Human hand allotransplantation has been carried out in over 80 cases to date, and the success of the procedure along with functional restoration makes it a clinical reality for the future. With new understandings in brain plasticity[1,2], hand transplantation provides a unique opportunity to study cortical neurointegration as the new limb is incorporated into the existing somatosensory and motor pathways. In this study, MRI based Diffusion Tensor Imaging (DTI) and Diffusion Spectrum Imaging (DSI)[3] are used in high definition fiber tracking (HDFT) study of the substantial structural reorganization occurring in neurointegration.

Methods

- Scanned under IRB protocol using a whole body Siemens TrioTim 3Tesla (Siemens, Erlangen, Germany).

Regions of Interest

Somatosensory:
- Spinothalamic
- Thalamo-
- Spinothalamic
- Thalamocortical

Motor:
- Corticospinal

HDFT using Diffusion Toolkit Track Vis[3]

Unilateral Transplant Patient
- 24 yo, male, right mid-forearm allotransplant
- 4 scans over 12 months
- 4 x DTI 256 directions
- TE/TR=91/8900ms,
  Vox=2x2x2mm³, Res=128x128x67
- b-value is from 0 to 1000s/mm²

Bilateral Transplant Patient
- 35 yo male bilateral
- Left – wrist; Right – above elbow
- 4 scans over 24 months
- 2 x DTI (256); TE/TR = 91/8900ms,
  Vox=2x2x2mm³, Res=128x128x67, b-
  value: 0 to 1000 s/mm²
- 2 x DSI (257); TE/TR = 154/9500ms,
  Vox = 2.4 x 2.4 x 2.4 mm³, Resolution = 96 x 96 x 50.
  b-value is variable from 0 to 7,000 s/mm²

Acknowledgments: Stephen Yutzy, Denise Davis

Results

The study demonstrates changes in cortical fiber tracts after hand transplantation. This suggests cortical neurointegration occurring as the new allotransplants undergo somatosensory and motor connections. MRI diffusion based HDFT provides an objective sequential analysis of cortical neurointegration, and fiber tractography serves as viable tool for relative comparison of structural reorganization in fibers. The tractography calculations suggest a possible correlation between the extent of increased fiber density and physical rehabilitation with active limb use.

References: