P-33

Age-Related Changes of the Arcuate Fasciculus in Healthy Adults : Diffusion Tensor Imaging Study

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Introduction

- The arcuate fasciculus (AF) is a primary white matter tract connecting language comprehension and production centers.
- Left-right asymmetry within the AF has been consistently reported.
- However, quantitative evidence on age-related changes and hemispheric differences in healthy Korean adults remains limited.
- This DTI study quantified age-related and hemispheric differences in the arcuate fasciculus of healthy adults.

Methods

- **51 healthy Korean adults aged 20 to 75**
  - ✓ Participants were clinically screened, and those with neurological disorders or structural brain abnormalities were excluded.
- **Divided into three age groups based on white matter aging trends**
  - ✓ : Young (20-39), Middle-aged (40-59), Older adults (60-75).
- **Fiber tracking of the arcuate fasciculus (AF) was performed using DTI Studio software**
- **The AF was reconstructed using a two-region-of-interest (ROI) "AND" approach based on anatomical definitions.**
  - ✓ First ROI : the subcortical white matter of the superior temporal gyrus
    - to capture language comprehension pathways.
  - ✓ Second ROI : the inferior frontal gyrus
    - to capture language production pathways.
  - ✓ Fibers successfully passing through both ROIs were defined as the AF.
  - ✓ Conducted independently for both the left and right hemispheres.

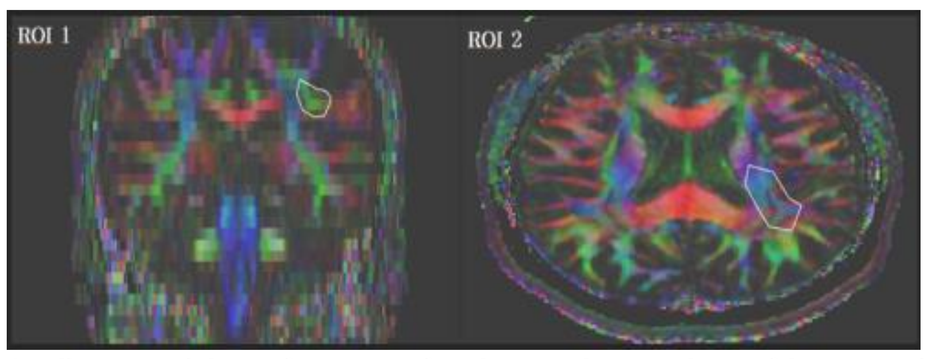


Fig. 1. Fiber tracking of arcuate fascicus using region-of-interest (ROI)

