

DIFFUSION TENSOR IMAGING AND TRACTOGRAPHY



Introduction

- Diffusion- random molecular motion also known as Brownian movement
- Biological systems depend on diffusion for normal functioning like diffusion of metabolites into the cell.

Introduction

- Diffusion MRI- Produces in vivo images of biological tissues weighted with the local microstructural characteristics of water diffusion.
based on
- 2 types- DWI and DTI based on isotropy and anisotropy

- Isotropy- symmetrical diffusion in all directions
- Anisotropy- asymmetrical diffusion in different directions

DWI

- Most applicable when the tissue of interest is dominated by isotropic water movement
 - Eg- grey matter and major brain nuclei
- DTI
 - Most applicable when the tissues have a highly organised structure and hence diffusion is anisotropic because of barriers
 - Eg- Neural axons- myelin forms important barrier

Terminologies

- 1) Eigen values- $\lambda_1, \lambda_2, \lambda_3$ - to quantify the diffusion in three orthogonal directions
- 2) Fractional anisotropy- The anisotropy is expressed relative to the magnitude of diffusion.
FA values ranges from 0 to 1(0- isotropic and corresponds to a perfect sphere
1- anisotropic diffusion and corresponds to ideal linear diffusion)
- 3) Mean Diffusivity (ADC)- average of the three eigen values

Tractography

- A technique used to demonstrate the white matter tracts
- Uses DTI sequence.

The number of fibres and degree of anisotropy have a direct relationship

Colour coding of tracts

- RED- Directions in x axis (left-right)
- GREEN- Y axis (Posterior to anterior)
- BLUE- z axis (Superior to inferior)

