APPLICATIONS OF MR DIFFUSION TRACTOGRAPHY IN INTRA-AXIAL BRAIN TUMORS

Essay

Submitted for Paratial Fulfillment of
Master Degree in Radio Diagnosis

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2018

بسم الله الرحمن الرحيم

﴿وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا﴾

صدق الله العظيم

سورة النساء آية (١١٣)

Acknowledgment

First and foremost, I feel always indebted to
***ALLAH,** the Most Kind and Most Merciful.*

*I'd like to express my respectful thanks and profound gratitude to **Prof. Dr. Amany Emad El-Din Rady,** Professor of Diagnostic Radiology Faculty of Medicine Ain Shams University for her keen guidance, kind supervision, valuable advice and continuous encouragement, which made possible the completion of this work.*

*I am also delighted to express my deepest gratitude and thanks to **Prof.Dr. Waleed Mohamed Abd El-hamed Hetta,** Assistant Professor of Diagnostic Radiology Faculty of Medicine Ain Shams University, for his kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.*

Ahmed Gamal Hares Metawae

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List of Abbreviations

Abb.	Full term
1H-MRSI	Proton MR spectroscopic imaging
3D	3-Dimensional
ADC	Apparent Diffusion Coefficient
ALIC	Anterior Limb Of The Internal Capsule
BOLD	Blood Oxygen Level Dependent
CC	Corpus Callosum
cg	Cingulum
Cho	choline
CNS	Central Nervous System
	Computerized Tomography
CPC	Choroid Plexus Carcinoma
CPP	Choroid Plexus Papilloma
CPT	Choroid Plexus Tumors
CSF	Cerebrospinal Fluid
cst	Corticospinal Tract
CT	
DT	Diffusion Tensor
DTI	Diffusion Tensor Imaging
DTI-FT	DTI Fiber Tracking
DTT	Diffusion Tensor Tractography
DW	Diffusion Weighted
e ADC	enhanced Apparent Diffusion Coefficient
EPI	Echo Planar Imaging
FA	Fractional Anisotropy
FACT	Fibre Assignment By Continuous Tracking
fMRI	Functional MR Imaging
fx	Fornix
IC	Internal Capsule
icp	Inferior Cerebellar Peduncle
ifo	Inferior Fronto-Occipital Fasciculus
ilf	Inferior Longitudinal Fasciculus
iMRI	Intraoperative MR Imaging
LGN	Lateral Geniculate Nucleus

List of Abbreviations Cont...

Abb.	Full term
mcp	Middle Cerebellar Peduncle
ml	Medial Lemniscus
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
MRS	MR spectroscopy imaging
MS	Multiple Sclerosis
NAA	*N*-acetylaspartate
OR	Optic Radiation
PLIC	Posterior Limb Of The Internal Capsule
PMAs	Primary Motor Areas
PROPELLER	Periodically Rotated Overlapping Parallel Lines With Enhanced Reconstruction
ROI	Regions Of Interest
RT	Radiotherapy
scp	Superior Cerebellar Peduncle
sfo	Superior Frontooccipital Fasciculus
slf	Superior Longitudinal Fasciculus
SNR	Signal-To-Noise Ratio
SRT	Stereotactic Radiotherapy
st	Stria Terminalis
T2WI	T2 Weighted Image
unc	Uncinate Fasciculus
WHO	World Health Organization
WM	White Matter
WMT	White Matter Tractography

Abstract

The goal of surgical treatment is to remove as much tumor tissue as possible, while in the same time preserving the integrity of eloquent cortical areas and/or white matter tracts, and thus avoid postoperative neurological deficits. However, tumor infiltration of eloquent cortical areas and/or white matter tracts may preclude safe gross total resection

KEY WORDS: Applications Magnetic – Tractography

INTRODUCTION

The goal of surgical treatment is to remove as much tumor tissue as possible, while in the same time preserving the integrity of functionally eloquent gray and white matter structures, and thus avoids postoperative neurologic deficits. However, tumor infiltration of eloquent cortical areas and/or white matter tracts may preclude safe gross total resection. Consequently, knowledge of the relationship between tumor and eloquent cortical and white matter regions might be helpful for preoperatively determining the extent to which a brain tumor can be surgically removed, and also for guiding the actual surgical procedure ***(Talos et al., 2007).***

