Detailed Analysis of Age-Related Changes in the Corpus Callosum: Combined DTI and Morphometric MRI

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INTRODUCTION

The corpus callosum (CC) undergoes a variety of degenerative changes with normal aging, including atrophy that is particularly significant in anterior sectors relative to posterior sectors. Similar to patterns of atrophy, diffusion tensor imaging (DTI) studies demonstrate a reduction in fractional anisotropy (FA) in anterior sectors of the callosum with modest if any reductions in more posterior regions. The specific locations of fiber bundles affected by age-related changes within the CC are unclear because prior studies have limited their analyses to large subsectors of the CC based on somewhat arbitrary regional delineations. We examined age-related alterations in morphometric measurements of thickness and microstructural measurements of FA across the entire medial axis of the CC to determine the precise locations of age-related degeneration within the CC.

METHODS

•Younger (YA), middle aged (MA) and older adults (OA) were imaged on a Siemens 1.5 Tesla Sonata scanner:

•**T1-weighted MPRAGE scan:**TR = 7.3, TE = 3.2 or 3.0, flip angle = 7o, slice thickness = 1.3 mm, 128 slices, FOV = 256x256mm^2

•**Diffusion tensor scans:** TR = 14.4s, TE = 81ms, 2x2 mm in-plane resolution, 2 mm slice thickness, (no gap), 5/8 partial Fourier, 6 averages, 6 noncolinear directions with b value = 700 s/mm2, and 1 image, the T2 weighted 'lowb' image, with b value = 0 s/mm2. FA was calculated as described previously [1]

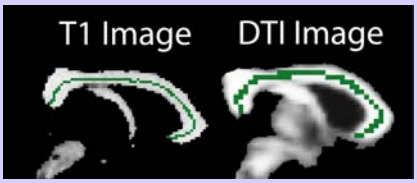
Medial Axis Extraction

•Image volumes were spatially normalized to optimally align the interhemispheric fissure in the superior-inferior orientation. The corpus callosum was segmented from the midsagittal plane.

•The skeleton of the corpus callosum is extracted with a topology preserving method [2].

•Thickness and fractional anisotropy values are measured at 100 equally spaced points along the medial axis.

•A point by point correspondence between thickness measurements from T1 scans and FA from DTI, allows the direct comparison of these values across imaging modalities.

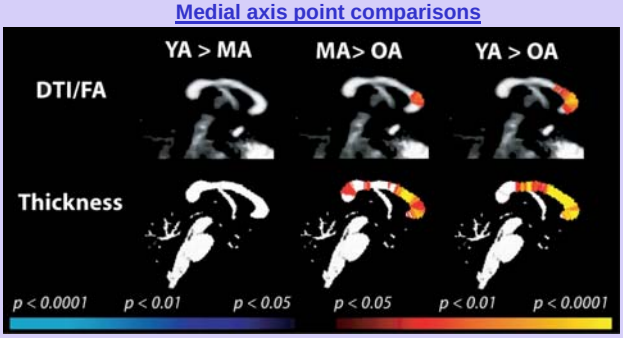


Demographics of YA, MA, and OA
All values presented for FA study/thickness

	N	Age	Sex	Edu
YA	28/41	26/26	11M/17F 15M/26F	17/17
MA	16/25	50/49	7M/9F 13M/12F	15/15
OA	20/31	71/72	10M/10F 13M/18F	16/16

