Sunnybrook Neuroimaging Summer School

Diffusion module – Lecture 3 – Applications and interpretation of diffusion MRI

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Overview

Diffusion-weighted imaging

- Stroke
- Cancer

Diffusion tensor imaging

- Surgical planning
- White matter integrity

Clinical applications of diffusion weighted imaging in neuroradiology

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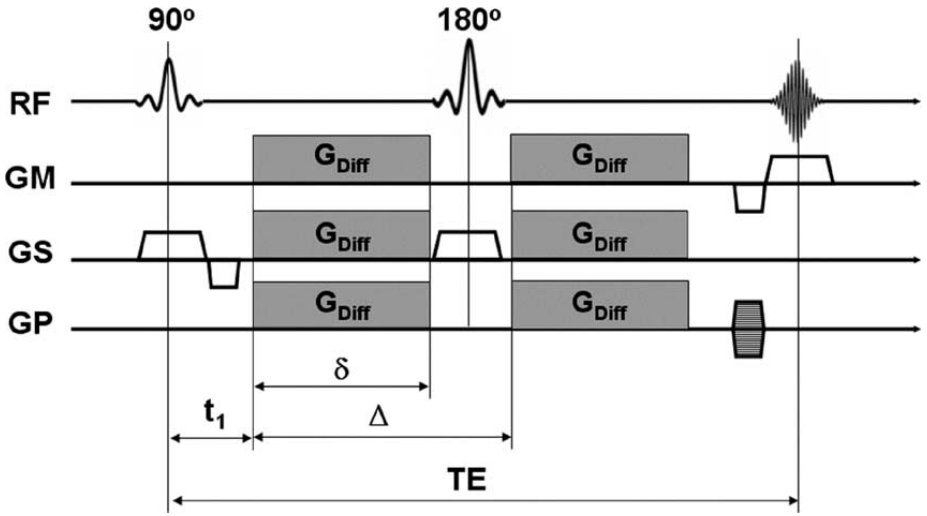
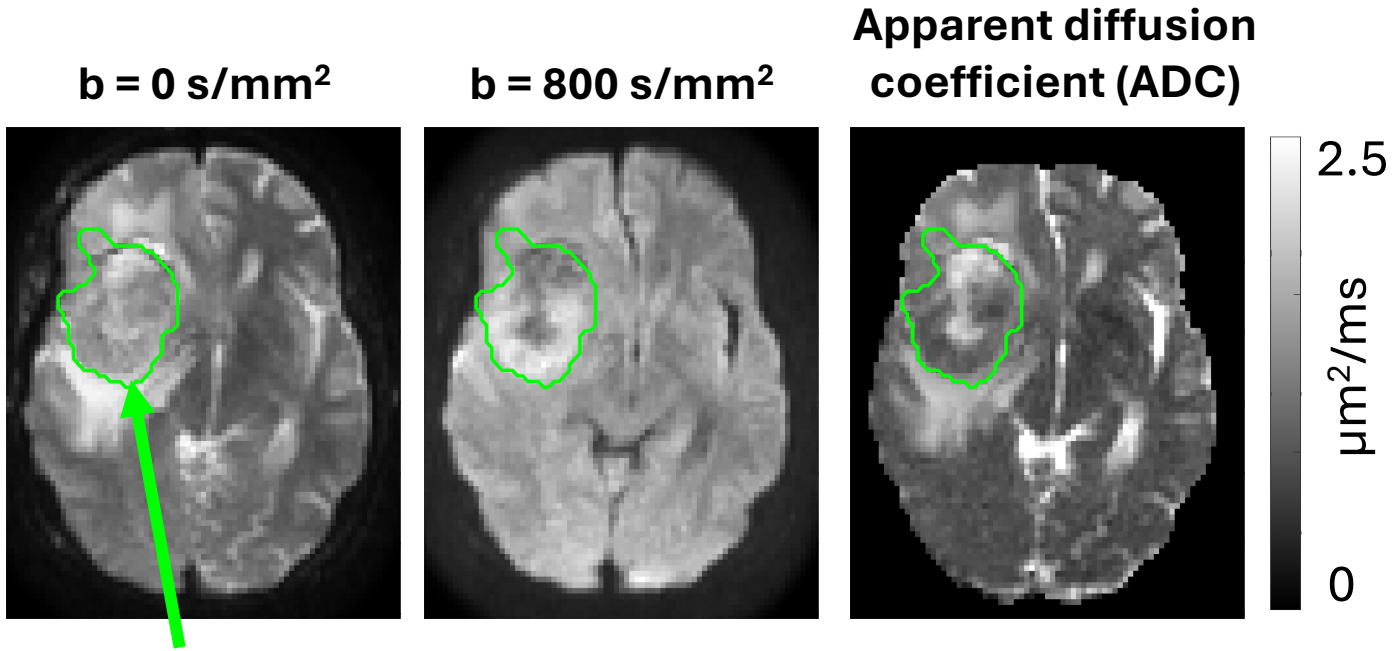
Clinical Applications of Diffusion Tensor Imaging

Alexander Lerner, Monique A. Mogensen, Paul E. Kim, Mark S. Shiroishi, Darryl H. Hwang, Meng Law

Recap of diffusion-weighted imaging

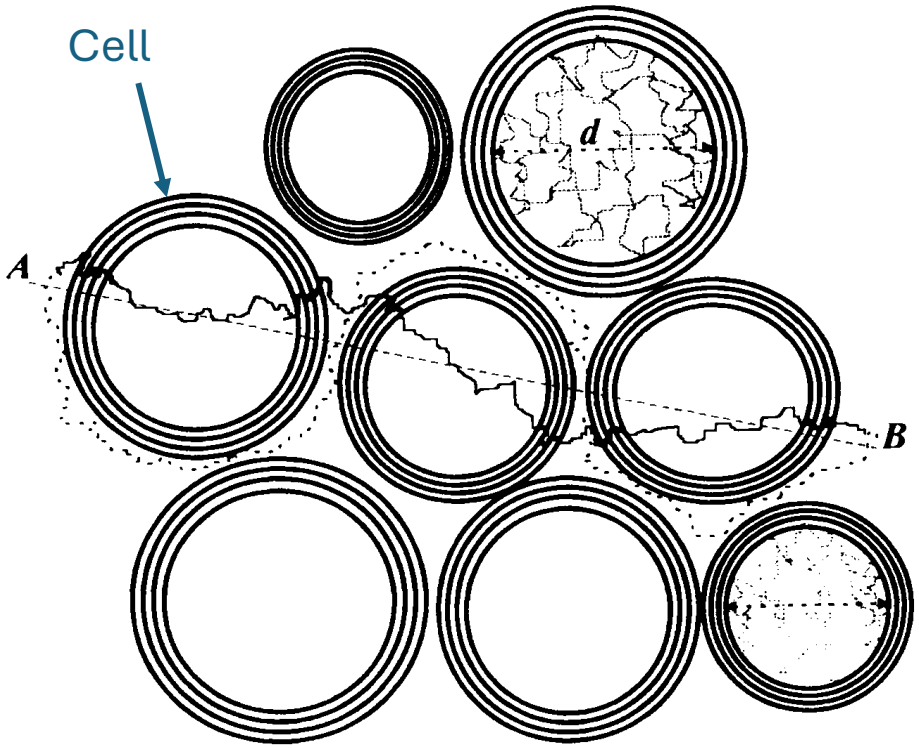


Bammer, *Eur J Radiol*, 2003



- Brownian motion of water attenuates signal
- Barriers restrict and hinder water diffusion (e.g., cell membranes)

