ABNORMALITIES IN THE ANTERIOR LIMB OF THE INTERNAL CAPSULE IN SCHIZOPHRENIA USING DIFFUSION TENSOR IMAGING

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Abstract
An integral part of higher order cognitive function lies in the cognitive and limbic feedback loops of the frontal-subcortical region. The white matter tracts found in the anterior limb of the internal capsule (AL-IC) from the last segment of these loops. Using structural MR for region of interest (ROI) volumetric measurements, and diffusion tensor imaging (DTI) for diffusion index analysis, we explored differences in the AL-IC between schizophrenics and normal controls.

Background
Volumetric measurements revealed no difference in volume between diagnostic groups. The diffusion analyses showed a significant decrease in FA in schizophrenics (p = .017 and p = .010 for left and right AL-IC, respectively), with no significant mode differences, and near-significant increases in MD in schizophrenics (p = .068 and p = .065 for left and right AL-IC, respectively).

Discussion
• By drawing the AL-IC ROIs on structural images, a higher level of accuracy of white-matter delineation is achieved
• With an upsampled DWI space, the coregistration loses a minimum amount of accuracy.
• The decrease in FA and near-significant increase in MD provide evidence for structural abnormalities that may underlie functional deficits found in the disorder.
• Further studies needed to definitively differ in feedbacks and MD to disorder characteristics.

Methods
Subjects
• 20 male chronic schizophrenics and 22 male normal controls, group matched for age and parental socioeconomic status

Data Acquisition
• Images were acquired on a 1.5-T GE scanner:
  - Structural: 128 axial slices, 1mm x 1mm x 1.5 mm voxel size
  - Diffusion tensor: 35 coronal slices, 1mm x 1mm x 1mm voxel size

ROI analyses
• AL-IC was manually delineated on structural images, from which volumetric measurements were calculated, normalized for head size (Fig 1, 2)
• Abnormalities in the AL-IC fibers may disrupt connections crucial for higher order cognitive function
• This pathology may be source of functional deficits in schizophrenics
• DTI is a better means of studying these white matter fibers than structural MRI (Kubicki et al., 2003)

Diffusion analyses
• DWI space was upsampled to match structural image resolution – Fractional Anisotropy (FA), mode, and Diffusivity (MD) maps were extracted from upsampled space (Fig 3, 4)
• Segmented AL-IC volumes were coregistered to the corresponding upsampled DTI scans (Fig 5, 6, 7)
• FA, mode, and MD were measured within the AL-ICs (Fig 8)

Results
Volumetric measurements revealed:
• No significant difference between diagnostic groups in left and right AL-ICs (p = .024 and p = .610, respectively)

Diffusion analyses showed:
• A significant decrease in FA in both left and right AL-ICs (p = .017 and p = .010, respectively) in schizophrenia
• No significant left AL-IC mode difference (p = .900), and a near-significant decrease in right AL-IC mode (p = .061) in schizophrenics
• Near-significant MD increases in both left and right AL-ICs (p = .068 and p = .063, respectively) in schizophrenia

References

Fig 1. Coronal view of structural MRI with striatum and AL-ICs drawn
Fig 2. 3-D view of striatum showing relative size of AL-ICs
Fig 3. The original DTI space with dimensions 1mm x 1mm x 5mm was resampled to match the structural space (1mm x 1mm x 1.5mm)
Fig 4. Diffusion tensor maps were extracted from the upsampled DTI space: Fractional Anisotropy (FA), Mode, and Mean Diffusivity (MD)
Fig 5. Pre-coregistration depition of DTI and structural spaces
(a) DTI and structural scans overlaid show misalignments between scans
(b) 2-D representation of pre-rigid coregistration
Fig 6. Post-rigid coregistration depiction
(a) Rigid coregistration yields better overlaying of DTI and structural spaces
(b) 2-D representation shows need for shear & scaling
Fig 7. Final mapping of striatum and AL-ICs onto DTI space (right) and 2-D representation (above)
Fig 8. Graphical representation of FA:mode: MD contributions to diffusion tensor shape

FA, MODE, & MD MEASUREMENTS
VOLUM MEASUREMENTS
AFFINE COREGISTRATION
RIGID COREGISTRATION

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