Role of Diffusion Magnetic Resonance Imaging in Assessment of Neoplastic and Inflammatory Brain lesions

Essay

Submitted in Partial Fulfillment of the Master Degree
in
Radio diagnosis

BY

Mohamed Ossama Elhassawy

M. B. B .Ch.
(2005)

Supervised BY

Prof. Dr.

Hossam Abdel Kader Morsy
Professor of Radio diagnosis
Faculty Of medicine
Ain Shams University

Dr.

Ahmed Fathy Abdel Ghany
Assistant Professor of Radio diagnosis
Faculty Of medicine
Ain Shams University

Radio Diagnosis Department
Faculty of Medicine
Ain Shams University
2011

Contents

Acknowledgements

First of all I thank God for without his help I couldn't have accomplished this work.

I would like to express my thanks and gratitude to *Dr. Hossam Abdelkader* , Professor of Radio diagnosis, Faculty of medicine Ain Shams University for his continuous encouragement help and valuable comments.

I would like to express my thanks and deep appreciation to *Dr. Ahmed Fathy* , Assistant professor of Radio diagnosis Faculty of Medicine Ain Shams University. For his helpful advice, guidance and thoughtful remarks.

Finally I would like to thank my family, my wife and my lovely young daughter (**HANA**), for their support.

Mohamed Ossama Elhassawy

Introduction

Introduction

Diffusion magnetic resonance imaging in human started in the last decade. Two main approaches in terms of reconstruction and evaluation of the images; The diffusion weighted imaging that shows possible areas of increased or decreased signal, reflecting restricted and facilitated diffusion, respectively and the apparent diffusion coefficient in which the T2-weighting of the diffusion sequence is cancelled out, and produce numerical evaluation of regions of interest ***(Mascalche M et al, 2005)***.

DWI is a type of MRI, most often used in neuro-imaging that measures the movement, or diffusion, of extracellular water molecules. Diffusion is restricted in areas of damage from such causes as trauma, stroke, or some tumors. ***(Nitkunan A, Barrick TR, Charlton RA, et al.2008).***

Common uses of DWI include, Detection of early stroke in the brain, Differentiation of benign from malignant tumors in many organs, including the brain, thyroid gland, and abdomen and Differentiation of active from dormant plaques in multiple sclerosis. ***(Nitkunan A, Barrick TR, Charlton RA, et al.,2008).***

The widest application of diffusion –weighted imaging has been evaluation of cerebral ischemia ***(Moussa et al., 2000).***

However, it gives useful clinical information in several brain disorders besides acute ischemic stroke ***(Nistri Met al., 2000).***

Diffusion weighted imaging is useful in distinguishing a brain abscess from a necrotic or a cystic tumor. ***(Shadab et al., 2002).***

Diffusion weighted imaging is superior to conventional magnetic resonance imaging in evaluating the success or failure of abscess therapy. ***(Fabiola et al.,2004).***

Diffusion weighted MR imaging provides useful and complementary information regarding the degree of involvement of white and grey matter in different pediatric neurologic disorders. ***(Oksuzler et al., 2005).***

The apparent diffusion coefficient may be predictive of tumor classification and may be a useful tool in characterizing tumor cellularity and total nuclear area. These parameters are not available in standard MR imaging. Therefore, diffusion-tensor imaging may enhance the diagnostic process in pediatric CNS malignancies. ***(© American Roentgen Ray Society 2003).***

ADC is useful for differentiation of some human brain tumors, particularly DNT, malignant lymphomas versus glioblastomas and metastatic tumors, and ependymomas versus PNETs***. (© RSNA, 2005)***