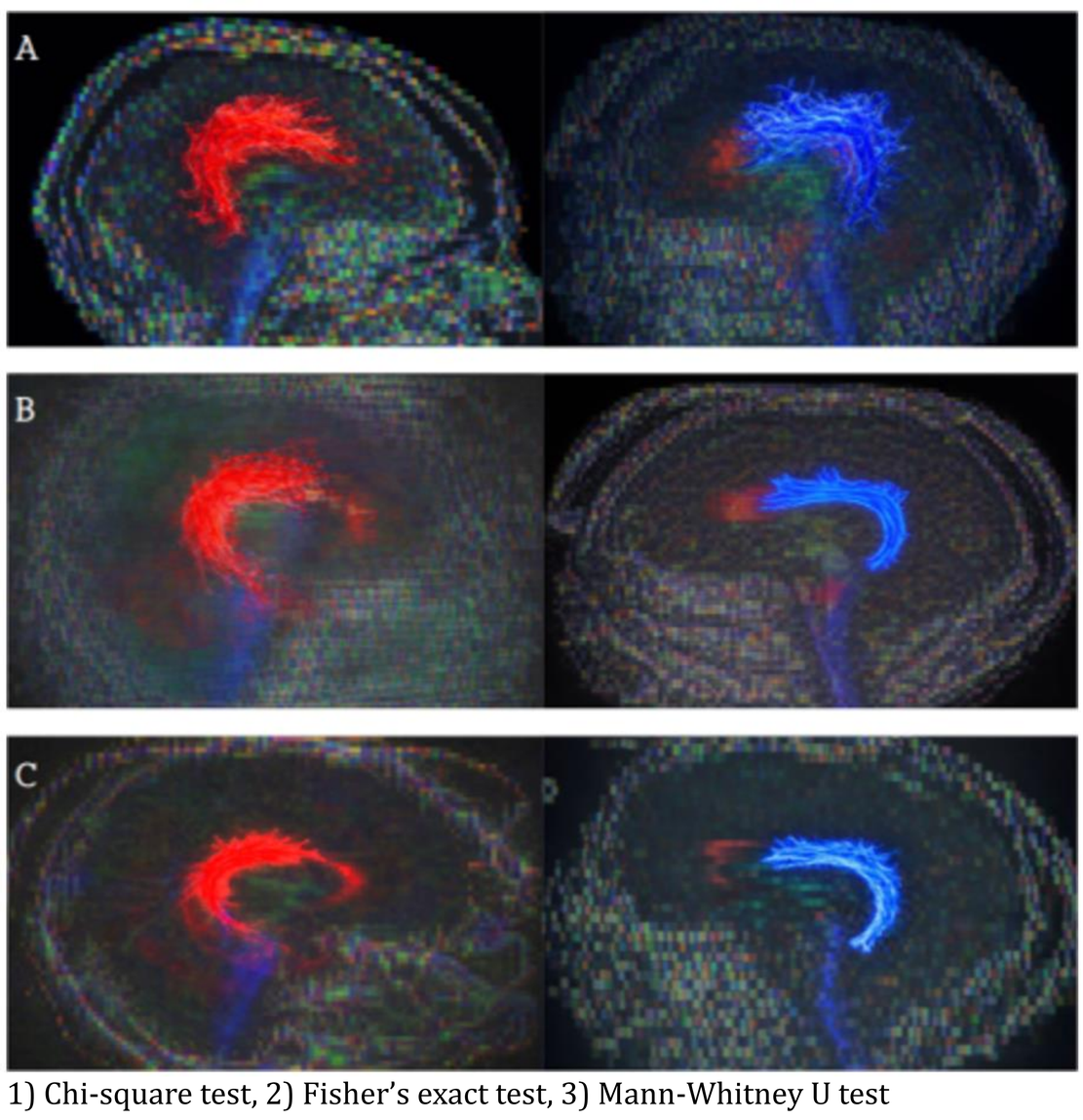
Results

Table 1. Comparison of left and right AF FN between age groups

	G1 (20–39y)	G2 (40–59y)	G3 (60–75y)	Inter-group comparison‡	Intra-group comparison†		
					G1–G2	G2–G3	G1–G3
FN Lt	611 ±124	608 ±110	497 ±108	**<.01***	.997	**.026***	**.025***
FN Rt	564 ±123	548 ±83	465.8 ±87	**.017***	.896	.065	**.027***

Data are presented as means ± standard deviations. * p < 0.05.
‡ One-way analysis of variance (ANOVA). † Scheffe post-hoc test.
FN, fiber number; AF, arcuate fasciculus; Lt, left hemisphere; Rt, right hemisphere

Figure 1. Tactography of Articulate fasciculus



1) Chi-square test, 2) Fisher's exact test, 3) Mann-Whitney U test
RG, rehabilitation group; NRG, non-rehabilitation group

Table 2. Comparison of left and right arcuate fasciculus fractional

	G1 (20–39y)	G2 (40–59y)	G3 (60–75y)	P-value (Inter-group comparison)‡
FA Lt	0.49 ±0.06	0.48 ±0.05	0.46 ±0.05	.069
FA Rt	0.47 ±0.05	0.46 ±0.05	0.45 ±0.05	.388

