


Figure 1: Example segmentation of FA map onto white matter atlas¹

This study is based on analysis of prospective clinical trial data of chronic stroke patients (n=31) who were enrolled in a randomized clinical trial of CIMT immediately following enrollment or delayed CIMT (17 days after enrollment). Primary motor measures including bilateral activity monitors, wolf motor function testing and action research arm testing were performed prior to, midway through, and immediately post treatment (up to two week follow up). All subjects were followed for a duration of 4-6 weeks and had brain MRI performed on 3T MRI during the primary motor assessment. DTI analysis was completed via Large Deformation Diffeomorphic Mapping to a white matter segmented atlas in MRISudio, followed by a preliminary two-sample Wilcoxon rank-sum test comparing white matter segments in MRI scans prior to initiating therapy and on last followup (4-6 weeks later).

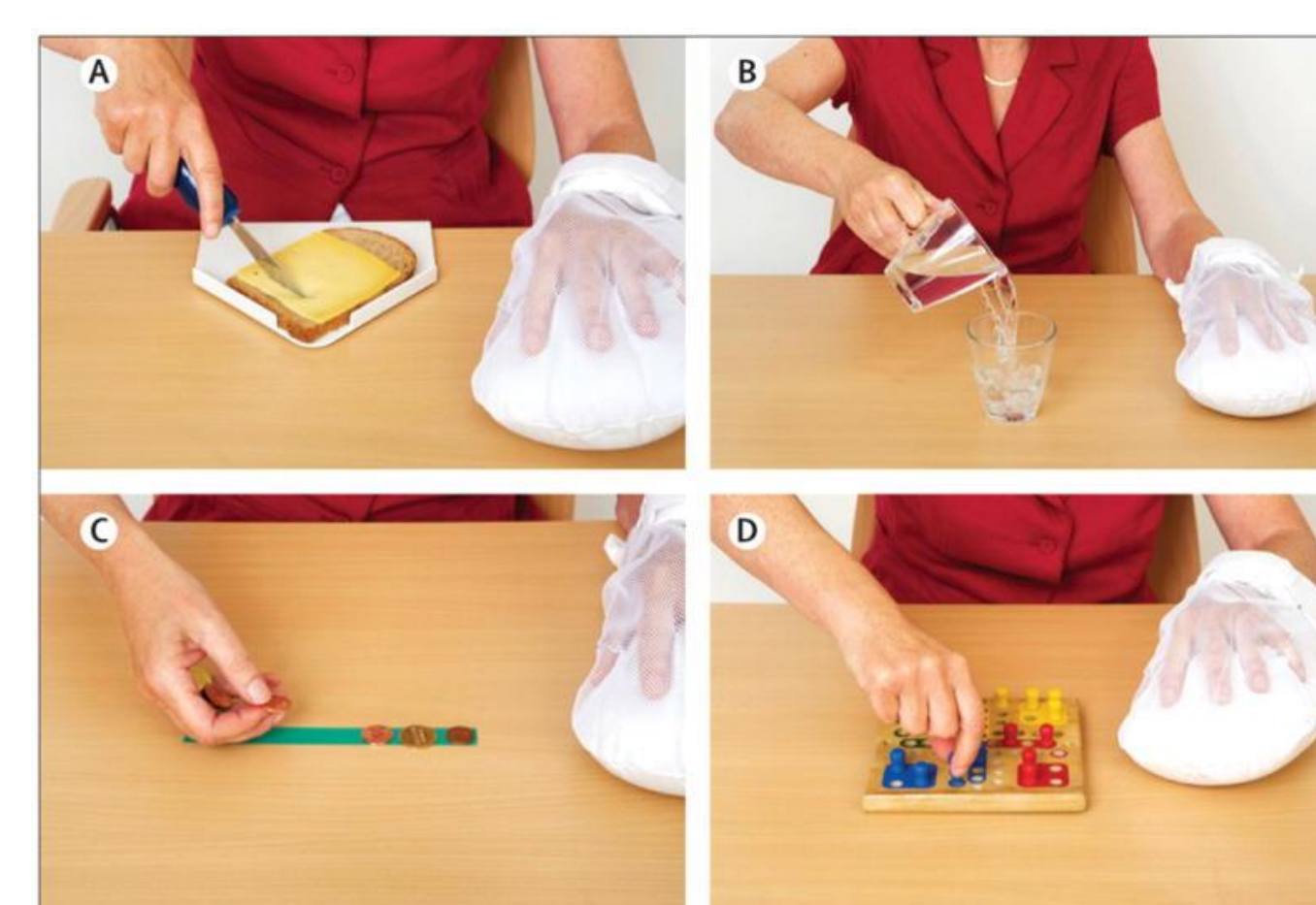


Figure 2: Constraint-induced motor therapy²

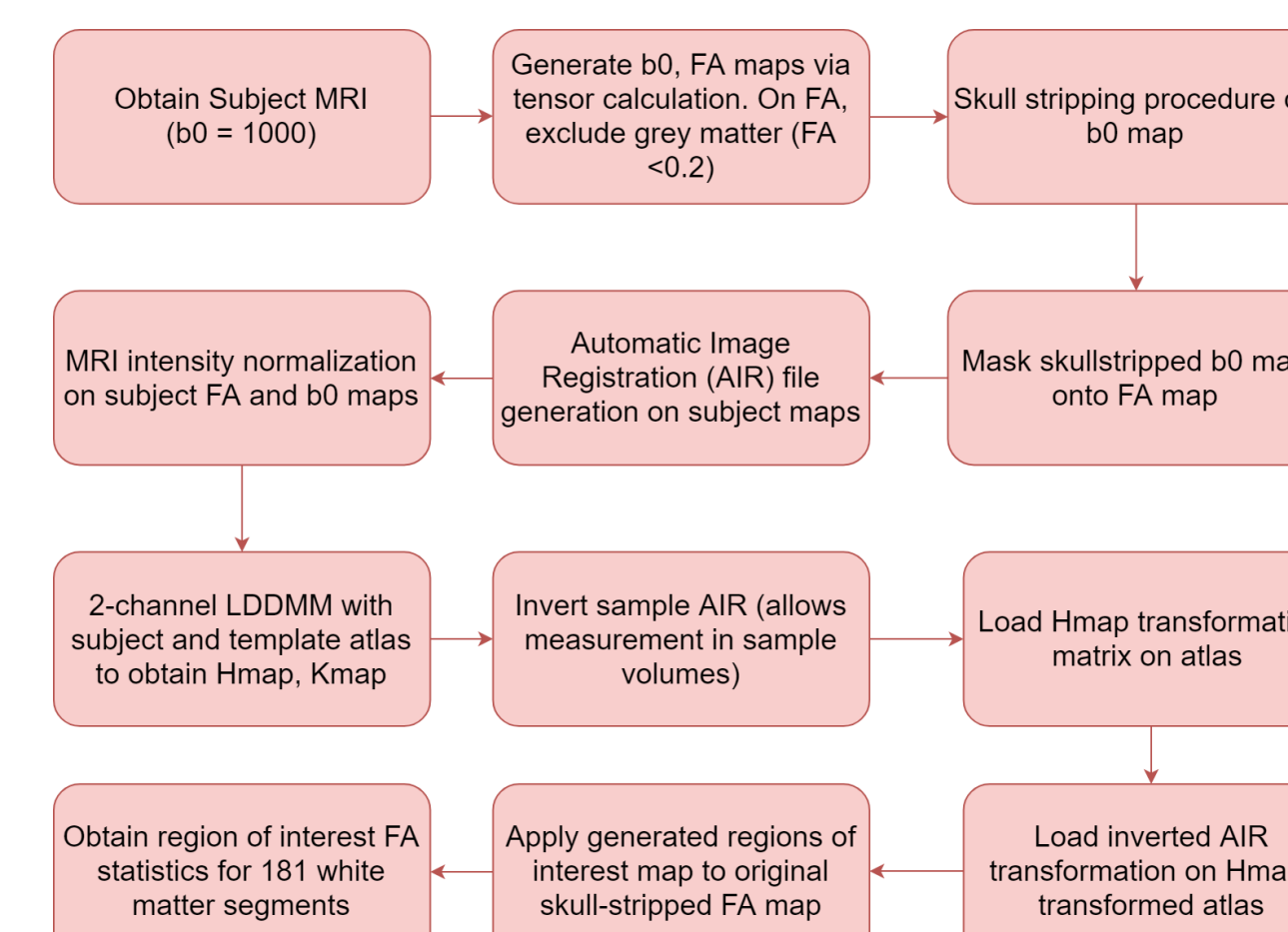


Figure 3: DTI analysis procedure

Results

