

# DTI AND FMRI STUDY IN EARLY DETECTION OF WHITE MATTER DEGENERATION – A REVIEW

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## ABSTRACT

*Diffusion tensor imaging used to identifying the impact of axonal injury. We used technique i.e. tract-based spatial statistics which is used to explore whether damage to specific white matter tracts. Therefore, various techniques have been introduced in early detection of white matter using various DTI and FMRI. The range of our study is 2009-2015.*

**Keywords:** *cognitive impairment, diffusion tensor imaging, Functional magnetic resonance imaging, magnetic resonance imaging, tract-based spatial statistics.*

## I. INTRODUCTION

White matter is a part of the central nervous system, in the brain and superficial spinal cord, and having mostly of glial cells and myelinated axons that transmit signals from one region of the cerebrum to another and between the cerebrum and lower brain centers. White matter actively affects how the brain learns and functions. Disability is often cause of traumatic brain injury due to cognitive impairments. The cognitive domains are commonly affected. Diffuse axonal injury has been difficult to study the location. Recently, to study white matter damage using diffusion tensor imaging becomes possible. Tract-based spatial statistics (TBSS) is a new voxel-based technique for analyzing white matter structure across the whole brain. We expect white matter structure as measured by DTI to corelate with information processing speed. Functional magnetic resonance imaging or functional MRI (fMRI) is a functional neuroimaging procedure using MRI technology that measures brain activity by detecting changes associated with blood flow. In this, how diffusion tensor tractography and functional magnetic resonance imaging can be combined, are provided. Both the techniques are complimentary and used identification of the eloquent areas of the brain.

## II. LONGCHUAN LI,CLAIRE D. COLES, MARY ELLEN LYNCH AND XIAOPING HU(2009) [1]

Researchers had presented an approach for analysis of DTI (voxelwise analysis using TBSS), skeleton based ROI and Statistical analysis. As only the central portion of the brain was scanned for the DTI data, all FA images were aligned onto a population-specific FA template derived from all of the subjects instead of the standard FMRIB58 FA template, using a nonlinear registration algo. implemented in the TBSS package. For ROI Analysis, the focus in this study was on the differences in the corpus callosum among the three groups, as the corpus callosum is particularly vulnerable to degradation in white matter integrity. The thresholded skeletons

of FA, MD, AD and RD were fed into a permutation based statistical inference algo., which does not require the assumption of Gaussian distribution of the data, to test for the significance of cluster size.

### **2.1 Critical Remarks**

The researchers studied the DTI outcomes among two groups of prenatally exposed young adults, those showing significant physical effects (DYSM) and those without such effects, but matched for level of cognitive functioning (ETOH) and compared them to unexposed controls using TBSS as well as a follow-up ROI analysis of DTI data.

### **III. KIRSI MARIA KINNUNEN, ET AL. (2010) [2]**

Researchers had presented an approach for analysis of data of diffusion tensor imaging, white matter structure and cognitive function. Voxelwise analysis of the fractional anisotropy, mean diffusivity and axial and radial diffusivity data was carried out using TBSS in the FMRIB software library. We also investigated the relationship between white matter structure and cognitive function within general model in FMRIB software library.

### **3.1 Critical remarks**

DTI provides a way to identifying the impact of axonal injury. The researchers studied a complex relationship between white matter structure and executive function. They found widespread fractional anisotropy, mean diffusivity and axial diffusivity differences between patients with traumatic brain injury and healthy controls using TBSS.

### **IV. TILMAN SCHULTE, EVA M. MÜLLER-OEHRING, ADOLF PFEFFERBAUM, EDITH**

### **V. SULLIVAN(2010) [3]**

The DTI based tracking with functional magnetic resonance imaging(FMRI) based connectivity in healthy subject .This result produce two dissociable amygdale centered brain network.DTI has enabled quantitative fiber tracking for in vivo noninvasive mapping of inter regional white matter fiber connection and the segmentation of axonal tracts in normal . DTI metrices include fractional anisotrophy and the apparent diffusion coefficient or mean diffusivity which is decomposed into two component ,the longitudinal or axial diffusivity and transverse or radial diffusivity .Alcoholic demonstrated the greatest abnormalities in frontal structure function relationship between poorer performance on cognitive tests and DTI signs of regional white matter compromise in several fibers indicated that fiber degeneration in alcoholism affect cognitive functions and specially cognitive processing speed .The midbrainpons fiber deficit in alcoholics was predictive of poorer cognitive flexibility.

### **4.1 Critical Remarks**

Researchers investigated neuroimaging and diffusion tensor imaging(DTI) in vivo structural. They using the white matter for fiber tractography to know how impaired integrity of neuroanatomical structural connectivity affects emotions and reward learning which can explain how the effect of chronic alcoholism on brain systems can mediate emotion, cognition, and behavior.