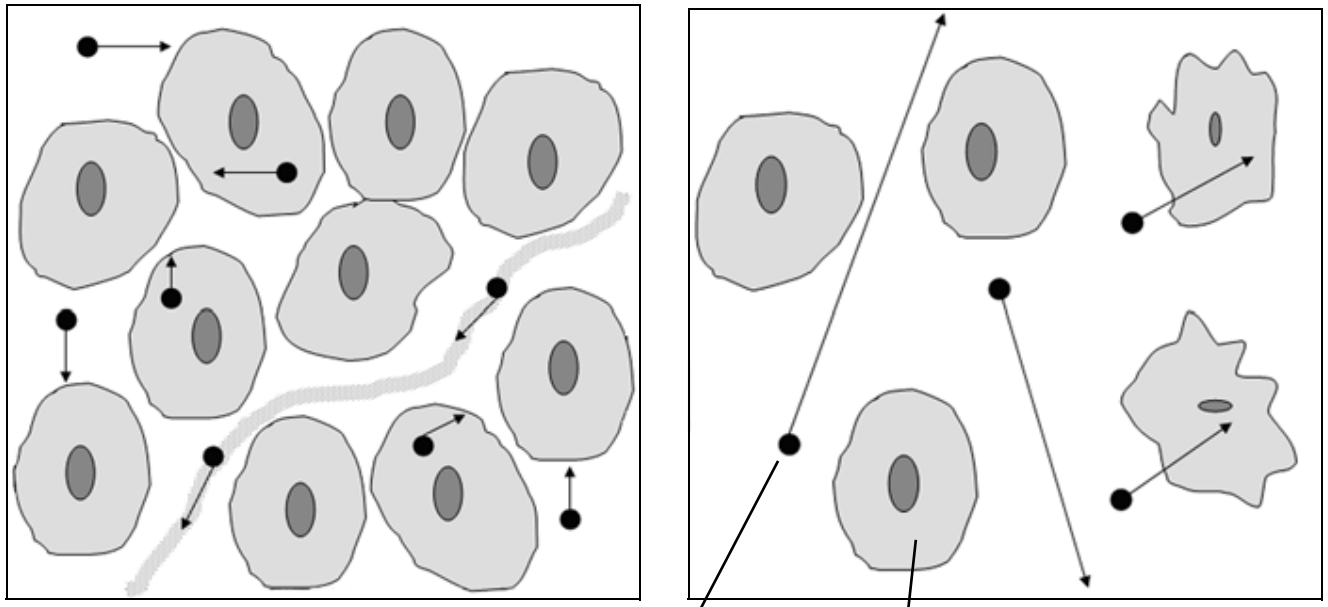
Interpretation of apparent diffusion coefficients (ADCs)