DTI analysis was completed on a 181 white matter segment “Eve” atlas. DTI metrics including FA were measured for each of these segmented regions. Wilcoxon rank-sum testing on a subset of patients (n=15) and 20 was performed with Stata as preliminary analysis of white matter recovery.

Atlas (L, R)	Anatomical reference	p-value	
		Left	Right
133, 134	Internal capsule	0.5068	0.2371
139, 140	Cingulum	0.254	0.8846
151, 152	Sagittal stratum	0.5069	0.9174
155, 156	Superior longitudinal fasciculus	0.5202	0.3614
101, 102	Corticospinal tract	0.5475	0.6041
117, 118	Corona radiata (anterior)	0.4937	0.7244
119, 120	Corona radiata (superior)	0.2211	0.3506
121, 122	Corona radiata (posterior)	0.6334	0.5203
123, 124	Genu of corpus callosum	---	0.4306
125, 126	Body of corpus callosum	0.221	---
127, 128	Splenium of corpus callosum	1	0.8682

Acknowledgement

Student engagement in this project was made possible by the Roessler Medical Student Research Scholarship.

References

- Hannawi, Y., L. R. Yanek, B. G. Kral, et al. 2018 Hypertension Is Associated with White Matter Disruption in Apparently Healthy Middle-Aged Individuals. *AJNR. American Journal of Neuroradiology* 39(12): 2243–2248.
- Kwakkel G, Veerbeek JM, van Wegen EE, Wolf SL. Constraint-induced movement therapy after stroke. *Lancet Neurol.* 2015;14(2):224–234. doi:10.1016/S1474-4422(14)70160-7