بسم الله الرحمن الرحيم

∞∞∞

تم رفع هذه الرسالة بواسطة / سامية زكى يوسف

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد

Role of MRI diffusion tensor imaging in assessment of response of normal-appearing white matter in case of multiple sclerosis.

Thesis

Submitted for partial fulfillment of Doctorate Degree in Radio-diagnosis

By

Mona Mahmoud Hassan Alsherif
M.B. B. Ch., M. Sc
Faculty of Medicine – Ain Shams University

Under Supervision of

Prof. Dr. Eman Soliman
Professor of Radio-diagnosis
Faculty of Medicine, Ain Shams University

Asst Prof. Dr. Remon Zaher Elia
Assistant Professor of Radio-diagnosis
Faculty of Medicine, Ain Shams University

Dr. Mona Ali Mohammed Ali Nagi
Lecturer of Radio-diagnosis
Faculty of Medicine Ain Shams University

Faculty of Medicine
Ain Shams University
2022

Acknowledgement

First and foremost, my deep gratefulness and indebtedness are to Allah**,** the Most Gracious and the Most Merciful.

I wish to express my deep gratitude to Prof. Dr. Eman Soliman**,** Professor of Radio-diagnosis, Faculty of Medicine, Ain Shams University for accepting the idea of this work, his efforts, and encouragement.

I also extend my great appreciation to Asst Prof. Dr. Remon Zaher Elia Assistant Professor of Radio-diagnosis, Faculty of Medicine, Ain Shams University for her great help in supervising this work.

No words can express my feelings, respect, and gratitude to Dr. Mona Ali Mohammed Ali Nagi**,** Lecturer of Radio-diagnosis, Faculty of Medicine, Ain Shams University for his patience, great support, and continuous encouragement.

Finally, I dedicate this work to the soul of my father and all members of my family **for their patience and support until finishing my work**

LIST OF CONTENTS

LIST OF ABBREVIATIONS

Abb.		Full Term
AD	**:**	Axial diffusivity.
ADC	**:**	Apparent diffusion coefficient.
AHSCT	**:**	Autologous hematopoietic stem cell transplantation.
AQP4	**:**	Aquaporin 4.
CIS	**:**	Clinically isolated syndrome.
CNS	**:**	Central nervous system.
CSF	**:**	Cerebrospinal Fluid.
DEC-FA	:	Diffusion-encoded-color fractional anisotropy
DIR	**:**	Double inversion recovery.
DIS	**:**	Dissemination in space.
DIT	**:**	Dissemination in time**.**
DMTs	**:**	Disease-modifying therapies.
DTI	**:**	Diffusion tensor imaging**.**
DWIs	**:**	Diffusion-weighted images**.**
EPI	**:**	Echo planar imaging.
FA	**:**	Fractional anisotropy**.**
FLAIR	**:**	Fluid-attenuated inversion recovery.
FOV	**:**	Field of view
LME	**:**	Leptomeningeal contrast enhancement.
MAGNIMS	**:**	Magnetic Resonance Imaging in Multiple Sclerosis.
MD	**:**	Mean diffusivity.
MOG	**:**	Myelin-oligodendrocyte glycoprotein.
MPRAGE	**:**	Magnetization-prepared rapid gradient echo.
MS	**:**	Multiple sclerosis.

LIST OF ABBREVIATIONS

Abb.		Full Term
NAWM	**:**	Normal appearing white matter.
NMOSDs	**:**	Neuromyelitis optica spectrum disorders.
NMR	**:**	Nuclear magnetic resonance.
OCB	**:**	Oligoclonal band.
OCT	**:**	Optical coherence tomography.
PD	**:**	Proton density**.**
PPMS	**:**	Primary progressive MS.
PSIR	**:**	Phase-sensitive inversion recovery.
RD	**:**	Radial diffusivity.
ROI	**:**	Region of interest.
RRMS	**:**	Relapsing-remitting MS.
SE	**:**	Spin echo.
SPMS	**:**	Secondary progressive MS.
TE	**:**	Echo Time.
TR	**:**	Repetition Time.
VEP	**:**	Visual evoked potentials.
WI	**:**	Weight image.
WM	**:**	White matter.