Le Bihan, 1995

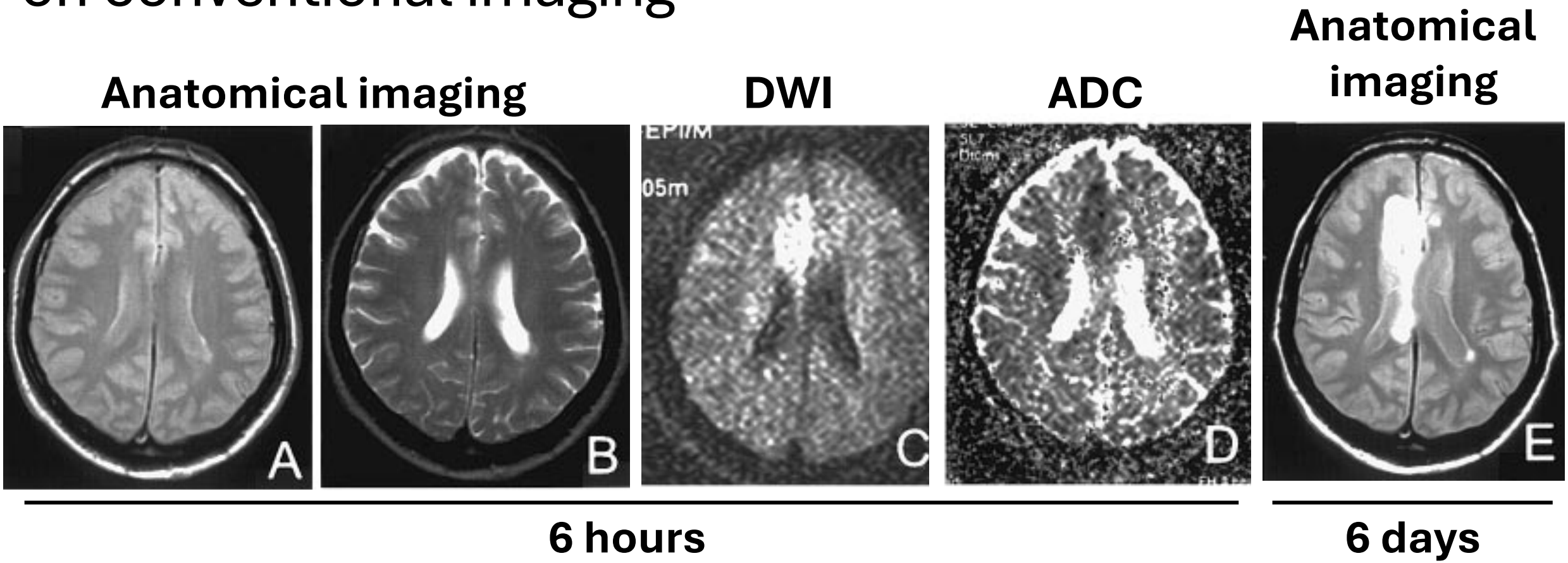
High cell density ⇒ Low ADC

Low cell density ⇒ High ADC



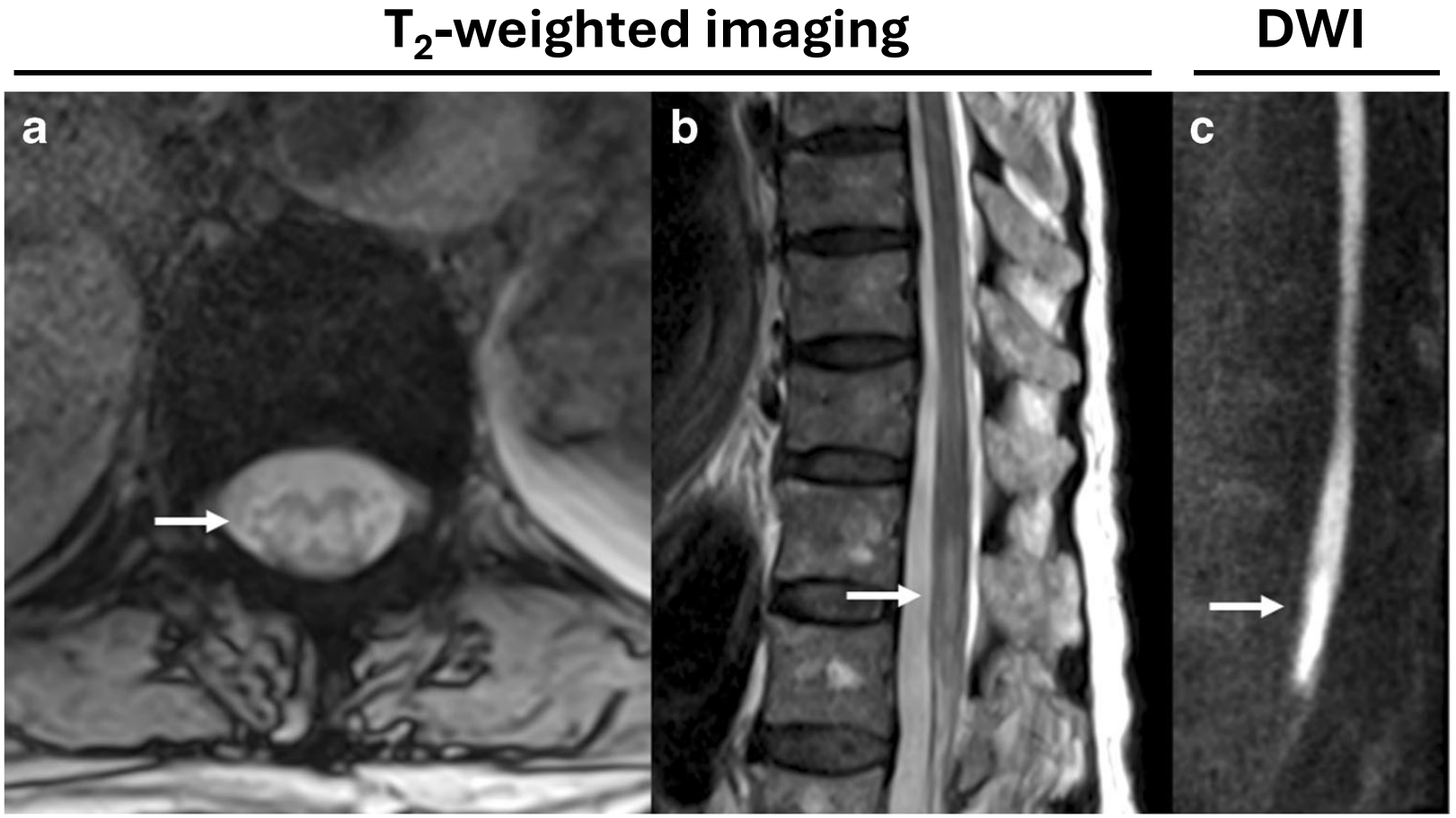
Koh and Collins, *AJR*, 2007

Diffusion shows early changes in stroke not visible on conventional imaging



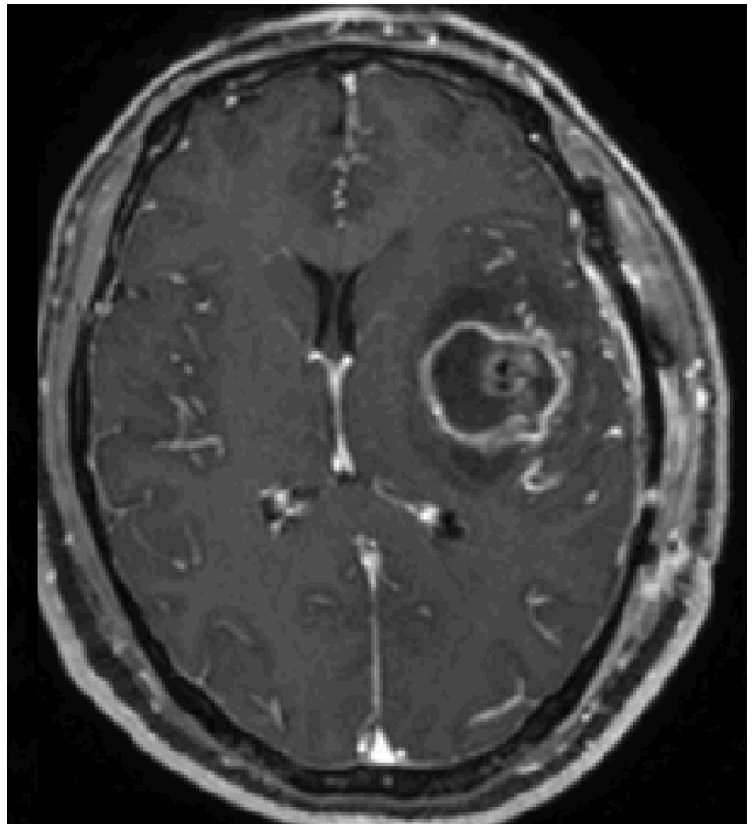
- Cell swelling (cytotoxic edema) causes decrease in ADC
- Can use known ADC & T_2 changes to estimate time of stroke onset