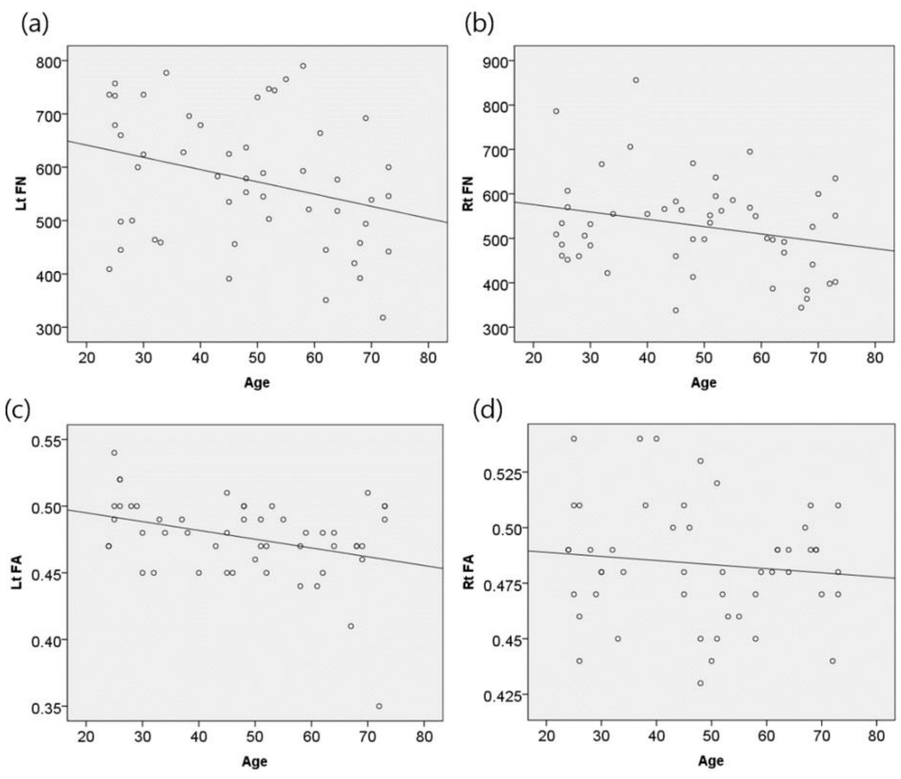
Data are presented as means ± standard deviations. Statistical significance was set at p < 0.05.
‡Kruskal–Wallis test. FA, fractional anisotropy; Lt, left hemisphere; Rt, right hemisphere.

Table 3. Correlation between age and FN, FA of AF

	r	P
FN Lt‡	−0.300	**0.033***
FN Rt‡	−0.252	0.075
FA Lt†	−0.268	0.057
FA Rt†	−0.103	0.470

Data are presented as correlation coefficients (r) and p-values. * p < 0.05.
‡ Pearson correlation analysis. † Spearman's rank correlation analysis.
FN, fiber number; FA, fractional anisotropy; Lt, left hemisphere; Rt, right hemisphere.

Figure 2. Correlations between age and FN and FA of the AF in both hemisphere



Left AF FN:
Significant negative correlation with age
(r = −0.300, p = 0.033)

Right AF FN:
negative correlation trend
(r = −0.252, p = 0.075)

Bilateral FA:
decreasing with age
no statistical significant
(lt: p 0.057, rt p 0.470)

- **Significant age-related decline in structural connectivity of arcuate fasciculus (AF) tracts**
- Left AF FN decreased significantly across age groups (Group 3 < Groups 1, 2)
- Age negatively correlated with left AF FN (r = -0.300, p = 0.033)
  - ✓ Clear age-related reduction in structural connectivity of the left language pathway

- Right AF FN declined significantly (post-hoc differences confirmed between Groups 1 and 3)
- Gradual but non-significant age-related decrease in bilateral fractional anisotropy (FA)
- Trend-level negative correlation between age and left FA (r = -0.268, p = 0.057)

Conclusion

- Age-related structural changes in the arcuate fasciculus are primarily characterized by a significant decline in fiber number (FN).
- This reduction in structural connectivity is found to be especially prominent within the left hemisphere of the brain.
- Consequently, FN serves as a more sensitive indicator for white matter aging than the relatively stable FA values.
- Overall, this study provides valuable normative reference data for healthy Korean adults, emphasizing distinct hemispheric aging patterns.