THE ROLE OF DIFFUSION MAGNETIC RESONANCE IMAGING IN EVALUATION OF BRAIN TUMORS AND RECURRENCE

Essay

Submitted for Fulfillment of Master Degree in
Radiodiagnosis

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2010

بسم الله الرحمن الرحيم

(يرفع الله الذين امنوا منكم والذين اوتوا العلم درجات)

(سورة المجادلة١١)

صدق الله العظيم

ABSTRACT

Diffusion weighted imaging adds useful information in diagnosis of brain tumors; helps in grading of gliomas, and in differentiation of some brain tumors. It can distinguish tumor recurrence from post radiotherapy effect and benign from malignant cystic lesions. In addition, it can assess the response of brain tumors to therapy.

Key words: Diffusion, Brain Tumors

ACKNOWLEDGEMENT

First and foremost, I always indebted to ALLAH, *the most kind and merciful.*

I would like to express my special thanks deep gratitude to Prof. Dr. ***Hassan Ali Hassan Elkiky****, Professor of Diagnostic Radiology, Cairo University for his unfailing patience, tolerance and generosity. For this outstanding humbleness that parallels his invaluable knowledge. For delightful work atmosphere he creates and the kindest patronage.*

I would like to express my wormiest appreciation and cardinal thanks to Dr. ***Ramy Edward Asaad****, Lecturer of Diagnostic Radiology, Cairo University for her persistant effort, valuable guidance and meticulous revision of the work.*

I also express my great appreciation to all my professors and colleagues for their cooperation and help.

I would also like to express my special thanks to my father, mother, and dear brother for their support and help.

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List of Abbreviations

ADC	: Apparent diffusion coefficient
AIDS	: Acquired immunodeficiency syndrome
BOLD	: Blood oxygenation level–dependent imaging.
CNS	: Central nervous system
CPA	: Cerebro pontine angle
CSF	: Cerebrospinal fluid
CT	: Computerized tomograghy
CSF	: cerebro spinal fluid
DNET	: Dysembryoplastic neuroepithelial tumor
DTI	: Diffusion tensor imaging
DWI	: Diffusion weighted imaging
EP SE	: Echoplanar spin echo
EPI	: Echoplanar imaging
FLAIR	: Fluid-attenuated inversion recovery
GBM	: Glioblastoma multiforme
GIT	: Gastrointestinal tract
MRI	: Magnetic resonance imaging
MRS	: Magnetic resonance spectroscopy
N/C	: Nuclear- to cytoplasmic
NADC	: Normalized apparent diffusion coefficient
NADCt	: Normalized apparent diffusion coefficient of the tumor
NF I	: Neurofibromatosis type 1
PNET	: Primitive neuroectodermal tumor
rCBR	: Relative cerebral blood volume
RF	: Radiofrequency
SE	: Spin echo
SI	: Signal intensity
SEGA	: Subependymal gaint cell astrocytoma
TR	: Time of repetition
TS	: Tuberous sclerosis
VEGF	: Vascular endothelial growth factor

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INTRODUCTION ANDAIM OF THE WORK

There are two types of brain tumors: primary brain tumors that originate in the brain and metastatic (secondary) brain tumors that originate from cancer cells that have migrated from other parts of the body. A primary brain tumor rarely spreads beyond the central nervous system, and death results from uncontrolled tumor growth within the limited space of the skull. Metastatic brain cancer indicates advanced disease and has a poor prognosis (***Stanley , 2007)***.

Primary brain tumors can be cancerous or noncancerous. Both types take up space in the brain and may cause serious symptoms and complications. All cancerous brain tumors are life threatening (malignant) because they have an aggressive and invasive nature. A noncancerous primary brain tumor is life threatening when it compromises vital structures. Brain cancer is the leading cause of cancer-related death in patients younger than age 35 (***Stanley, 2007)***.

Primary brain tumors account for 50% of intracranial tumors and secondary brain cancer accounts for the remaining cases. Approximately 17,000 people in the United States are diagnosed with primary cancer each year and nearly 13,000 die of the disease. The annual incidence of primary brain cancer in children is about 3 per 100,000.Secondary brain cancer occurs in 20–30% of patients with metastatic disease and incidence increases with age. In the United States, about 100,000 cases of secondary brain cancer are diagnosed each year **(Stanley, 2007)**.

