Infantile esotropia: white matter alterations, recovery and age effect

Abstract

Infantile esotropia (IE) is a complex condition characterized by early-onset strabismus that can disrupt visual and neural development. This study aims to explore the neuroimaging biomarkers of IE in children using the Automated Fiber Quantification (AFQ) method, focusing on white matter changes in relation to age and surgical intervention. The research examines the interaction between the pathology of IE and typical brain development, specifically the effects of surgery on brain microstructure. We compared the normal control group with the IE group, as well as preoperative and postoperative cohorts, focusing on changes in mean diffusivity (MD) and fractional anisotropy (FA). No significant age differences were observed between the normal control and IE groups ($p > 0.05$), while significant differences were found between preoperative and postoperative cohorts ($p < 0.05$). The IE group exhibited higher MD values compared to both the normal control and postoperative groups, suggesting alterations in white matter microstructure. FA values showed greater variability, with some regions showing lower FA and others higher in the IE group. Age-related effects were most pronounced in younger children, particularly between 5 and 6 years, who demonstrated more substantial postoperative changes in both MD and FA. Additionally, a positive correlation between strabismus angle and MD changes indicated that more severe ocular misalignment is associated with greater brain microstructural alterations. These findings underscore the complex interaction between developmental processes and the pathology of IE, highlighting the importance of early intervention. This study contributes to the understanding of how both the timing of surgical intervention and the severity of strabismus impact brain plasticity, offering new insights into the optimal age for surgery and the potential for recovery in children with IE.

Data

> Children under 8 years old (Age)

> Structural MRI & Diffusion MRI

* For T1:
* Align to AC-PC plane
* dtiMakeDt6FromFSL

* For DWI:
* EDDY CORRECT
* DTIFIT from FSL

> Strabismus Angle

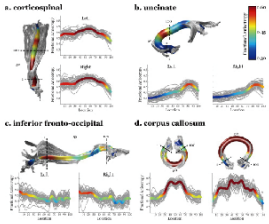
Control
AVE: 3.36 years
SD: 1.70
F/M=14/15

Esotropia -- preoperative
AVE: 2.56 years
SD: 2.06
F/M=6/11

Esotropia --postoperative
AVE: 3.55 years
SD: 2.00
F/M=7/6

AFQ

Automated Fiber Quantification

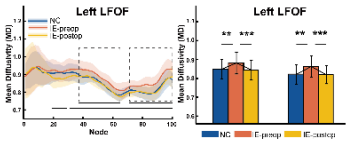


Yeatman JD, Dougherty RF, Myall NJ, Wandell BA, Feldman HM (2012) Tract Profiles of White Matter Properties: Automating Fiber-Tract Quantification. PLoS ONE 7(11): e49790. doi:10.1371/journal.pone.0049790

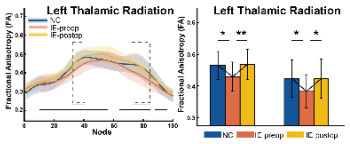
Analysis

1. MD/FA Analysis

* MD Representative Fibre

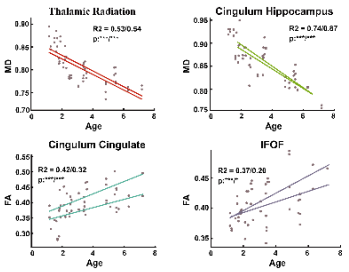


* FA Representative Fibre

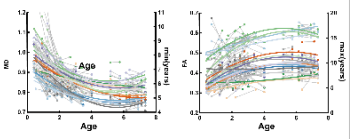


2. Age Effect on MD/FA

* Representative Fibre



3.Age-Dependent Variability



4. Contrasting Effects of Age and IE