Aim of the work

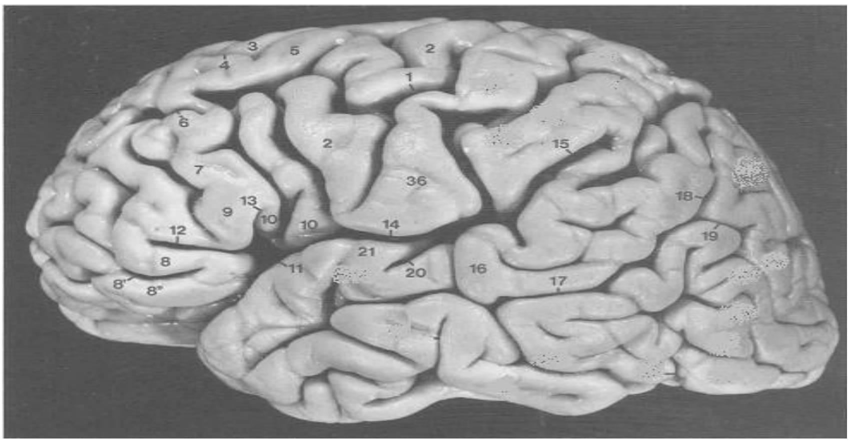
Aim of work

To highlight the role of diffusion magnetic resonance imaging in the assessment of the neoplastic and inflammatory brain lesions.

Anatomical consideration and pathological overview.

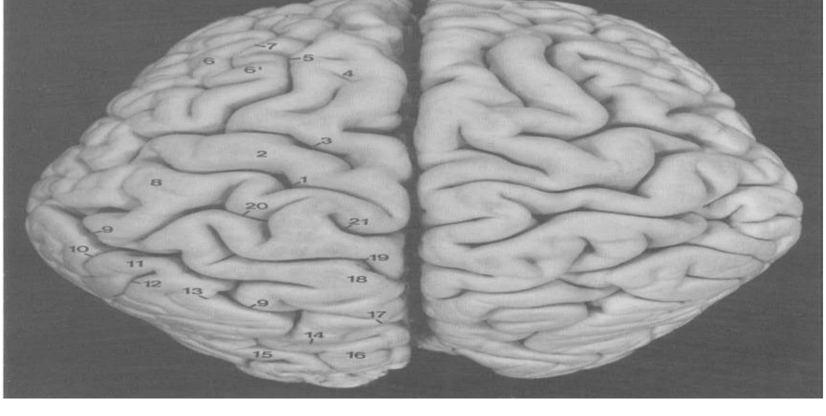
BRAIN ANATOMY

The hemispheres are divided into frontal, temporal, parietal, and occipital lobes by fissures and sulci (central sulcus , lateral, parieto-occipital, and temporo-occipital fissures). The lateral surface of the frontal lobe is divided into precentral, superior, middle, and inferior gyri by three sulci: superior frontal, inferior frontal, and precentral. The middle frontal gyrus is often subdivided into superior and inferior parts by the middle frontal sulcus. (Fig 1- 2). **(Martin, 1996).**



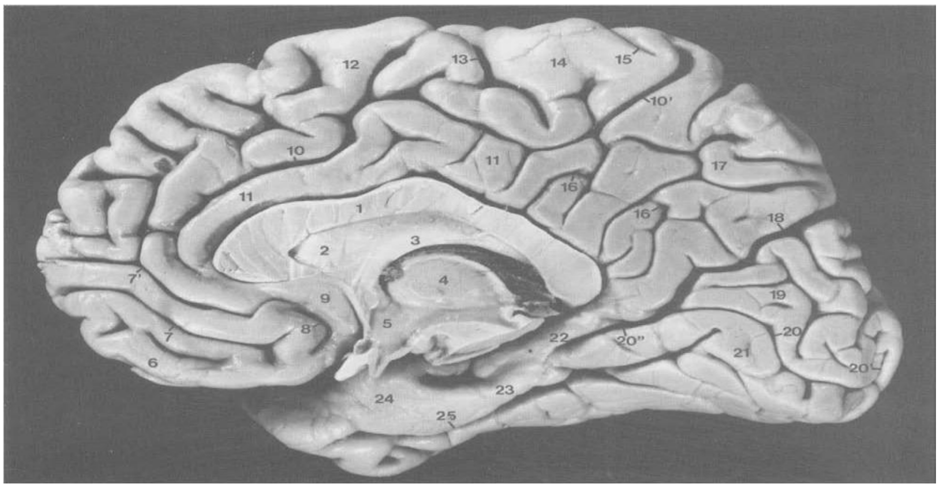
1 Central sulcus **2** Precentral gyrus **3** Superior frontal gyrus (F1) **4** Superior frontal sulcus
5 Middle frontal gyrus (F2) **6** Inferior frontal sulcus **7** Inferior frontal gyrus (F3) **8** Pars orbitalis
8' Lateral orbital sulcus **8''** Lateral orbital gyrus **9** Pars triangu **10** Pars opercularis
11 Lateral fissure, anterior segment **12** Horizontal ramus of lateral fissure **13** Vertical ramus of lateral fissure **14** Lateral fissure, middle segment **15** Lateral fissure, posterior segment
16 Superior temporal gyrus (T1) **17** Anterior segment of superior temporal sulcus
18 Ascending posterior segment of superior sulcus **19** Horizontal posterior segment of temporal sulcus
Transverse temporal sulcus **21** Transverse temporal gyrus