Colour- direction of greatest diffusion

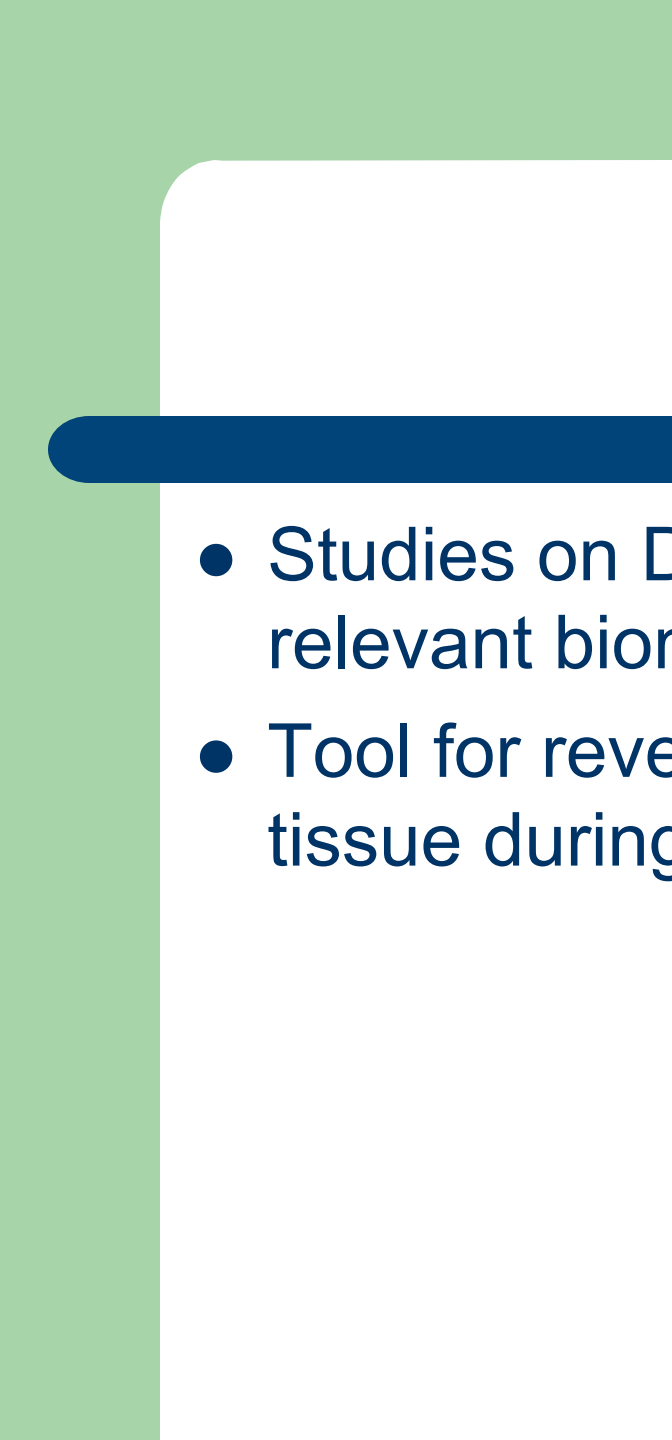
Brightness- degree of anisotropy

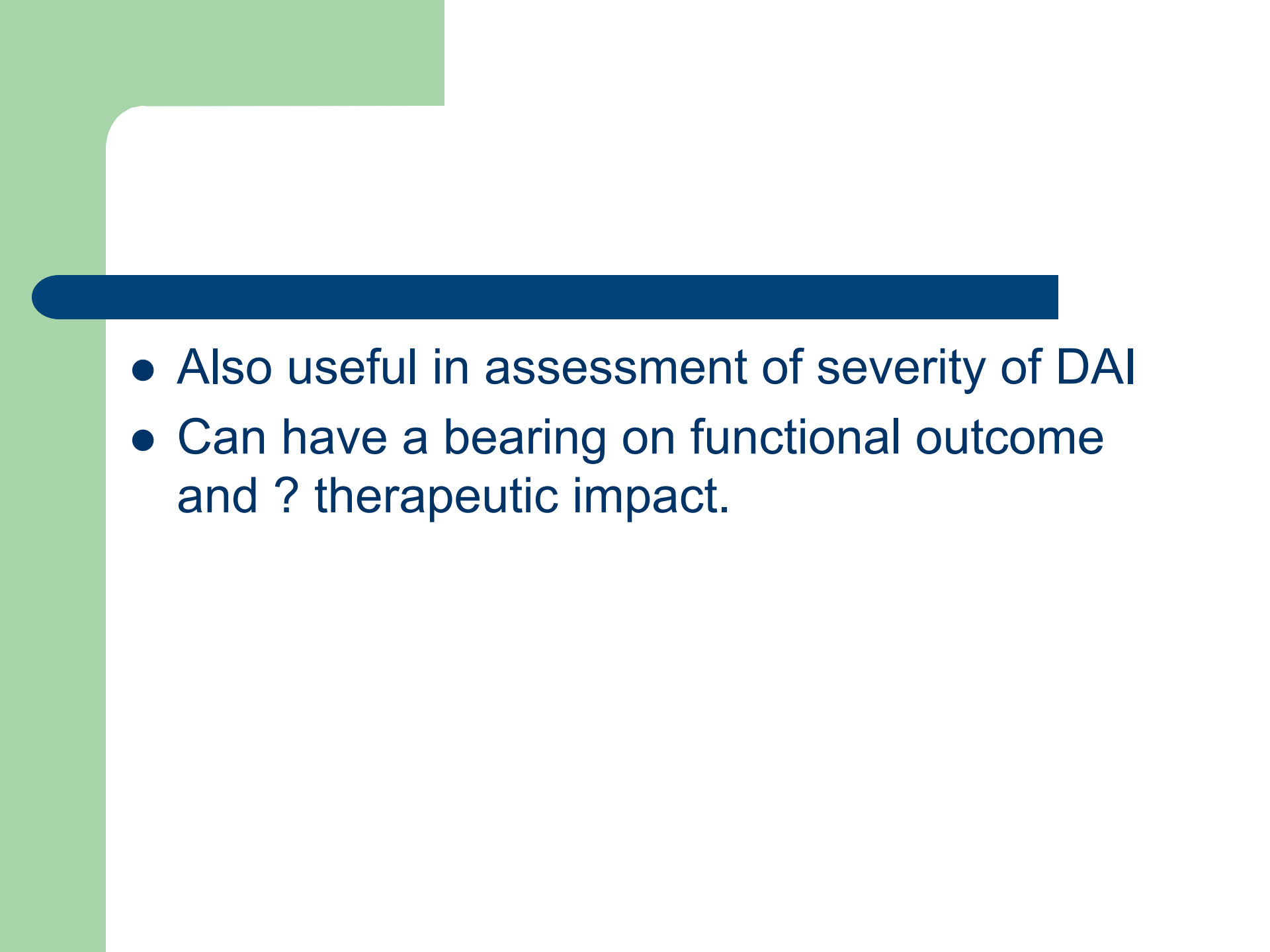
Applications

- Traumatic brain injury-DAI
- Assessment of the morphology of tracts in lesions adjacent to eloquent areas of brain
- Spinal disorders-
 - Acute and chronic spinal cord compression
 - Spinal cord tumours- characterisation
 - AV malformations
 - Syringomyelia
- Alzheimer's disease

DTI in TBI

- Reliable tool for in vivo quantification of white matter microstructural alterations following TBI
- They provide valuable information about the axonal integrity and function
- Useful for the identifying the early signs of axonal injury in TBI

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- A decorative graphic on the left side of the slide, consisting of a light green vertical bar and a dark blue horizontal bar with rounded ends.
- Studies on DTI state that it is a clinically relevant biomarker in TBI
 - Tool for revealing the changes in neural tissue during recovery

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- Also useful in assessment of severity of DAI
 - Can have a bearing on functional outcome and ? therapeutic impact.