The primary motor cortex and the motor fibers constitute one of the most important eloquent regions of the brain; they are connected to the lower motor neurons and control muscular movement. Thus, being able to determine whether a surgically treatable brain lesion (such as a tumor) is located near the motor system would be of major clinical importance. The primary motor cortex is relatively easily identified on CT and magnetic resonance (MR) imaging using well-established neuroradiologic methods ***(Chen et al., 2013).***

On the other hand, identifying the location of the motor pathways has been much more challenging. Extensive white matter infiltration by primary brain tumors is a common occurrence ***(Talos et al., 2007).*** Moreover, resecting brain tumors involves the risk of damaging the descending motor pathway. Diffusion tensor (DT)-imaged fiber tracking is a noninvasive magnetic resonance (MR) technique that help to visualize the white matter fibers such as corticospinal (pyramidal) tract, optic radiation and arcuate fasciculus with relationship to brain tumors and can delineate the subcortical course of the motor pathway ***(Berman et al., 2007).***

Diffusion tensor imaging (DTI) and white matter tractography (WMT) are promising techniques for estimating the course, extent, and connectivity patterns of the white matter (WM) structures in the human brain. DTI provides details on tissue microstructure and organization well beyond the usual image resolution. With diffusion tensor imaging, diffusion anisotropy can be quantified and subtle white matter changes not normally seen on conventional MRI can be detected ***(0ppenhaim et al., 2007).***

Preoperative assessment with (DT)-imaged fiber tracking can be used to demonstrate displacement of the white matter tracts and in assessment of microstructural integrity white matter adjacent to tumors and thus it can could be useful for neurosurgical planning to minimize injury to the white tracts and improve preoperative risk analysis ***(Nilsson et al., 2007).***

Incorporating functional MRI into DT tractography in the preoperative assessment of patients with brain tumors may provide additional information on the course of important white matter tracts and their relationship to the tumor ***(Smits et al., 2007).***

Fiber tracks delineated using DT imaging can be used to identify the motor tract in deep white matter and define a safety margin around the tract. Intraoperative subcortical stimulation mapping of the motor tract and magnetic source imaging validated the utility of DT-imaged fiber tracking as a tool for presurgical planning ***(Berman et al., 2007).***

Postoperatively, DTI is used to assess surgical outcome. WMT alteration patterns including deviation, deformation, infiltration, and apparent tract interruption are examined postoperatively. In general, the organization of WM tracts appeared more similar to normal anatomy after tumor resection ***(Smits et al., 2007).***

AIM OF THE WORK

Elaboration of the role of magnetic resonance tractography in preoperative planning, intra-operative and post operative assessment of integrity of white matter tracts in patients with intra-axial brain tumors.

RADIOLOGICAL ANATOMY OF WHITE MATTER FIBERS TRACTS

White Matter (WM) Fiber Classification

White Matter (WM) fiber tracts have been classified as follows: Association fibers, Projection fibers, Commissural fibers and Brain stem fibers. ***Linnman et al.*** **in** ***(2012)*** summarized WM fibers identified on diffusion tensor imaging (DTI) into:

Association fibers: interconnect cortical areas in each hemisphere. Fibers of this type include cingulum, superior and inferior occipitofrontal fascicule, uncinate fasciculus, fornix, superior longitudinal (arcuate) fasciculus, and inferior longitudinal (occipitotemporal) fasciculus.

Projection fibers: interconnect cortical areas with deep nuclei, brain stem, cerebellum, and spinal cord. There are both efferent (corticofugal) and thalamic radiations.

Commissural fibers: interconnect similar cortical areas between opposite hemispheres. Fibers of this type typically include corpus callosum and anterior commissure.

Brain stem fibers: Five major white matter tracts were reconstructed in the brainstem. These are: the superior, middle,