Fig. 1 Lateral aspect of the left hemisphere ***(Gilman S, et al., 2003).***



1 Central sulcus **2** Precentral gyrus **3** Superior precentral sulcus
4 Superior frontal gyrus (F1) **5** Superior frontal sulcus **6**" Middle frontal gyrus
7 Middle frontal sulcus **8** Postcentral gyrus **9** intraparletal sulcus
10 Sulcus intermedius primus (Jensen) **11** Angular gyrus **12** Superior temporal sulcus13 Sulcus intermedius secundus **14** Transverse occipital gyrus **15** Middle occipital gyrus (02)
16 Superior occipital gyrus (01) **17** Parieto-occipital fissure **18** Superior parietal gyrus (PI)
19 Transverse parietal sulcus **20** Superior postcentral sulcus **21** Cingulate sulcus,marginal segm.

Fig. 2 Superior aspect of the left and right hemispheres.***(Gilman S,et al., 2003).***



1 Corpus callosum **2** Septum pellucidum **3** Fornix **4** Thalamus **5** Hypothalamus **6** Gyrus rectus **7,7'** Suborbital sulci **8** Anterior paraolfactory sulcus **9** Subcallosal gyrus
10 Cingulate sulcus **10'** Marginal segment of cingulate gyrus **11** Cingulate gyrus

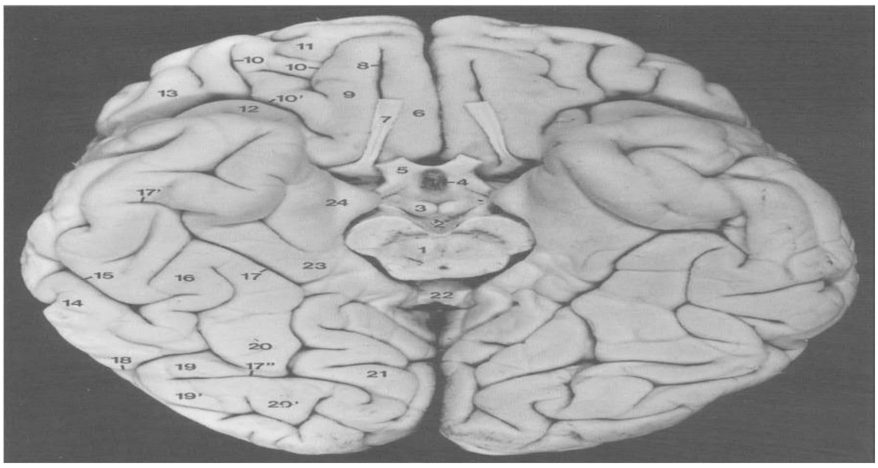
12 Medial aspect of superior frontal gyrus (F1) **13** Paracentral sulcus **14** Paracentral lobule **15** Central sulcus **16** Subparietal sulcus **17** Precuneus **18** Parieto-occipital fissure

19 Cuneus **20** Calcarine sulcus **20'** Retrocalcarine sulcus **20**" Anterior calcarine sulcus **21**Lingulal gyrus **22**Isthmus **23**Parahippocampal gyrus **24**Uncus **25**Collater

Fig. 3 Medial aspect of the right cerebral hemisphere. ***(Gilman S, et al 2003).***