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Several methods have been proposed, mainly using conventional MR modalities like T1, FLAIR, or T2 images and enhanced MRI to delineate lesions. Enhanced MRI is reported as the most sensitive measure of short-term MS activity and is widely used to monitor disease evolution, either natural or modified by treatment **(Uysal . Ender, et al., 2007).**

Trials have shown that an early diagnosis can make a big difference to the efficacy of MS drug treatments. Non-conventional MR techniques are becoming increasingly important in preclinical and clinical trials as companies move forward in developing disease-modifying therapies (DMTs)**(Commowick. Olivier, et al.,2008).**

Diffusion MRI is one of the non-conventional MRI techniques used for the assessment of multiple sclerosis. During typical diffusion periods, water molecules move in the brain on average over distances bouncing, crossing, or interacting with many tissue components such as cell membranes, fibers, or macromolecules. The overall effect observed in a diffusion MRI reflects on a statistical basis as the displacement distribution of water molecules present within a voxel **(Mori and Van Ziji, 2002).**

In WM fiber tracts, organized bundles of axonal membranes and myelin sheaths present substantial barriers to diffusion, especially in directions perpendicular to that of the fibers. The architecture of the axons in parallel bundles, and their myelin sheaths, facilitate the diffusion of the water molecules preferentially along their main direction. Such preferentially oriented diffusion is called anisotropic diffusion (directionally dependant) **(Mori and Van Zijl,2002).**

The 3-D imaging of anisotropy is an extension of diffusion MRI. If a series of diffusion gradients are applied that can determine at least 3 directional vectors, it is possible to calculate, for each voxel, a tensor that describes the 3-dimensional shape of diffusion. The fiber direction is indicated by the tensor's main eigenvector. This vector can be color-coded, yielding cartography of tracts' position and direction. The brightness is weighted by the fractional anisotropy which is a scalar measure of the degree of anisotropy in a given voxel. **(Lazar et al., 2003).**

Imaging findings include the apparent diffusion coefficient (ADC) which is a measure of the magnitude of molecular motion divided by overall diffusivity, and fractional anisotropy (FA), which is the measure of the portion of the diffusion tensor that results from anisotropy (i.e, a measure of the directionality of the molecular motion of water); Mean diffusivity (MD) or trace is a scalar measure of the total diffusion within a voxel. These measures are commonly used clinically MRI **(Lazar et al., 2003).**

AIM OF WORK

To evaluate the role of DTI in the examination of the brain white matter that shows normal appearance on conventional MRI sequence in a patient with M.S, thus assessing its ability to detect early abnormalities at diffusion level.

Review of Literature

Multiple sclerosis

Multiple sclerosis (MS) is an immune-mediated, inflammatory demyelinating disease of the central nervous system (CNS) that leads to irreversible disability and currently is estimated to affect 1 million people in the United States and more than 2 million people globally **(Goldschmidt and McGinley,2021).**

In 85% of patients, MS starts with a clinically isolated syndrome (CIS), a first clinical episode of CNS demyelination. A CIS can remain a single event but can also be followed by the relapsing disease MS. Multiple sclerosis is diagnosed based on clinical or magnetic resonance imaging (MRI) evidence of dissemination in space (DIS) and time (DIT). The diagnostic criteria for MS evolved over the years to diagnose MS earlier and more easily **(Mescheriakova et al, 2018).**

The diagnosis of MS is primarily clinical and is dependent on the demonstration of neurologic signs and symptoms after white matter lesions. To distinguish MS from other conditions with similar neurologic manifestations, several criteria including McDonald criteria have been proposed. **(Huang et al, 2017)**.