Advanced, Sensitive, Broad Tractography Metrics to Characterize Cerebral White Matter (Case 1732)

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Technology description

Brief Description:

Diffusion tensor imaging (DTI) is a magnetic resonance imaging (MRI) technique that measures the directionally dependent rate of water self-diffusion in each image voxel or volumetric picture element - a 3-dimensional pixel. Water diffusion in cerebral white matter tends to be anisotropic due to the highly linear organization of white matter fibers. Anisotropic refers to the preferential rapid diffuse along white matter tracts as a result of physical barriers (e.g., axonal walls) restricting water movement in other directions. Medical conditions such as subcortical ischemic injury, inflammation, neurodegenerative diseases, and traumatic brain injury cause changes in the organization of white matter pathways with corresponding anisotropy changes – the speed and direction of diffusion. DTI, sensitive to such changes, is a powerfulin vivoimagining tool for studying microstructural integrity of cerebral white matter and potentially other non-nerve tissue.

Conventional methods of visualization to assess white matter microstructure/connectivity in clinical samples have been based on 2-dimensional greyscale maps of scalar values that do not generally incorporate eigenvector information. Widely accepted tractography methods, which explore white matter, and the pathological effects on, connectivity, complement scalar methods by providing detailed information about the orientation and curvature of white matter pathways, and incorporate both tensor eigenvalues and eigenvectors to calculate trajectories generally in the direction of fastest diffusion. As such, tractography methods represent improvements in data acquisition, visualization, and reproducibility of metrics. However, only few studies have explored the combination of tractography with scalar methods in a clinical setting, and prior to this invention [below], researchers were limited in their ability to study the integrity of entire specific white matter pathways, i.e., follow the pathway trajectory in all three dimensions, and understand relationships to cognitive and behavioral changes in a variety of conditions affecting cerebral white matter.

This robust invention overcomes all current limitations and realizes further advantages. The novel technology is most simply a system to characterize white matter in the brain to detect the presence of white matter impairment, as in the etiology of Alzheimer’ s disease, vascular cognitive impairment (VCI), HIV infection, stroke, and brain injuries, among others. It is an exemplary DTI, tractography-based characterization method of quantitative trace-of-interest (TOI) metrics – operating on the set of curves

to calculate metrics and not on regions-of-interest (ROI) of prior methods – for white matter integrity based on DTI-MRI data. To note, this innovation may be broadly applicable to non-nerve tissues and associated impairments. The method may be more sensitive to smaller alterations, used to quantify differences among multiple patients in the clinic, and for tracking longitudinal changes in cerebral white matter. The innovation consists of MRI data (input) and computing power in the form of a data processor, GUInterface, memory, programs/software, and a set of reference metrics, algorithms, a 3D graphical representation/reconstruction of brain axonal projectionsin vivo, among other system components, to process data generated by an imaging system, e.g., magnetic resonance imaging (MRI).

Applications may include: sensitive detection/diagnosis of white matter impairments in many brain and other (e.g., HIV) diseases/disorders – physical and psychological – and injuries that partially manifest in white matter; sensitive detection/diagnosis of other tissues such as muscle, tendon, cardiac muscle, and spinal cord; study of plant life, where water and water-containing fluids are capable of diffusing through pathways.

Markets include: pharmaceutical – diagnostics/medical devices/imaging; scientific R&D to advance the fields of neuroscience, medicine, medical imaging, and botany/ecology/environmental studies.

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