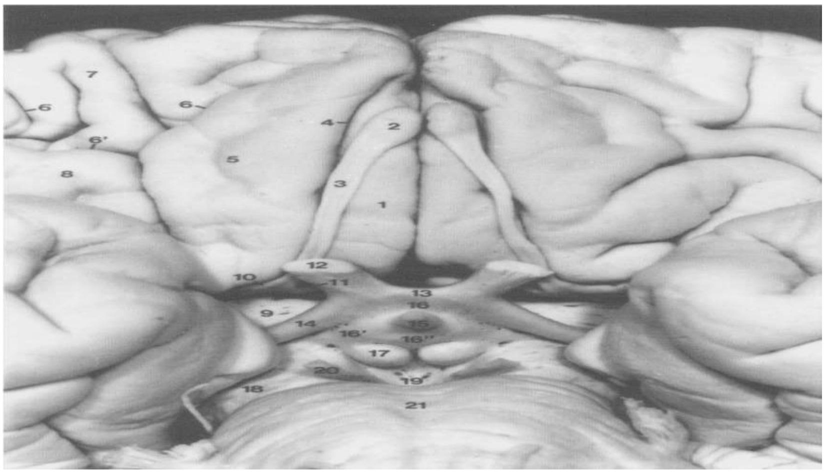
The inferior surface of the frontal lobe, often called the orbital lobe, is composed of the lateral, medial, anterior, and posterior orbital gyri and by the gyrus rectus (Fig. 4&5). The temporal lobe is situated on the lateral, inferior, and medial aspects of the hemisphere. Four sulci - the superior temporal (or parallel), inferior temporal, lateral occipitotemporal and medial occipitotemporal (or collateral) – divide the temporal lobe in five gyri: superior temporal (Tl), middle temporal (T2), inferior temporal (T3), fusiform (T4), and parahippocampal (T5). The occipital lobe, like the temporal lobe, is visible on the lateral, inferior, and medial aspects of the hemisphere. Its anatomy is intricate. Sulci and gyri are difficult to identify. Nevertheless, the occipital lobe can be divided into six gyri: superior (01), middle (02), and inferior (03), occipital gyri, fourth occipital gyrus (04), lingual gyrus (05), and cuneus (06).

On the lateral surface of the hemisphere, the superior, middle, and inferior gyri are separated from each other by the superior and inferior occipital sulci. The large middle occipital gyrus is often subdivided into superior and inferior parts by the lateral occipital sulcus (Fig.3&6). On the inferior and medial surfaces, the lateral temporo-occipital, collateral, and calcarine sulci delimit the inferior occipital, fourth occipital, and lingual gyri and the cuneus. The lateral surface of the parietal lobe is divided by the intraparietal sulcus into three gyri: the postcentral, superior (PI), and inferior (P2) parietal gyri. The inferior parietal gyrus is itself subdivided into supramarginal and angular gyri. The superior parietal gyrus lies on the superior margin of the hemisphere and overlaps its medial surface, where it is called precuneus (Fig. 1, 3, 6&7). ***(Martin, 1996)***



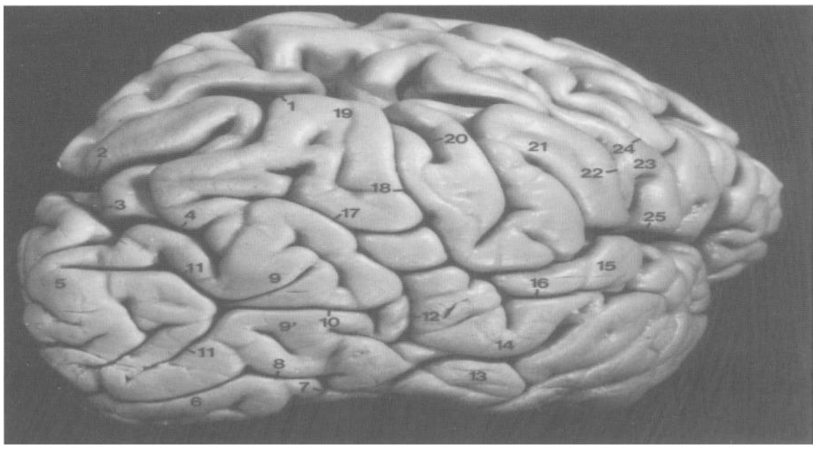
1 Cut surface of mesencephalon **2** Interpeduncular fossa **3** Mamillary body 4 Hypophyseal stalk and median eminence **5** Optic chlasm **6** Gyrus rectus **7** Olfactory tract 8 Medial orbital sulcus **9** Medial orbital gyrus **10** H-shaped orbital sulcus **10'** Arcuate orbital sulcus **11** Anterior orbital gyrus **12** Posterior orbital gyrus **13** Lateral orbital gyrus **14** Inferior temporal gyrus **15** Lateral occipitotemporal sulcus **16** Fusiform gyrus (T4) **17** Collateral sulcus **17**' Anterior transverse collateral sulcus **18** Tempore occipital incisures **19** Inferior occipital gyrus (03) **19'** Inferior occipital gyrus (03) **20** Fourth occipital gyrus (04) **20'** Fourth occipital gyrus **21** Lingual gyrus(05) **22** Splenium **23** Parahippocampal gyrus **24** Uncus

