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Detection of Neurological Conditions And White Matter Pathologies by Delphitm - Dolev Iftach - QuantalX Neuroscience Ltd

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Introduction:

The disruption of normal patterns of structural brain connectivity is believed to play a central role in the pathophysiology of many neurological and psychiatric disorders, such as, dementia, movement disorders, stroke, traumatic brain injury (TBI) etc., Particularly, white matter changes lay in the heart of the onset of many pathologies.

Traditional brain imaging technologies are expensive, inaccessible, and fail to provide actionable insights regarding brain network health. Therefore, there is a huge need, for a simple, precise and accessible tool that objectively evaluates brain functional status.

Since the development of the X-ray in 1895, there have been many major advancements in medical imaging, and today the use of volumetric medical imaging is the backbone of 3D printing in medicine. Patient-specific 3D printed anatomic models may be created from any volumetric imaging dataset, with sufficient contrast and spatial resolution to separate structures, using dedicated image postprocessing software. The purpose of this chapter is to give a broad overview of the imaging systems that are typically used to create 3D printed anatomic models including computed tomography, magnetic resonance imaging, and ultrasound. In addition, imaging considerations for creating 3D printed anatomic models will be discussed.

Brain tumor segmentation using Magnetic Resonance (MR) Imaging technology plays a significant role in computer-aided brain tumor diagnosis. However, when applying classic segmentation methods, limitations such as inhomogeneous intensity, complex physiological structure and blurred tissues boundaries in brain MR images usually lead to unsatisfactory results.

DELPHITM is an active system for the visualization of brain health. It is a proprietary acquisition and analysis AI based algorithm that interfaces with available 'Off-the-Shelf' hardware to enable direct stimulation and monitoring of the brain (TMS-EEG). DELPHI'soutput measures, which areindicative for several electrophysiological features were significantly different between age defined groups as well as mild Dementia patients and age matched healthy controls.

In a multidimensional approach the DELPHIoutput measures ability in identification of brain white matter fibres connectivity damage in stroke and traumatic brain injury (TBI) was tested. DELPHI output measures were able to classify healthy from unhealthy with a balanced accuracy of 0.81±0.02and AUC of 0.88±0.01. additionally, DELPHI output measures, differentiated successfully, between cerebral small vessle disease (cSVD) diagnosed subjects and age matched healthy controls, with AUC of 0.88 ($p<0.0001$), sensitivity of 0.83 and specificity of 0.75.

These results indicate DELPHI as a possible aid for early detection of white matter integrity and pathologies.

The disruption of normal patterns of structural brain connectivity is believed to play a central role in the pathophysiology of many neurological and psychiatric disorders, such as dementia, movement disorders, stroke, traumatic brain injury (TBI), etc. White matter (WM) pathways consist of myelinated axonal structures that constitute the connectivity between different brain regions. Axonal injury and degeneration may occur even in the absence of tissue disruption. Therefore, patients may experience significant impairment despite the absence of abnormal findings on conventional CT or MRI. Moreover, focal imaging abnormalities that can

be detected using CT and MRI are poor predictors of outcome.

Axonal injury is a key determinant of clinical outcome in cases of brain injury and has been shown to be an important factor determining long-term motor, cognitive, and neuropsychiatric disability following brain injury (Mac 2019). Diagnostic tests that can discriminate significant axonal injury and degeneration are needed in order to accurately assess injury severity and effectively determine treatment and follow-up pathway.

WM pathways determined through diffusion tensor imaging (DTI) are traditionally considered to be the biophysical representation of axonal bundles and their myelin sheets. DTI streamlines between cortical and subcortical gray matter (GM) regions of interest (ROIs) can be used as a measure of the magnitude and strength of connection between ROIs. Analyzing changes in brain connectivity using DTI tractography is widely used to evaluate axonal injury that is a hallmark of stroke and TBI (in which WM tracks can be injured directly or indirectly through Wallerian degeneration (the anterograde distal degeneration of injured axons accompanied by demyelination) DTI metrics are used to address specific or diffused WM damage that is frequently affected by stroke lesions in order to describe stroke focality and severity and predict rehabilitation potential In TBI patients, a consistent reduction in fractional anisotropy (FA) has been typically found in areas affected by traumatic axonal injury (TAI). These regions include the subcortical WM of the frontal and temporal regions, the splenium of the corpus callosum, the posterior limb of the internal capsule, and the cerebral peduncles .

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