The diagnosis of brain tumors by magnetic resonance imaging (MRI) is usually based on basic unenhanced T1- and T2-weighted images and post contrast T1-weighted images. Conventional MRI techniques are not sufficient for the grading and specification of brain tumors. Furthermore, several non neoplastic lesions, such as arachnoid cysts, heterotopic gray matter, tubers of tuberous sclerosis, cavernous hemangiomas, aneurysms, granulomas, abscesses, radiation necrosis and acute demyelination with a mass effect can mimic brain tumors on MRI ***(Stepha, 2007)***

In diffusion-weighted imaging (DWI), the image contrast is determined by the random translational (Brownian) motion of water molecules and DWI is most often used for the evaluation of stroke .The quantification of diffusion using DWI, i.e. diffusion imaging, has been attracting growing interest as an easy method to further characterize the nature of brain tumors **(Stephan , 2007)**.

So Diffusion imaging appears to have the potential to add important information to pre-surgical planning. While experience is limited, DWI appears to provide useful local information about the structures near the tumor, and this appears to be useful in planning. In future, DWI may provide an improved way to monitor intra-operative surgical procedures as well as their complication. Furthermore, the evaluation of the response of treatment to chemotherapy and to radiation therapy might also be possible. While diffusion imaging has some limitations, its active investigation and further study are clearly warranted **(Inoue et al., 2005)**.

Diffusion-weighted (DW) MR imaging is a means to characterize and differentiate morphologic feature, including edema, necrosis, and tumor tissue, by measuring differences in apparent diffusion coefficient (ADC). It is hypothesized that DW imaging has the potential to differentiate recurrent or progressive tumor growth from treatment-induced damage to brain parenchyma in high-grade gliomas after radiation therapy (**Patric et al., 2006**).

ADC could provide addition useful information in the diagnosis of patient with brain tumor, such as tumor malignancy, peritumoral infiltration and the type of meningioma **(Kono et al., 2005)**

diffusion fiber tractography is the only method giving an indirect, in-vivo view of the nerve fiber trajectory. It can be associated with functional MRI to study the interconnections between nerve centers, used to analyze brain maturation and development (myelination), assist in the preoperative check-up for brain tumors (corticospinal bundle) or for medullary compression ***(Escolar, 2006)***.

Aim of the work

The aim of study is to evaluate the role of Diffusion Magentic resonance imaging in the assessment of brain tumors and recurrence.

CHAPTER I

Introduction to Brain Tumors

1. Incidence

About 10% of primary brain tumor occurs in children. Although it is occurs over all age the peak incidence at young than age 5, which declines until about age 20, then increase in older ages. In general, more males than female develop brain tumor. For example, the relation risk for males compared to female for glioblastoma multiforme(GBM) is approximately 1.6(i.e. the incidence rate are 16 times higher in males than female for this tumor type) ***(Davis et al., 1999)***.

Mortality and incidence rate for primary brain tumors have been consistently higher in whites than in black. Meningiomas are the major exception with higher incidence rate in females than males and in blacks than whites .The 5 years survival rate for patients with malignant brain tumors is estimated to be 30%, compared to survival rate that estimated to be 72% for patient diagnosed with benign brain tumors. Five years survival rate for malignant brain tumor is inversely related to the age at diagnosis, with those in the oldest age groups having the worst survival rates 75 year- 3.6% where as those in the youngest age group have better survival< 45 years-57.3% ***(Edwards, 1994)***.

2. Brain tumor classification

In 1993 the WHO ratified a new comprehensive classification of neoplasm affecting the central nervous system. The classification of brain tumors is based on the premise that each type of tumor results from the abnormal growth of a specific cell type .To the extent that the behavior of a tumor correlates with basic cell type, tumor classification dictates the choice of therapy and predicts prognosis. The new WHO system is particularly useful in this regard with only a few notable exceptions (for example all or almost all gametocyte astrocytomas are actually anaplastic and hence labeled grade III or even IV rather than grade II as designated by the WHO system). The WHO classification also provides a parallel grading system for each type of tumor. In this grading system most named tumors are of a single defined grade ***(Kleihues et al., 1993)***.

The new WHO classification provides the standard for communication between different centers in the United States and around the world ***(Louis et al., 2007).***