

Multi-modal measurement of the myelin-to-axon diameter g -ratio in preterm-born neonates and adult controls

Andrew Melbourne¹, Zach Eaton-Rosen¹, Enrico De Vita³, Alan Bainbridge⁴, M. Jorge Cardoso¹, David Price⁴, Ernest Cady⁴, Giles S. Kendall², Nicola J. Robertson², Neil Marlow², and Sebastien Ourselin¹

¹Centre for Medical Image Computing, University College London, UK

²Academic Neonatology, EGA UCL Institute for Women's Health, London, UK

³Academic Neuroradiological Unit, UCL Institute of Neurology, London, UK

⁴Medical Physics, University College Hospital, London, UK



1) The UCL Preterm Development Project

Very preterm birth coincides with a period of rapid brain growth and development.

During the period between 30-40 weeks gestation rapid changes in micro and macro scale complexity occur.

Specifically, the development of axonal myelin sheaths is vital for increased speed and efficiency of electrical activity in the brain.

High performance MRI (multi-shell diffusion imaging, multi-echo T2 relaxometry and spectroscopy) can be used to measure brain changes during this crucial period.

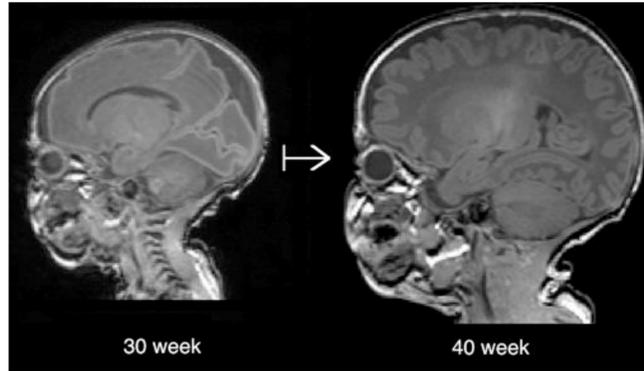


Fig 1. Cerebral growth visible on T1 weighted imaging in the same infant

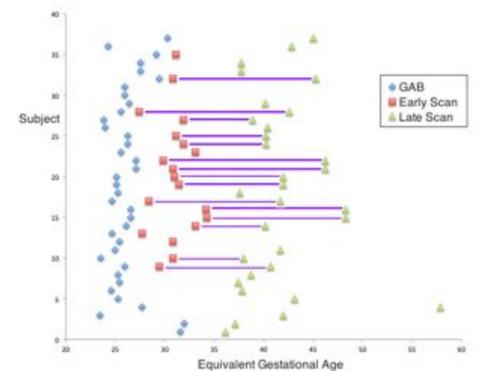
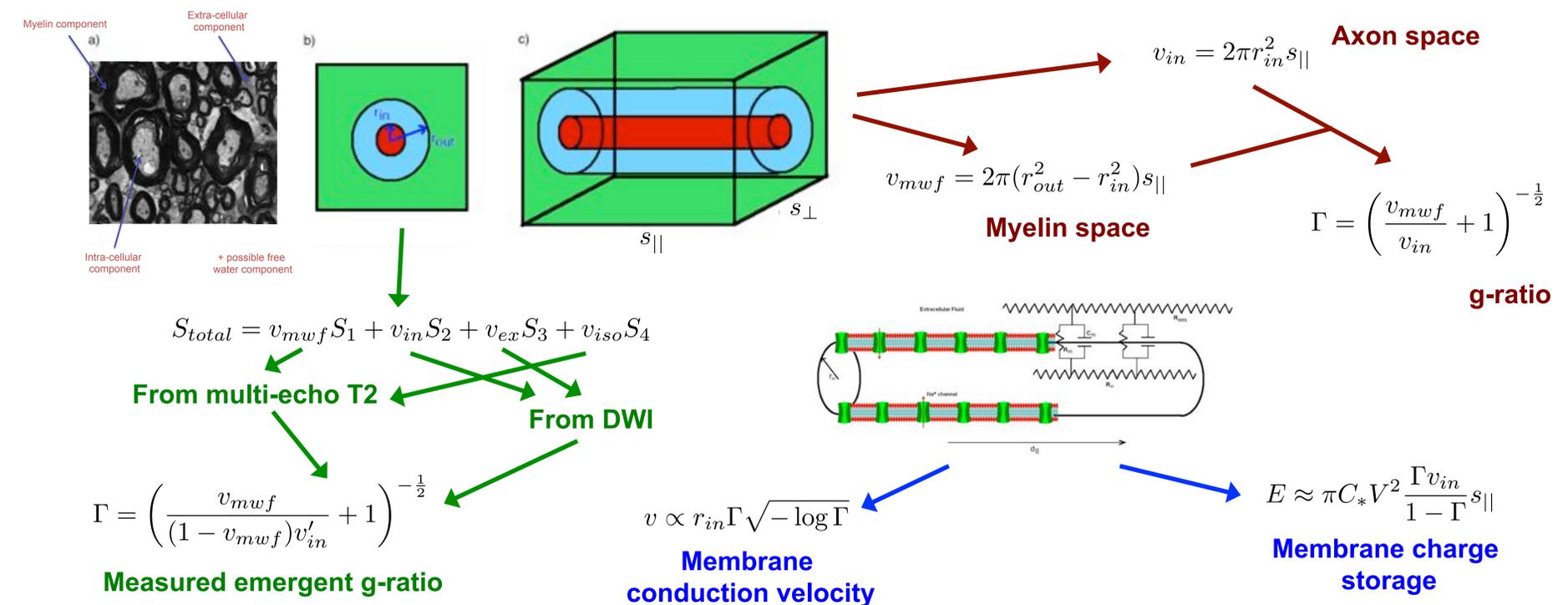