Diffusion imaging can detect spinal cord ischemia

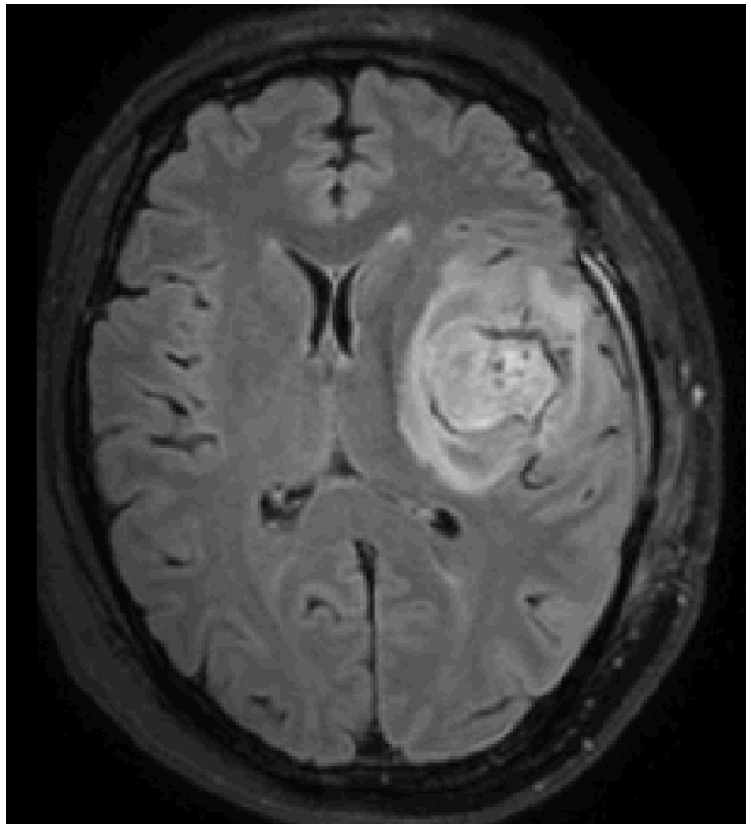


High-grade brain tumours often show diffusion restriction

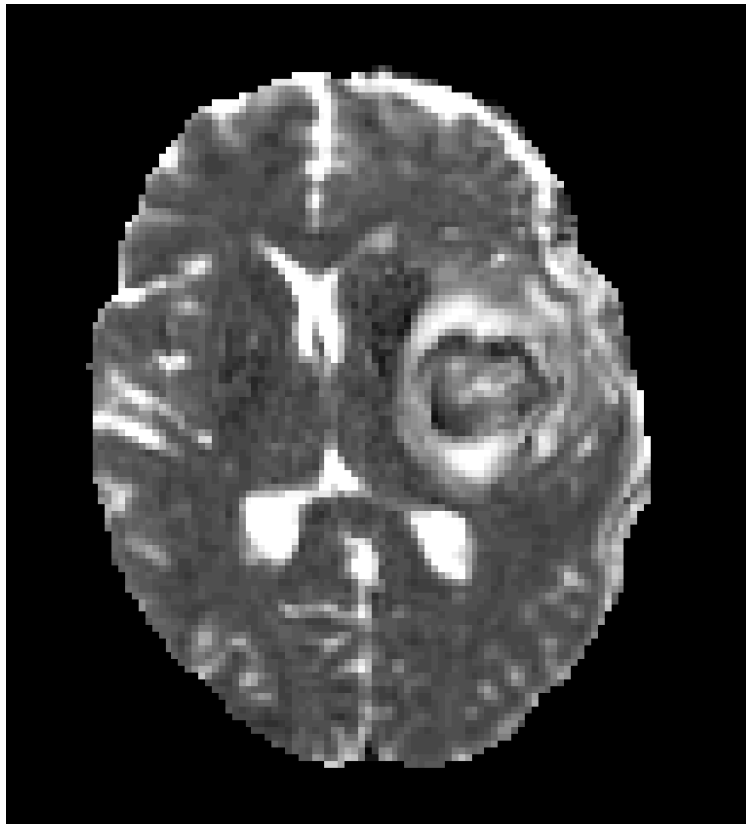
T_1-weighted imaging



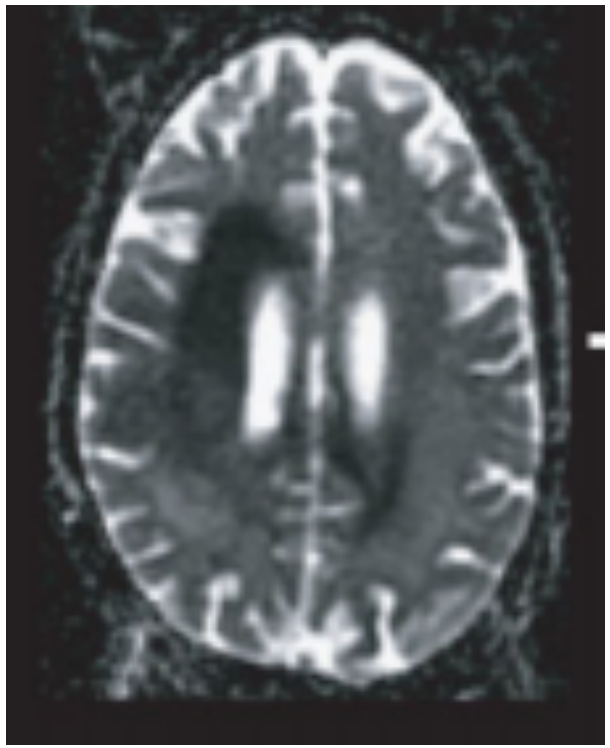
T_2-weighted FLAIR

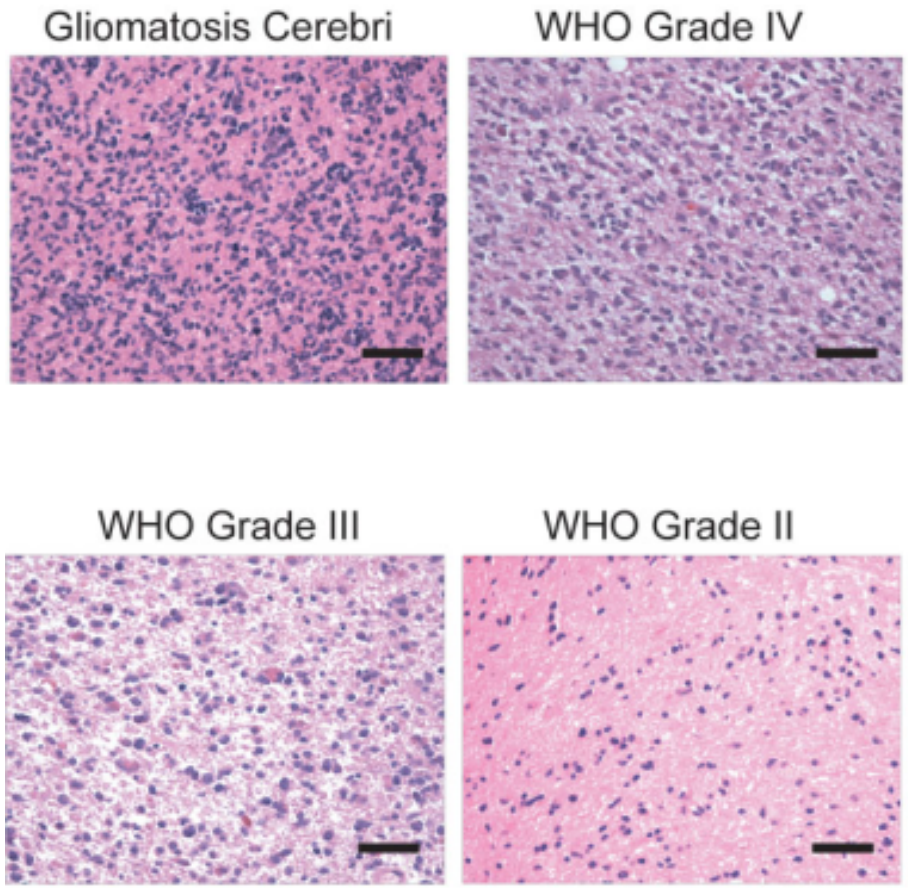


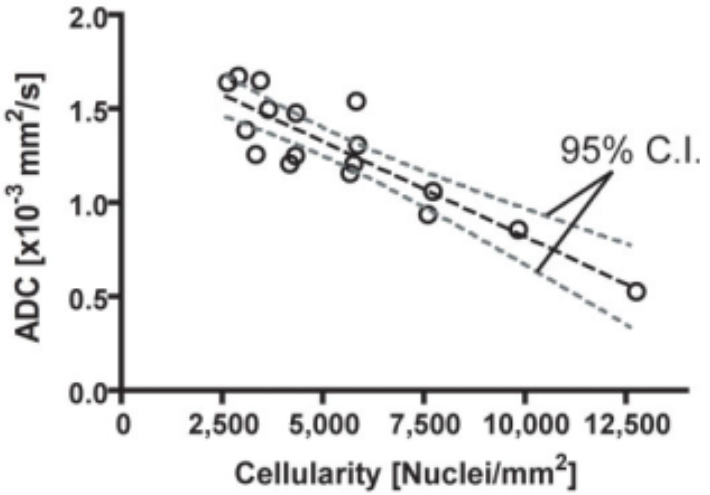
ADC map