**V. VICTORIA E. JOHNSON, JANICE E. STEWART, FINN D. BEGBIE ,JOHN Q. TROJANOWSKI,DOUGLAS H. SMITH AND WILLIAM STEWART (2013) [4]**

There are three injury which are examined by cohort for demography and clinical data .First type of injury consisted of patient who died after moderate TBI ,within 10 days .In second type of injury the patient died in the sub acute phase from 2 week to 1 year .In third and last injury comprised long term survivor of TBI with atleast 1 year from 1 -47 year. After that the brain tissue preparation and immunohistochemistry merge in 10% formal salient at autopsy and fixed for at least 3 week before dissection.with the primary antibodies was performed for 20h at 4C. Analysis of immunohistochemical findings serial image of multiple overlapping field for the annotated region of interest were then captured ,exported and combined. The order of axonal pathology within the entire hemi-corpus callosum was classified semiquality(0-> is described as absent or minimal pathology ,1-> is described as moderate pathology and 2->is defined for extensive pathology.).The statistical analyses were performed use to perform the pearson's co relation testing which was used to determined any association between age and the percentage age are of CR3/43 in all groups .The T-test was used to compare the percentage area of between groups.

**5.1 Critical Remarks**

Activated microglia and phagocytic (which is cells that protect the body by ingesting harmful foreign particles, bacteria and dead or dying cells) macrophages were observed spanning extensive regions of the corpus callosum up to 18 years. In addition, ongoing axonal degeneration and tissue atrophy were found in association with this inflammatory process

**VI. CARLOS R HERNANDEZ-CASTILLO, VICTOR GALVEZ, CONSUELO MORGADO-VALLE AND JUAN FERNANDEZ-RUIZ (2014) [5]**

Researchers had presented the method of Image acquisition during functional MRI acquisition subjects, keep their eyes closed, to think about nothing in particular and stay awake from the starting five dummy scan are performed in functional acquisition. After that Resting state fMRI pre-processing method added brain extraction time shifting ,motion correction, spatial smoothing, linear trend removal and temporal filtering .In whole brain functional connectivity analysis using MATLAB. Reducing the number of classification features accelerates computation and diminishes noise. Support vector machine classification explain differentiate between SCA7 group and healthy controls used abnormal functional connections to fill the SVM classifies. Classification accuracy, sensitivity and specificity were calculated based on a 10 fold cross validation.

**6.1 Critical Remarks**

Researchers used a univariate approach as a feature selection method to select a small number of high discriminative abnormal connections across the patient's brain. The selected subset of connections reached high classification accuracy between patients and healthy controls, proving their high discriminative power. However, this approach is limited by its own nature, comparing voxel by voxel. Different alternatives try to address this problem using multivariate approaches as principal component analysis.

**VII. RICHARD WATTS, CONOR LISTON, SUMIT NIOGI AND AZIZ M. ULU (2015) [6]**

Researchers were presented Diffusion in Uniform Medium, diffusion is the random motion of particles, through the thermal energy. Particles travel some distance before colliding with another particle and changing direction. Measure of diffusion is the “root” mean square” value of the displacement. Diffusion –weighted Magnetic Resonance Imaging [DW-MRI] defines the water molecules between one gradient pulse and the other the rephrasing of the MR signal is incomplete and the measured signal is decreased. Magnetic Resonance Diffusion Tensor Imaging [MR-DTI] measured MR signal depends on both the direction and magnitude of the diffusion weighting gradient. And the Display of Diffusion tensor Data may difficult to visually interpret how images combine. Fiber Tracking method is used for fiber tracking is schematically starting from a user selected seed point, a line in the direction of maximum diffusion is followed until the edge of the current voxel is encountered. such tracking in which each region of interesting has been subdivided and color coded according to its position.

**7.1 Critical Remarks**

Diffusion tensor imaging is an ideal tool for assessing brain development because it is unique in its ability to quantify changes in neural tissue microstructure non-invasively. The human brain undergoes extensive postnatal development neurons differentiate and proliferate neuronal connectivity is refined as new synapses form. These changes in the strength and directionality of neuronal tracts can be indexed by diffusion and anisotropy measures.

**VIII. CONCLUSION AND FUTURE SCOPE**

A survey on various techniques have been done in order to identify the degeneration of DTI and FRMI study in early detection of White Matter diseases. Various techniques like demographic, clinical data, Statistical analyses, Tract-based spatial statistics, Image Processing, MATLAB tools have been used. Apart from identifying the particular diseases using a technique, various other diseases can also be detected.

Diffusion tensor imaging is a powerful tool for the visualization of white matter structures. The fact that DTI assumes Gaussian diffusion limits its applications. The problem of non-Gaussian diffusion has been studied and solved theoretically for defined nonbiologically related structures in the “q-space” framework. this approach was implemented on white matter, and the terms q-space imaging and diffusion spectrum imaging of the human brain. Although these methodologies provide a better theoretical basis on which to address the complicated diffusion of water in white matter. At present, fMRI is a useful research tool, and reliable analysis and display methods have been developed. Future perspectives include development of fMRI paradigms for patients with MS-related disability and effects of various therapeutic approaches on central nervous system plasticity.

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