Fig 2: Infants imaged as part of the longitudinal UCL Preterm Development Project

2) From structural measurement to functional prediction?



3.1) Neonatal Results

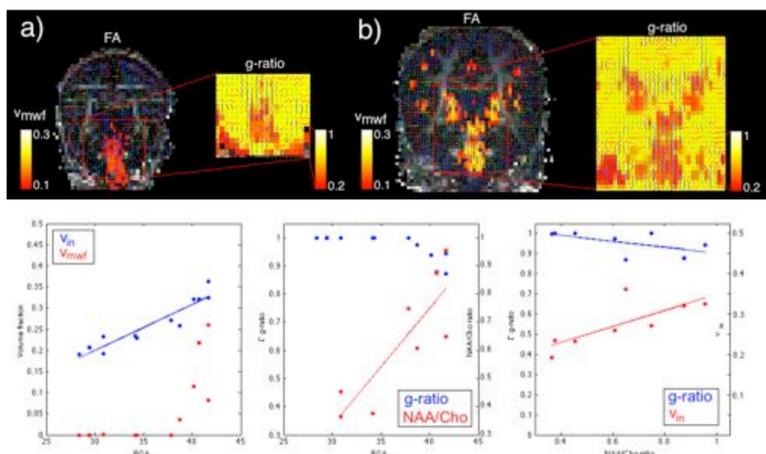


Fig 3. Multi-modal changes observed in neonatal white matter are consistent with a theory of T2 decrease with axonal proliferation rather than increased myelin.

11 preterm infants (mean birth gestation=25.1±0.7wks) DWI 16x b750s.mm⁻², 32x b2000s.mm⁻² (2mm isotropic), 32-echo T2 imaging T2 Relaxometry using GraSE with 12ms TE. WM voxel H-MRS (PRESS; TR/TE 2288/288ms).

3.2) Adult Results

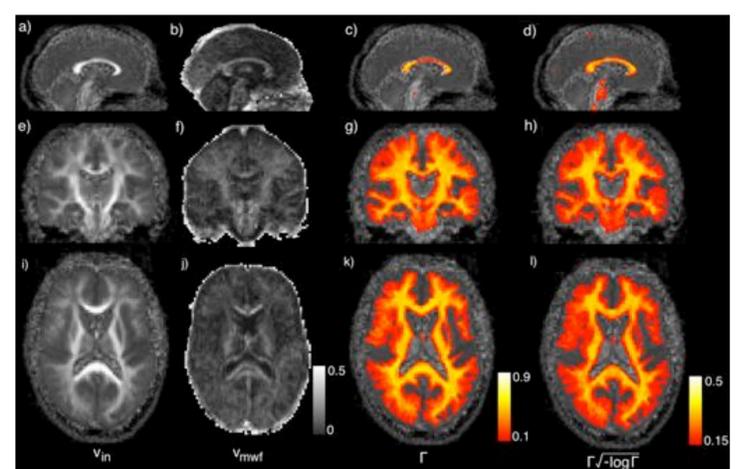


Fig 4. The group average g-ratio, overlaid here on anatomical imaging, has plausibility to be developed as a biomarker of energetic function.

7 adult controls (age range 23-54 yrs) DWI: 8x b300s.mm⁻², 32x b700s.mm⁻², 64x b2000s.mm⁻² (2.5mm isotropic). T2 imaging: 21 echo times (2.5mm isotropic, 19-150ms).

4) Conclusion

Myelin measurement is difficult, but we show here that in principle it can be used to make functional measurement from structural imaging.

Future work will improve performance and begin to investigate the longitudinal changes seen on imaging between 30 and 40 weeks equivalent gestational age..

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