Fig. 4 Inferior aspect of the brain with cerebellum and brainstem removed. ***(Gilman S, et al 2003)***



1 Gyrus rectus **2** Olfactory bulb **3** Olfactory tract **4** Medial orbital sulcus **5** Medial orbital gyrus
6 H-shaped orbital sulcus **6'** Arcuate orbital sulcus **7** Anterior orbital gyrus **8** Posterior orbital gyrus **9** Anterior perforated substance **10** Lateral olfactory stria **11** Medial olfactory stria
12 Optic nerve **13** Optic chiasma **14** Optic tract **15** Hypophysial stalk **16** Anterior tuber **16'** Lateral tuber **16''** Posterior tuber **17** Mamillary body 18 Crus cerebri **19** Interpeduncular fossa **20** Oculomotor nerve **21** Pons

Fig. 5 Basal surface of the brain - orbital lobe. (***Gilman S, et al., 2003).***



1 Intraparietal sulcus 2 Parieto-occipital fissure 3 Intra-occipital sulcus
4 Transverse occipital sulcus 5 Superior occipital gyrus 6 Inferior occipital gyrus
7 Temporo-occipital incisure 8 Inferior occipital sulcus 9,9' Middle occipital gyrus
10 Lateral occipital sulcus 11 Sulcus lunatus 12 Anterior occipital sulcus
13 Inferior temporal gyrus 14 Middle temporal gyrus 15 Superior temporal gyrus
16 Superior temporal sulcus 17 Superior temporal sulcus, horizontal posterior segment
25 Lateral sulcus 18 Superior temporal sulcus, ascending posterior segment 19 Angular gyrus 20 Sulcus intermedius primus 21 Supramarginal gyrus 22 Inferior postcentral sulcus 23 Postcentral gyrus 24 Central sulcus.

Fig. 6 Occipital pole, right hemisphere, lateral aspect. ***(Gilman S, et al 2003).***

A supernumerary lobe, the limbic lobe, is often described on the medial and inferior aspects of the hemisphere (Fig. 3). The limbic lobe is delimited by the limbic fissure, which is mainly composed of cingulate and collateral sulci. The limbic lobe may be divided into large limbic and slender intralimbic gyri. The limbic gyrus is successively made up of the subcallosal gyrus, the cingulate gyrus, and the isthmus, which together belong, from an anatomical point of view, to the frontal and parietal lobes, and the parahippocampal gyrus (T5), which is part of the temporal lobe (see above). The uncus or anterior part of the parahippocampal gyrus curves posteriorly and overlaps the parahippocampal gyrus; monly the anterior segment of the uncus belongs to the parahippocampal gyrus and so to the limbic gyrus, whereas its posterior segment is a part of the intralimbic gyrus. The intralimbic gyrus is mainly formed by the hippocampus; the hippocampus bordering the parahippocampal gyrus belongs to the temporal lobe from an anatomical point of view (Fig. 8) and to the limbic lobe functionally. It is a cortical fold, which bulges into the floor of the temporal horn of the lateral ventricle. After opening the temporal horn and removing the choroids plexuses, the hippocampus appears as an arc, medially concave, which may look like a sea horse. This arc is composed of three segments: a head or anterior part transversally oriented, a body or middle part, which is sagittally oriented, and a tail or posterior part, again transversally oriented and situated beneath the splenium. When viewing sections through the brain, three mutually perpendicular planes are commonly considered, as shown in (Fig. 9). These are axial (or transverse) coronal, and sagittal. ***(Martin, 1996).***