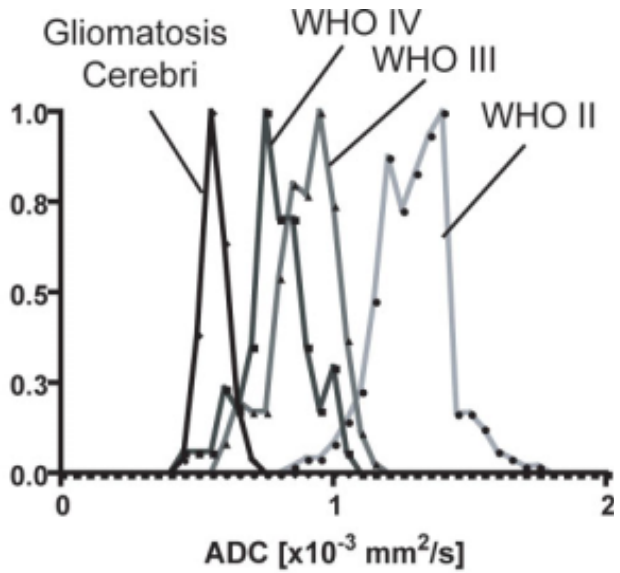


ADC values are sensitive to tumour cell density





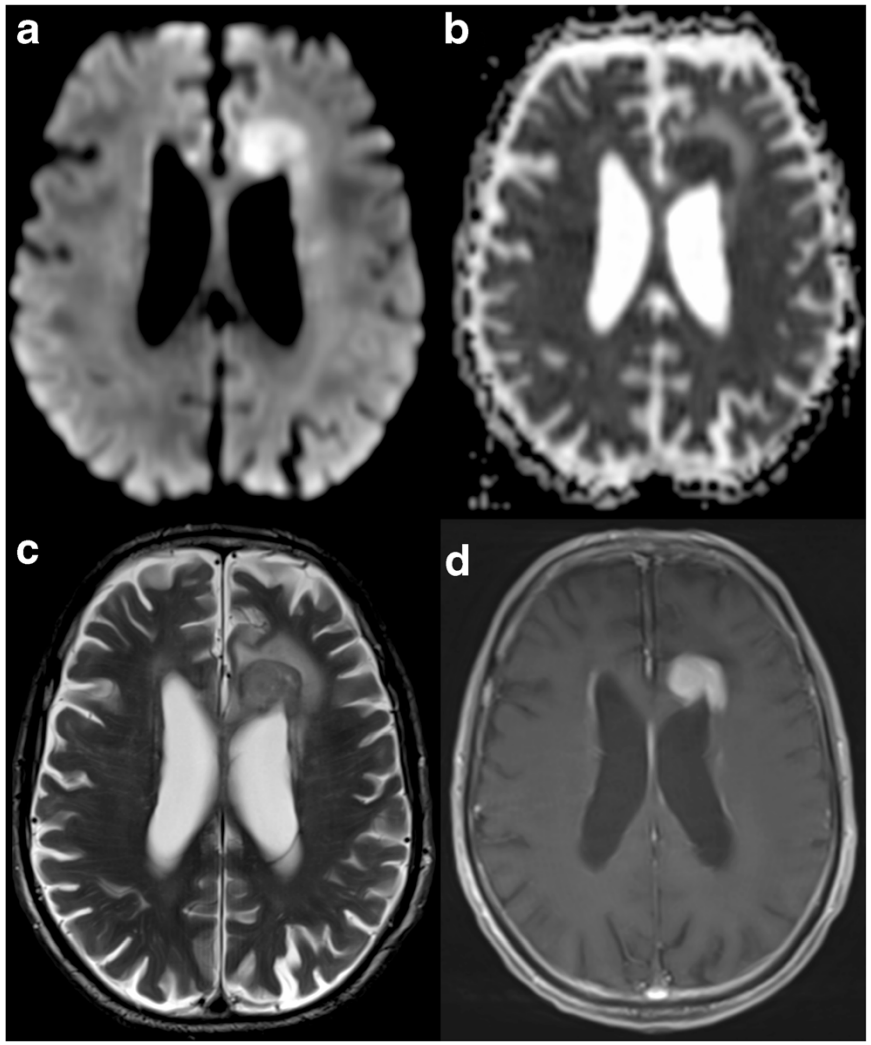




Ellingson et al., 2010

ADC can differentiate between glioblastoma and primary CNS lymphoma

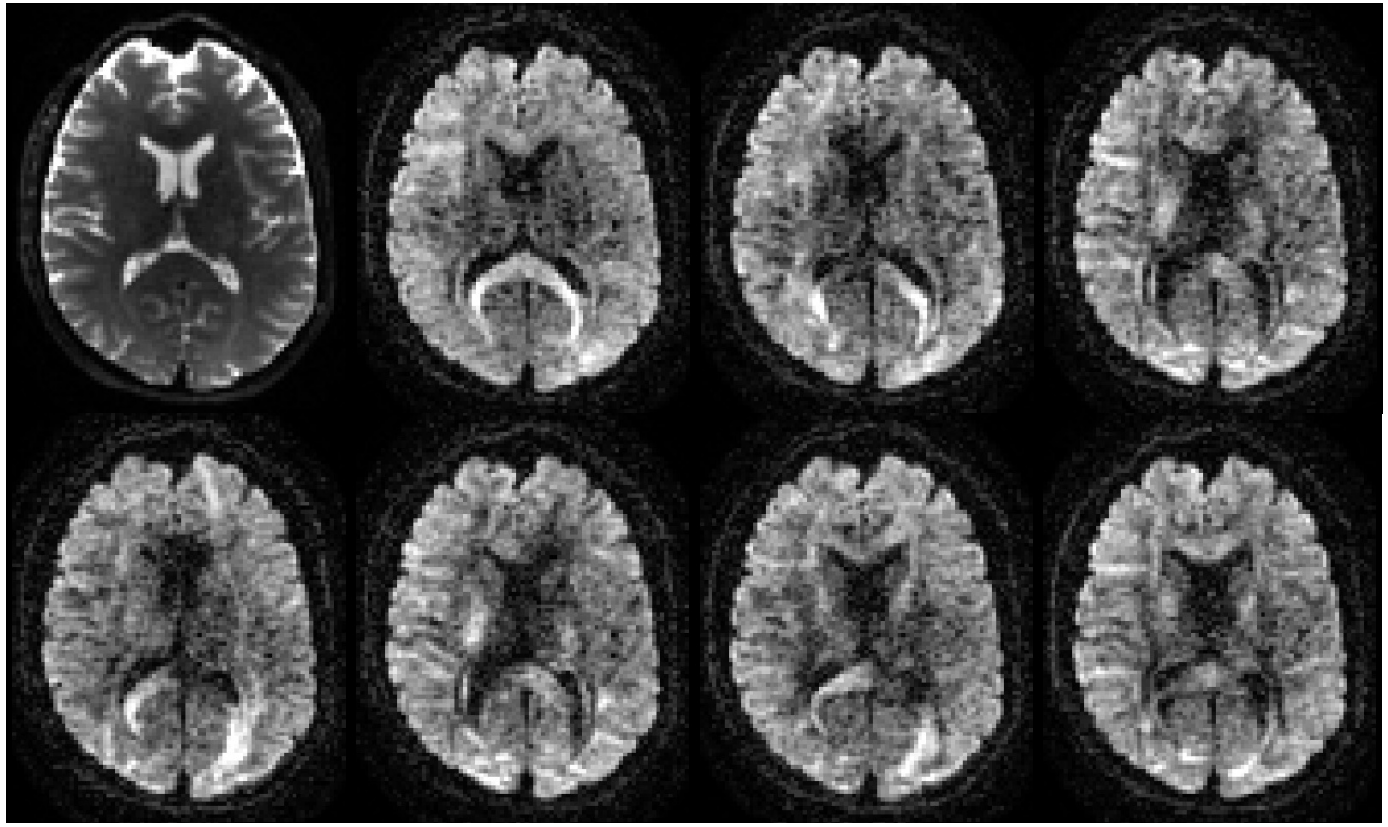
Example of CNS lymphoma



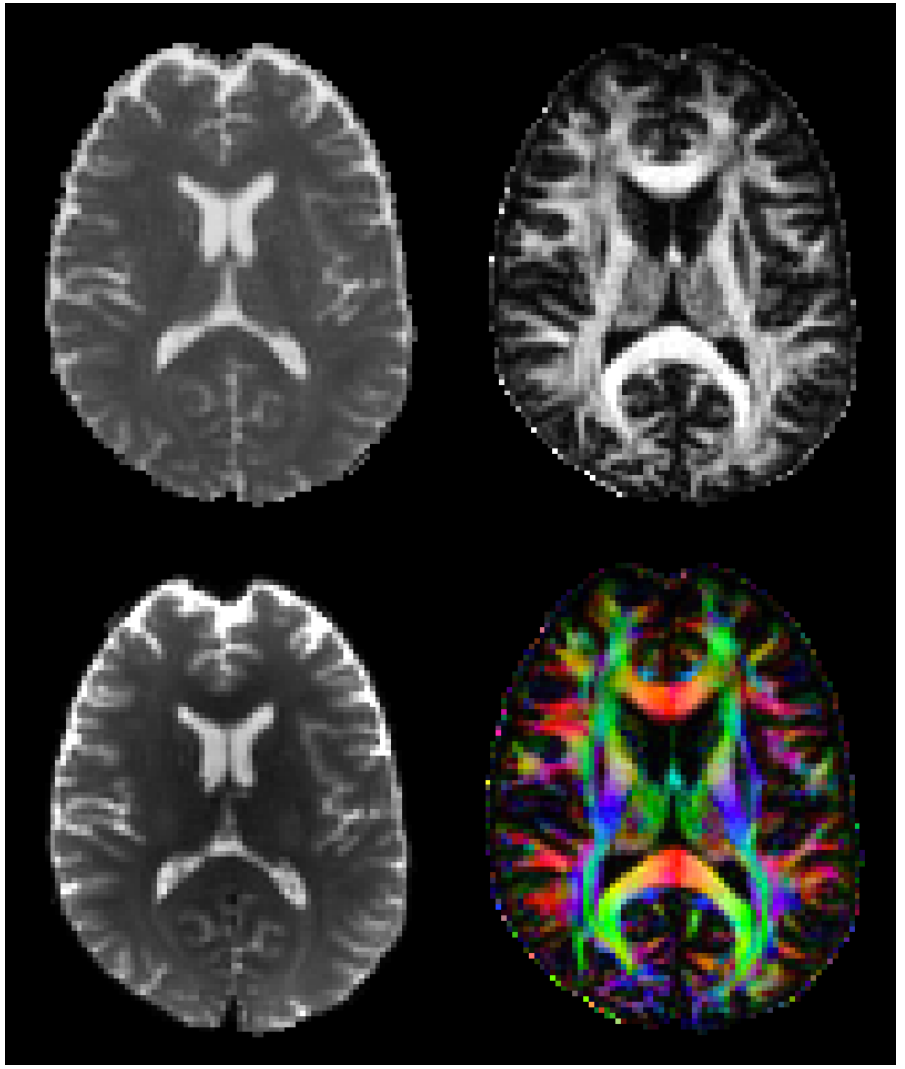