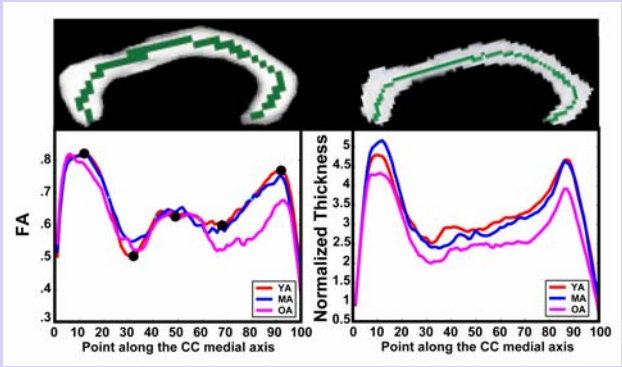
RESULTS

Medial axis point comparisons



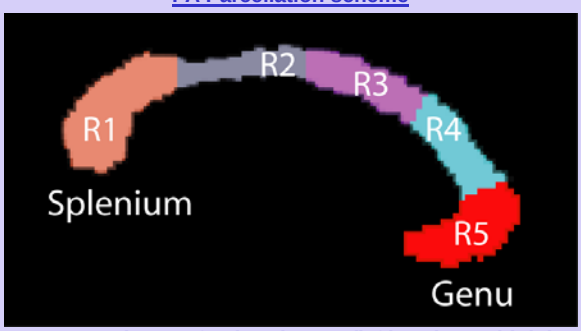
Point by point measures of FA and thickness were compared along the medial axis of the callosum by unpaired t-test. Note that a greater number of participants, and thus, greater statistical power exists for the thickness analyses.

Mean group plots of variation in FA (left) and thickness (right) along the medial axis of the callosum

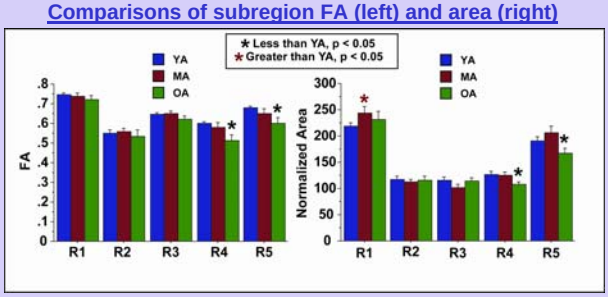


Peaks and valleys in FA, as demonstrated by the black circles above, were used to subdivide the callosum into 5 sections. Each parcellation is performed on an individual basis

FA Parcellation scheme

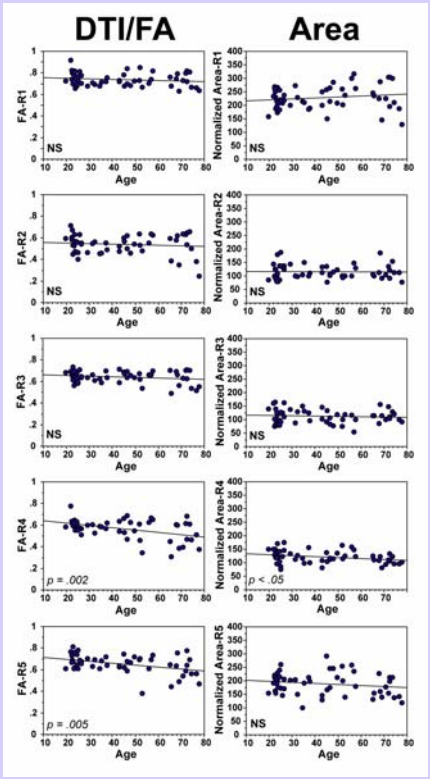


Comparisons of subregion FA (left) and area (right)



FA and area in the 4th and 5th (anterior) subregions were significantly reduced in OA compared to YA.

Callosal FA and area are regionally correlated with age



FA in the 4th and 5th (anterior) subregions of the callosum were most strongly correlated with age. Area in the 4th subregion was most strongly correlated with age.

CONCLUSIONS

•The corpus callosum shows regional degenerative changes with aging.

•Medial axis and subregion results suggest that these changes are most significant 4/5ths anteriorly in the callosum, with secondary changes in the most anterior segment of the structure.

•Changes in the anterior segments of the callosum were also apparent in the OA participants compared to the MA participants.

•Medial axis analysis and subregional designations based on FA variation could be useful for examining a variety of age and disease related changes in the callosum.

•Future research will examine how such changes are related to cortical degeneration and cognitive decline.

REFERENCES

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