Advanced MR Techniques in Differentiation between Residual/ Recurrent Pediatric Brain Tumors and Post treatment Gliosis/ Necrosis

Thesis

Submitted in partial fulfillment of MD Degree in Diagnostic Radiology

By

EL Shaimaa Mahmoud Abdallah Sharaf
MB. B.CH. (Cairo University)
M Sc (Cairo University)

Supervisors

Prof. Essam Aly El Shiekh
Professor of Diagnostic Radiology
Faculty of medicine
Cairo University

Prof. Iman Mohamed Zaki
Professor of Diagnostic Radiology
The National cancer institute
Cairo University

Dr. Ahmed Reda Semesem
Assistant Professor of Diagnostic Radiology
The National cancer institute
Cairo University

Cairo University
2013

Acknowledgement

I would like to express my deep gratitude to Allah for all the blessings I have in my life. A special gratitude I give to my great father Prof. Mahmoud Sharaf for the useful comments, valuable remarks and guidelines given through the learning process of this thesis. Furthermore I would like to thank Prof Dr Essam El Shiekh for his continous support & encouragement all through the way. I would also like to acknowledge with much appreciation the crucial role of Prof Dr Iman Zaky, who gave the permission & allowed me to use all required equipment and the necessary materials to complete my thesis at The Childrens' Cancer Hospital 57357. Thank you my Professors, without your guidance this thesis would not have been made.

Last but not least, I would like to thank my loved ones, who have supported me throughout the entire process, both by keeping me harmonious and helping me putting pieces together. Thank you my great mother. Thank you my beloved husband. I will be grateful forever for your love.

Abstract

Keywords:NAA-MR- ADC- Gliosis/ Necrosis

In this study 50 pediatric brain tumors were analysed in the intial(preop.), early (one month postop.) & late follow up(six months postop.) for determining the treatment outcome using the ADC values as well as specteroscopic metabolites peaks & ratios.We correlated all the available values in our results including ADCvalue, NAA, tCho which were discussed both alone and as combined relations and their statistical significance & p values were calculated. Statistically significant results were found in combining diffusion values & MRS findings.

CONTENTS

LIST OF ABBREVIATIONS

AA: Anaplastic Astrocytoma

ADC: Apparent Diffusion Coefficient

AO: Anaplastic Oligodendroglioma

ATRT: Atypical Teratoid Rhabdoid Tumor

BBB: Blood-Brain Barrier

CBV: Cerebral Blood Volume

CBF: Cerebral Blood Flow

CNS: Central Nervous System

CMS; Cerebellar Mutism Syndrome

Cr: Creatine

CSF: Cerebrospinal Fluid

CT: Computed Tomography

DNET*:* Dysembryoplastic Neuroepithelial Tumor

DT: Diffusion Tensor

DWI: Diffusion weighted Image

fMRI: Functional MR Imaging

FOV: Field Of View

FSE: Fast spin echo

GBM: Glioblastoma Multiforms

Gd-DTPA: Gadopentetate dimeglumine

Gln: Glutamine

Glu: Glutamate

Glx: Total Glutamate_ Glutamine

GTR: gross total resection

HGGs: High-Grade Gliomas

IM: Intramuscular

IV: Intravenous

Lac: Lactate

LGGs: Low Grade Gliomas

IR: Inversion Recovery

LipMM: Lipids and Macromolecules

MMP-2: matrix metalloproteinase-2

MDCT: Multidetector Computed Tomography

MI: Myoinositol

MT: Magnetization Transfer

MR: Magnetic Resonance

MRS: MR Spectroscopy

NAA: N-Acetylaspartate

PDWI: Proton Density-Weighted Image

Ppm: Parts per million

PXA: pleomorphic xanthoastrocytoma

PNET: Primitive Neuroectodermal Tumor

RF: Radiofrequency

ROI: Regions Of Interest

ROC: Receiver operating characteristic

SE: Spin Echo

SI: Signal intensity

SEGA :Subependymal giant cellastrocytoma

SNR: Signal-to-Noise Ratio

SPECT: Single Photon Emission Computed Tomography

SRS: Stereotactic Radiosurgery

STEAM: Stimulated-Echo Acquisition Mode

STR: Subtotal resection

STIR: Short Tau Inversion Recovery

Tau: Taurine

tCho: Total Choline

USA: United State of America

WHO: World Health Organization

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Brain tumors during childhood account for 15%-20% of all primary brain tumors. Central nervous system tumors are the second most common pediatric tumor. In most larger series, posterior fossa tumors and supratentorial tumors occur in equal frequency. However, supratentorial tumors are more common in the first two to three years of life, whereas infratentorial tumors predominate from ages 4 to 10 (**Bonavita S., et al, 1999)**

Magnetic resonance (MR) imaging plays an important role in the detection and evaluation of brain tumors. To date, MR imaging has principally served the role of showing the neoplasm, helping distinguish tumors from other pathologic processes and depicting basic signs of tumor response to resection and therapy.

Contrast-enhancing lesions that arise on routine follow-up brain MRI at the site of a previously identified and treated intracranial neoplasm present a significant diagnostic dilemma. Radiation necrosis is the most substantial and most severe form of radiation-induced injury with therapeutic implications. The diagnosis of radiation necrosis on imaging has been challenging, primarily because the pattern of abnormal enhancement closely mimics that of recurrent brain tumor **(Hein PA., et al, 2004**).The two entities may be distinguished by a brain biopsy, the patient's clinical course, or follow-up imaging.

Among the noninvasive methods that are available for diagnosis include diffusion and perfusion weighted MRI (**Yang D., et al, 2002**), Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) which has been used in attempts to differentiate tumor from radiation necrosis.

Diffusion-weighted (DW) magnetic resonance imaging, currently the only MR imaging technique that provides information on water diffusion, involves the use of phase defocusing and phase-refocusing gradients to allow evaluation of the rate of microscopic water diffusion within tissues. DW MR imaging has been used to study brain tumors and response to treatment (James M., et al, 2006), and its diagnostic potential and usefulness for obtaining the apparent diffusion coefficient (ADC) have been reported