Inter-operator variability of tractography-derived measures in corticospinal tract

{Richard Agajanian, Averi Barrett, Rachel Custer, Yin He, Tasfiya Islam, Matthew Lahey, Cooper Larson, Omeed Mahrouyan, Clarissa Morales, Jovicarole Raya, Nooralhoda Sadeghi, Nien-Chu Shih, Matthew Thurston, Amaryllis Anna Tsiknia, Xin Wang}*, Kay Jann, Ryan P Cabeen, Farshid Sepehrband

*** Equal first authors**

USC Master of Science in Neuroimaging and Informatics (NIIN),
USC Stevens Neuroimaging and Informatics Institute, Keck School of Medicine, University of Southern California, Los Angeles, CA

LONI
USC Laboratory of Neuro Imaging

USC Stevens Neuroimaging and Informatics Institute

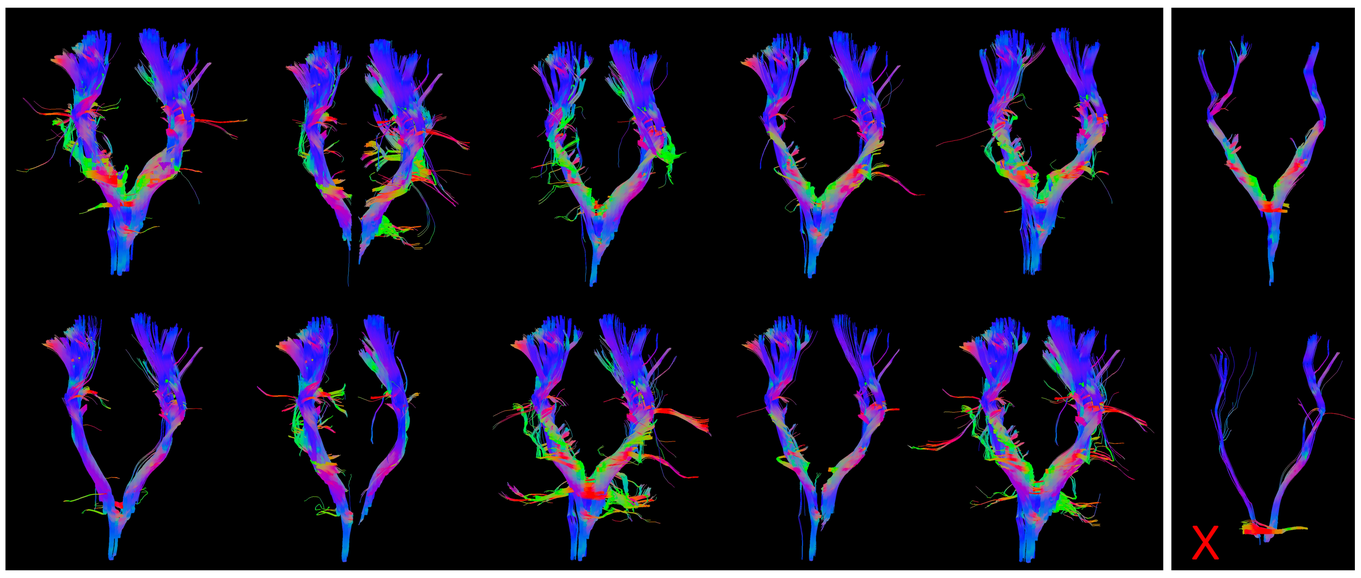
Introduction

Improved local reconstruction models, careful algorithm designs and optimized parameter setting have resulted to drastic improvement of tractography outcomes in comparison to its early days.

Yet, one aspect of the tractography which is less studied is the operator dependency for the steps that requires manual intervention, such as seed point identification and drawing inclusion and exclusion masks.

These steps could affect the tractography-derived measures about tract morphology and underlying structural properties.

Tractography



Tractography results of the corticospinal tract reconstruction. Two tracts on the right did not pass the quality control and were not included in the analysis.

Method

Here we compared tractography-derived morphometric and DTI measures of corticospinal tract reconstruction across 12 trained operators, while keeping data, preprocessing, local reconstruction, tractography algorithm and parameters identical.

- Multi-fiber ball-and-sticks local reconstruction
- Deterministic tractography
- Catani atlas was presented as guideline
- Only seed point and inclusion/exclusion criteria were drowned by operators
- No cortical endpoint was used

False positives and false negatives were intentionally not corrected by tractography experts, to allow a higher inter-rater variability.

Evaluation

After tractography, streamlines of left and right corticospinal tracts were merged. Average tract length and volume were estimated. Streamlines were then used to obtain a weighted average of DTI measures (FA, MD, RD and AD), which were weighted based on tract density.

