Visualisation of nerve fibre orientation in the human optic chiasm using photomicrographic image analysis

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Introduction:
Compression of the optic chiasm typically gives rise to bitemporal hemianopia due to selective damage to the decussating nasal fibres. It is unclear why nasal fibres are particularly vulnerable to the extent of generating a sharp vertical cut-off in the visual fields. One theory suggests that this is due to the geometry of individual fibres within the chiasm.¹ Unfortunately, detailed anatomical information about the precise arrangement and crossing of nerve fibres in the chiasm is limited. This study aimed to clarify the microscopic anatomy of the chiasm, looking particularly at nerve fibre distribution and the location of nerve fibre crossings.

Methods:
A human optic chiasm obtained at autopsy was stained en bloc with silver stain and sectioned in the axial plane at 5 μm intervals. Photomicrographs were digitized and subdivided into smaller regions of interest (ROIs). Fibre orientation distribution data for each ROI were obtained and processed using ImageJ software and custom-written MATLAB code. The orientation data and crossing angles were then represented graphically.

Results:
The central portion of the chiasm was found to contain fibres travelling predominantly in parallel in a medio-lateral direction. Nerve fibre crossings were located in the antero-inferior and supero-posterior portions of the para-central parts of the chiasm.

Conclusions:
This study suggests that nerve fibre crossings are not located centrally in the chiasm but in the paracentral regions. The data from the study will be used to inform models of the optic chiasm which, in turn, will generate further insight into the pathophysiology of bitemporal hemianopia.

References:

Keywords: Optic Chiasm, Histology, Bitemporal Hemianopia, Photomicrographs

Financial Disclosures: The authors had no disclosures.

Grant Support: None.