- CNS lymphoma has even higher cellularity than glioblastoma
- Research aimed at determining a cutoff value for ADC

Recap of diffusion tensor imaging

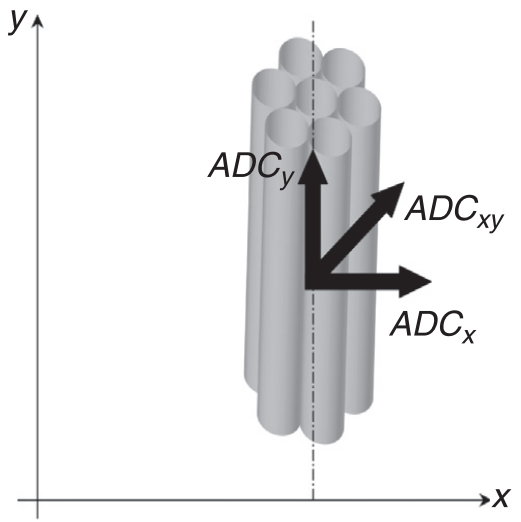
b=0 and diffusion-weighted images

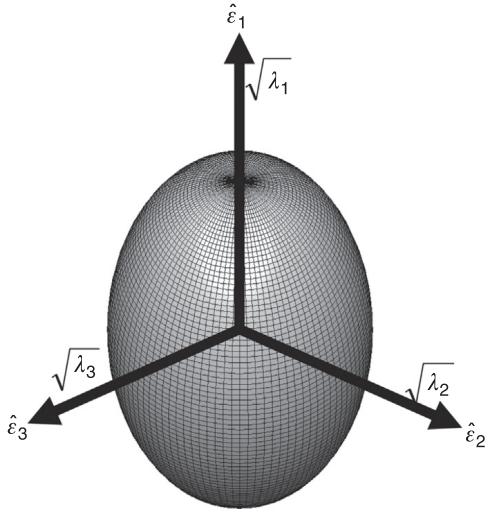


Diffusion parameter maps



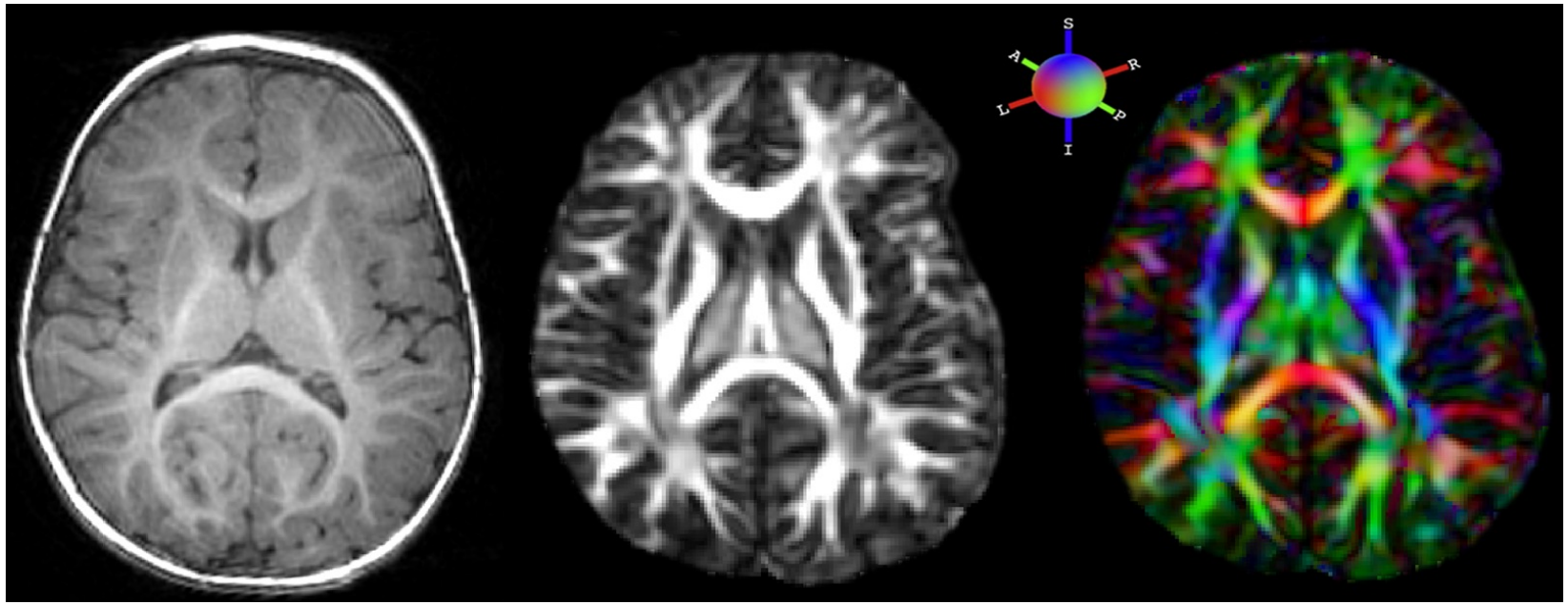
Interpretation of diffusion tensor imaging





