

Evaluation of the use and significance of diffusion tensor imaging tractography in neurosurgical management — a publication series.

Abstract

Diffusion tensor imaging (DTI) is a modern magnetic resonance (MR) technique based on the detection of microscopic physiological movements of water molecules in extracellular spaces of tissues, called Brownian motion. Two main parameters being evaluated in DTI are the quantity of water diffusion in a tissue volume, that is the apparent diffusion coefficient (ADC) and the degree of orientation of water molecule movement, that is, the so-called fractional anisotropy (FA). Because of its organized structure, a nervous tissue of the central nervous system (CNS) is characterized by a high FA and is a fine indicator for the evaluation of disorders with DTI.

Tractography has a special place in neurooncology with particular emphasis on gliomas that are lesions causing great problems in resection. Neuroimaging with tractography enables the evaluation of the layout and location of white matter fibres relative to a tumour and their correlation, damages to fibres in the white matter as well as changes in tissues adjacent to the tumour, i.e. neoplastic infiltration or oedema.

The publication series includes four thematically coherent articles:

1. Tractography-Based Analysis of Morphological and Anatomical Characteristics of the Uncinate Fasciculus in Human Brains (Sara Kierońska, Paweł Sokal, Marta Dura, Magdalena Jabłońska, Marcin Rudaś, Renata Jabłońska), which discusses the anatomy and morphology of the uncinate fasciculus and variants of fasciculus structure depending on gender and hemisphere.

2. Tractography Alterations in the Arcuate and Uncinate Fasciculi in Post-Stroke Aphasia (Sara Kierońska, Milena Świtońska, Grzegorz Meder, Magdalena Piotrowska, Paweł Sokal)

This article will analyse the use of DTI as a method to quantify ischaemic changes separately for white matter and grey matter. Tractography may be useful in monitoring motor deficits and aphasias which are complications of a stroke.

DTI is also useful in the visualisation of post-stroke lesions and monitoring the degree of aphasia.

3. Tractography-guided surgery of brain tumours: what is the best method to outline the corticospinal tract? (T. Szmuda, S. Kierońska, S. Ali, P. Słoniewski, M. Pacholski, J. Dzierżanowski, A. Sabisz, E. Szurowska)

This paper presents ways to map the corticospinal tract with deterministic tractography. Depending on the region of interest (ROI), the publication presents 10 possibilities for establishing CST in patients with tumours partially infiltrating the tract being mapped. The paper also describes the technical aspects of plotting the CST with possible acquisition parameters to allow mapping the corticospinal tract in other publications.

4. Reliability of diffusion tensor tractography of the facial nerve in cerebellopontine angle tumours. (Tomasz Szmuda, Paweł Słoniewski, Shan Ali, Pedro M. Gonçalves Pereira, Mateusz Pacholski, Fanar Timemy, Agnieszka Sabisz, Edyta Szurowska, Sara Kierońska)

This paper presents the use of tractography to visualise the facial nerve in cerebellopontine angle tumours. Although magnetic resonance imaging (MRI) techniques are continually being developed, there is still no reliable method to indicate the layout of a facial nerve relative to a cerebellopontine angle tumour with acceptable sensitivity and specificity. The aim of this paper is also to show the current possibilities of using facial nerve DTI neuroimaging in cerebellopontine angle tumours and to demonstrate the limitations of this method.

Diffusion tensor imaging appears to be a promising neuroimaging technique that complements the conventional MRI by providing quantitative information about the condition of white matter and is useful in making decisions on the treatment of patients with CNS disorders.