Data and Analysis

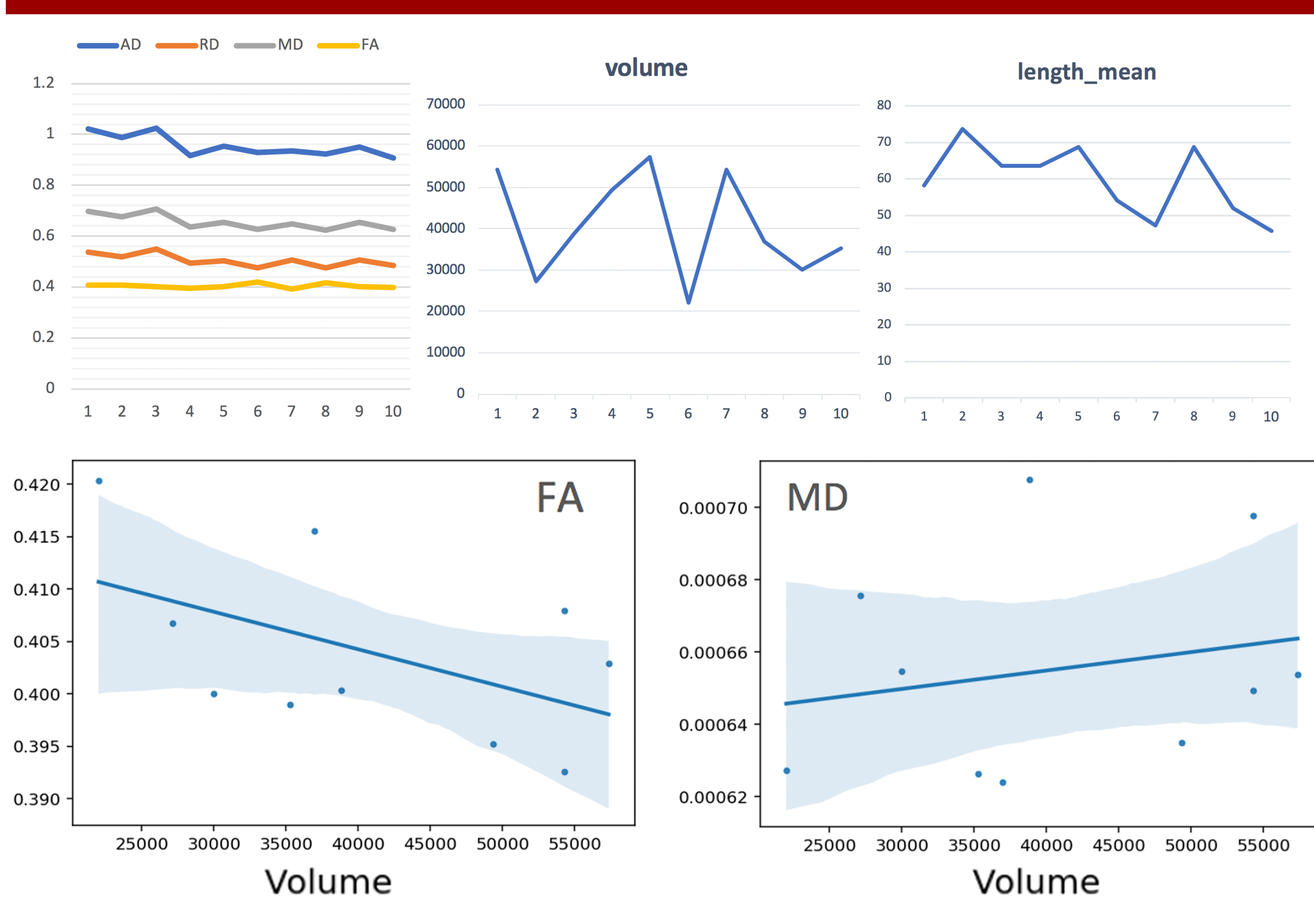
Data processing and Tractography was done using the Quantitative Imaging Toolkit (QIT) http://cabeen.io/qitwiki.

Data: MRI was acquired from a healthy normal adult in an IRB-approved study. Imaging was conducted on a GE 1.5 T clinical scanner and included a T1-weighted volume (1x1x1.3mm, resolution 256x256x120) and dMRI protocol (2x2x2mm, 64-direction, b=1000s/mm2, resolution 128x128x72).

Preprocessing: The dMRI data was corrected for motion and eddy current artifact by performing affine registration of each DWI to the baseline scan and performing a corresponding rotation of the b-vectors. Multi-fiber ball-and-sticks diffusion modeling was performed using FSL BEDPOSTX.

Tractography: Tractography was performed using the VolumeStreamTract module in QIT, which supports multi-fiber deterministic tractography.

Results



- FA and AD showed least inter-operator variability
- AD had the highest variance across diffusivity measures
- Tract volume showed high inter-operator variability
- We noted correlations (although non-significant) between volume of the extracted tract and DTI measures.

Resources (point your phone camera at the screen)

USC NIIN

QIT

Tracts video

USC IMG