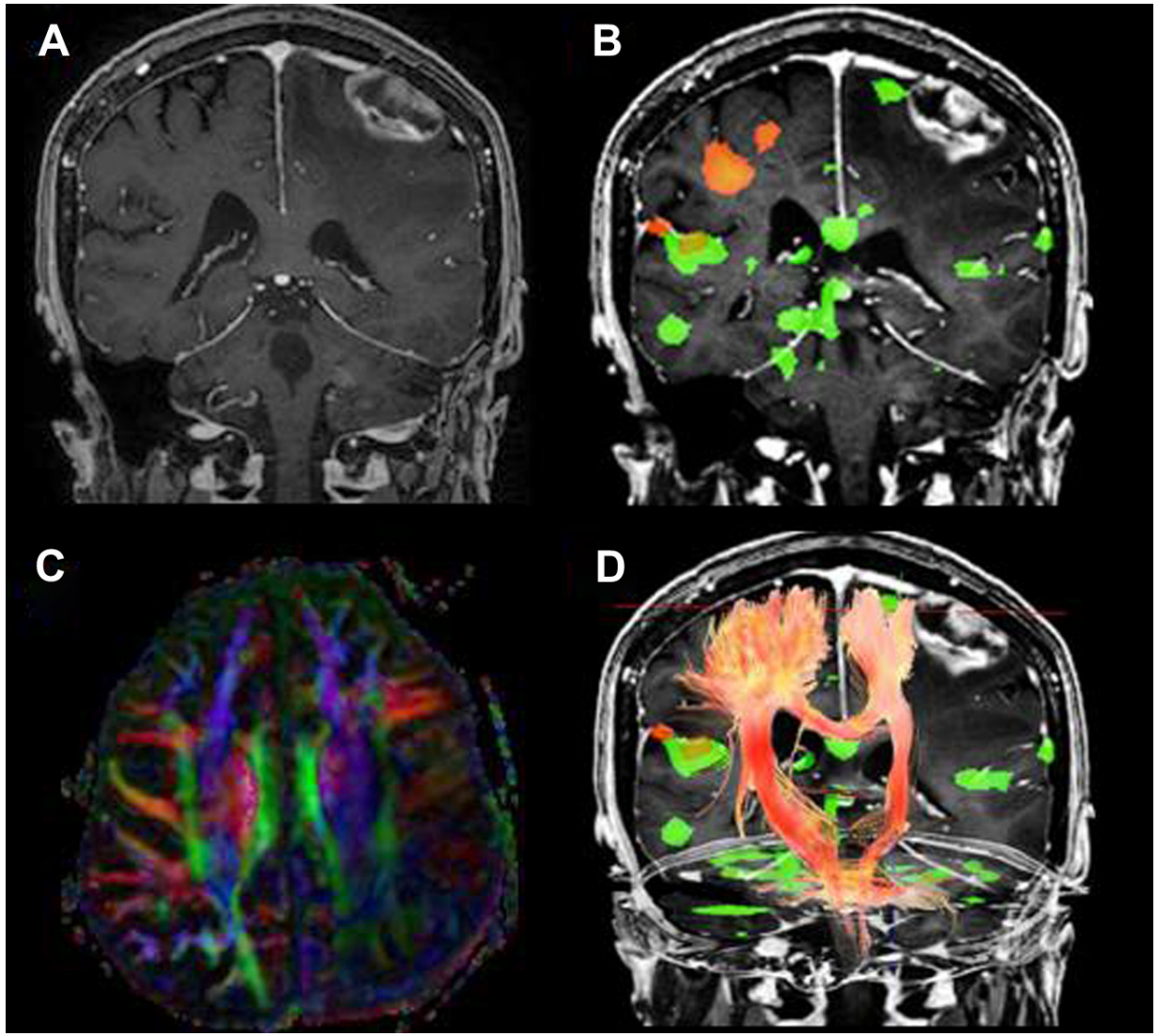
Jones, 2009

T_1-weighted imaging **Fractional anisotropy** **RGB color map**



DTI for guiding surgical planning to avoid white matter tracts

Anatomical imaging



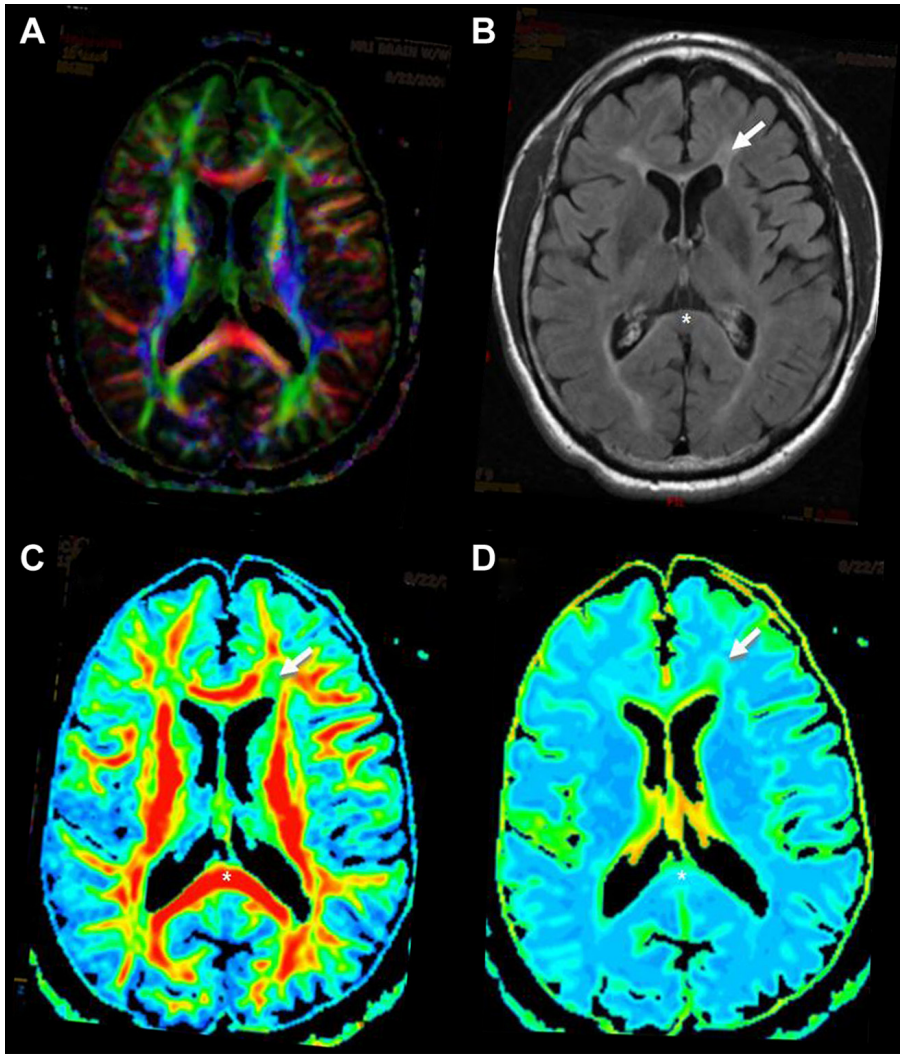
fMRI

DTI RGB color map

Tractography

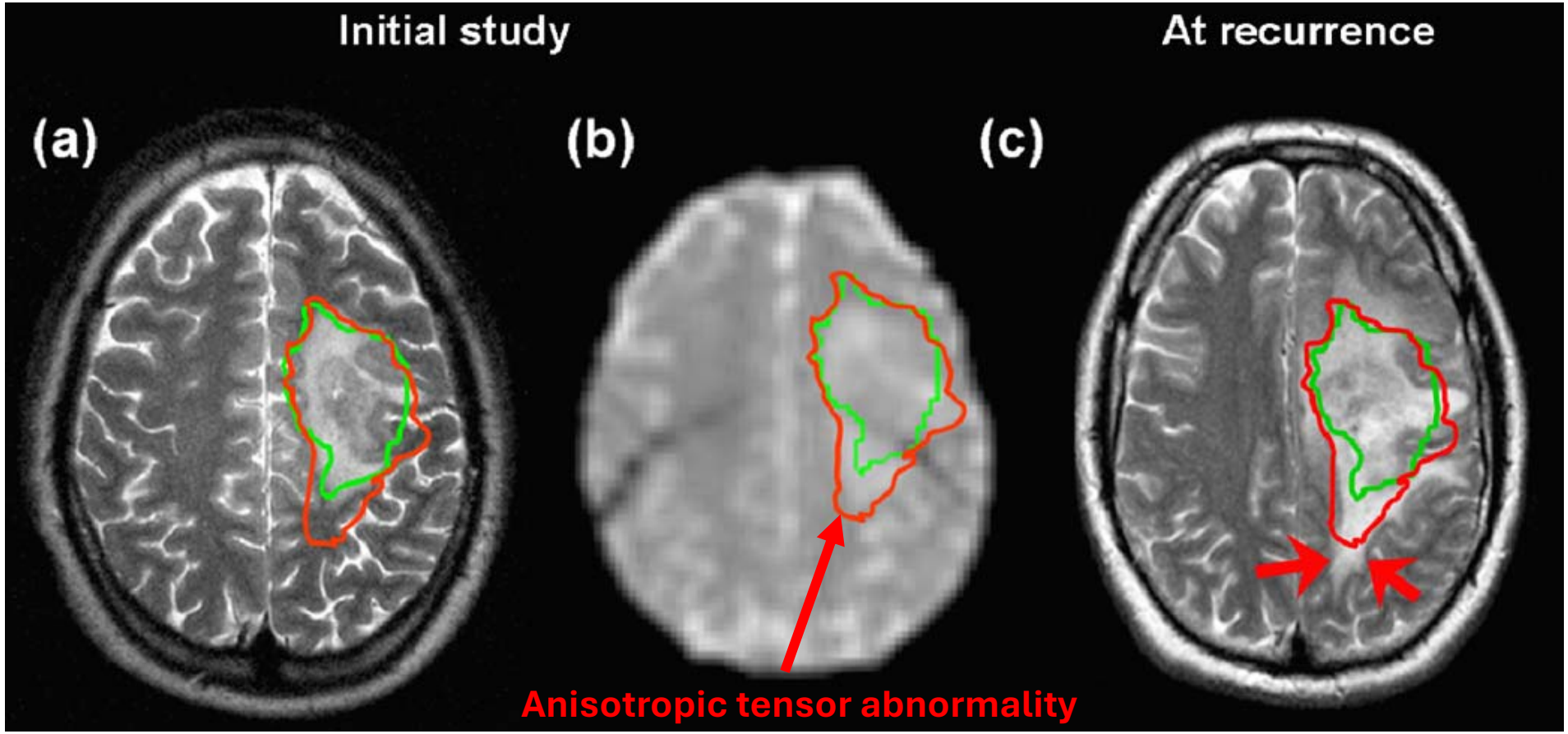
Lerner et al., 2014

Detecting multiple sclerosis lesions with anisotropy



