



# **Magnetic Resonance Imaging Spectroscopy In Diagnosis of Multiple Sclerosis**

*Thesis*

*Submitted for Partial Fulfillment of Master  
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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قَالَ

سُبْحَانَكَ لَا عِلْمَ لَنَا  
إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ  
الْعَلِيمُ الْعَظِيمُ

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## *List of Abbreviations*

Abb	Full term
<sup>1</sup> H-MRS .....	Proton magnetic resonance imaging
ADC .....	Apparent diffusion coefficient
ADEM .....	Acute disseminated encephalomyelitis
CADASIL.....	Cerebral autosomal dominant arteriopathy with subcortical infarcts and leucoencephalopathy
CDMS .....	Clinically definite multiple sclerosis
CHESSE.....	Chemical shift water suppression
Cho.....	Choline
CIS .....	Clinically isolated syndromes
C-MRI .....	Conventional magnetic resonance imaging
CNS.....	Central nervous system
Cr .....	Creatine
CSE .....	Conventional spin echo
CSF .....	Cerebrospinal fluid
CSI .....	Chemical shift imaging
CT .....	Computed tomography
DT .....	Diffusion tensor
DTI.....	Diffusion tensor imaging
DW .....	Diffusion weighted
DWI.....	Diffusion weighted imaging
EDSS .....	Expanded Disability Status Scale
FA .....	Fractional anisotropy
FDG .....	Fluorodeoxyglucose
FLAIR.....	Fluid attenuated inversional recovery
fMRI.....	Functional magnetic resonance imaging
FSE .....	Fast spin echo
GABA.....	Gamma-amino butyric acid

*List of Abbreviations Cont...*

Abb	Full term
Gd.....	Gadolinium
Glx.....	Glutamate-glutamine
HA.....	Hunter's angle
Lac .....	Lactate
Lip MD.....	Lipid Mean diffusion
Mi.....	Myoinositol
MR .....	Magnetic resonance
MRI .....	Magnetic resonance imaging
MRS .....	Magnetic resonance spectroscopy
MTI .....	Magnetization transfer imaging
MTR .....	Magnetization transfer ratio
NAA .....	N-acetylaspartate
NAGM.....	Normal-appearing gray matter
NAWM.....	Normal-appearing white matter
NMSS.....	National multiple sclerosis society
PD .....	Proton density
PET .....	Positron emission tomography
PML .....	Progressive multifocal leucoencephalopathy
Ppm.....	Part permillion
PPMS .....	Primary progressive multiple sclerosis
PRESS .....	Point resolved spectroscopy
PRMS.....	Progressive relapsing multiple sclerosis
RRMS.....	Relapsing remitting multiple sclerosis
SD .....	Standard deviation
SE.....	Spin echo
SLE .....	Systemic lupus erythematosus
SPECT .....	Single Photon Emission Computerized Tomography

*List of Abbreviations Cont...*

Abb	Full term
SPMS .....	Secondary progressive multiple sclerosis
STEAM .....	Stimulated echo acquisition mode
TDLS.....	Tumifactive demyelinating lesions
TE .....	Time of echo
TM.....	Maximum Time
TR .....	Time of repetition
VOI.....	Volume of interest
WBNA .....	Whole brain N-acetyl aspartate
WML .....	White matter lesions

## INTRODUCTION

**M**ultiple sclerosis (MS) is a relatively common acquired chronic relapsing demyelinating disease involving the central nervous system, and is the second most common cause of neurological impairment in young adults after trauma. Characteristically, and by definition, multiple sclerosis is disseminated not only in space (i.e multiple lesions in different regions of the brain) but also in time (i.e. lesions occur at different times) (*Sarbu et al., 2016*).

Multiple sclerosis (MS) is a chronic idiopathic disease of the central nervous system (CNS). Inflammation, demyelination and axonal injury are most typical pathological features, but their underlying pathogenetic mechanisms are still unclear (*Barnett et al., 2009; Lassmann et al., 2007*).

In most of the cases MS starts between adolescence and the sixth decade, with a peak at approximately 35 years of age (*Brust, 2006*) and follows a relapsing-remitting course with clear defined relapses with no apparent clinical deterioration between the relapses. Each MS patient follows his/her individual disease course (*Gilmore et al., 2010*).

MR is the most sensitive technique for detecting MS lesions and has proved to be an important paraclinical tool for diagnosing MS and monitoring therapeutic trials (*American Journal of Neuroradiology, 2006*).

Conventional MRI detects brain abnormalities with great sensitivity but does not provide specific information about the pathology underlying the detected abnormalities. This could be explained in part by the non specificity of T2W hyperintensity which can rise from edema, mild (reversible) or severe (irreversible) chronic demyelination, inflammation, axonal loss and gliosis (*Hock et al., 2013*).

These short comings prompted using additional MR techniques such as diffusion weighted imaging (DWI), magnetization transfer imaging (MTI), functional MRI and proton magnetic resonance spectroscopy( MRS) (*Öz et al., 2014*).

MRS permits the invivo study of certain cerebral metabolites thus it offers the possibility of greater pathological specificity in lesional areas of MS as well as in normal appearing white matter and even in the gray matter (*Naryana et al., 2005*).

## **AIM OF THE WORK**

**T**his work aims to highlight the role of magnetic resonance spectroscopy in diagnosis and evaluation of MS patients, staging of disease activity and monitoring of treatment response.

*Chapter 1***ANATOMICAL BACKGROUND****White matter tracts of the brain:**

**W**hite matter is composed of bundles(axons which are ensheathed with myelin), which connect various gray matter areas (the locations of nerve cell bodies) of the brain to each other, and carry nerve impulses between neurons. Myelin acts as an insulator, which allows electrical signals to jump, rather than coursing through the axon, increasing the speed of transmission of all nerve signals (*Klein et al., 2007*).

**White Matter (WM) Fiber Classification:**

White Matter (WM) fiber tracts have been classified as follows: Association fibers, Projection fibers and Commissural fibers (*Linnman et al., 2012*).

**Association fibers:** interconnect cortical areas in each hemisphere.

**Projection fibers:** interconnect cortical areas with deep nuclei, brain stem, cerebellum, and spinal cord.

**Commissural fibers:** interconnect similar cortical areas between opposite hemispheres.