- Shows increased mean diffusivity and decreased fractional anisotropy
- DTI can sometimes visualize MS lesions even when not visible on anatomical imaging

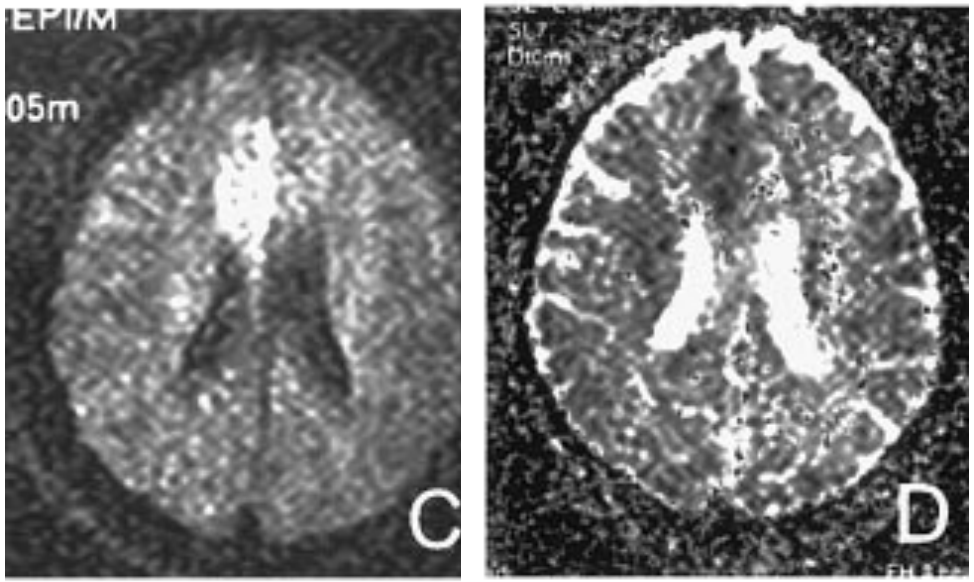
Detecting tumour infiltration with diffusion tensor imaging



Price et al., 2007

Thank you for listening – Questions?

DWI **ADC**



Diffusion parameter maps