ROLE OF MAGNETIC RESONANCE SPECTROSCOPY IN THE EVALUATION OF PATIENTS WITH MULTIPLE SCLEROSIS

Essay

Submitted for partial fulfillment of Master degree in Radiodiagnosis

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دور الرنين المغناطيسى الطيفى فى حالات التصلب المتعدد:

رساله مقدمه من الطبيبة

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بكالوريوس الطب و الجراحه
كليه الطب – جامعه القاهرة

توطئه للحصول على درجه الماجستيرفى الأشعة التشخيصية

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INTRODUCTION

Multiple sclerosis is a common cause of chronic neurological disability in young adults. It is an immune mediated disorder selectively affecting the central nervous system . The pathologic hallmark of MS is inflammatory demyelination, which can be limited by reparative mechanism (including remyelination) or can become irreversible and ultimately lead to tissue loss *(Cole et.al.,1998).*

Conventional magnetic resonance imaging (cMRI) is an important paraclinical tool for diagnosing multiple sclerosis and providing several markers of disease activity and evolution *(Rovaris et.al.,1999).*

Conventional MRI detects brain abnormalities with great sensitivity but does not provide specific information about the pathology underlying the detected abnormalities *(Mathews et.al.,2001).* This could be explained in part by the non specificity of T2W hyperintensity which can rise from oedema, mild (reversible) or severe (irreversible) chronic demyelination, inflammation, axonal loss and gliosis *(Barkohf et.al.,2000).*

These shortcomings prompted using additional MR techniques such as diffusion weighted imaging (DWI), magnetization transfer imaging (MTI), functional MRI (fMRI) and proton magnetic resonance spectroscopy (H1MRS) *(Fillipi et.al.,2002).*

H1MRS 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

This work aim to highlight the value of magnetic resonance spectroscopy in the evaluation of patients with multiple sclerosis and to what extent its use can add valuable information to conventional MRI.

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RECOMMENDATIONS

RECOMMENDATIONS

We recommend the following*:*

The use of proton magnetic resonance spectroscopy in conjunction with conventional MRI in the following conditions:

- Detection of disease activity.
- The study of normal appearing white and gray matter.
- Follow up of the disease progression and efficacy of treatment

CHAPTER 1

ANATOMICAL BACKGROUND

White matter tracts of the brain:

The white matter of the brain is located in the central and subcortical regions of the cerebral and cerebellar hemispheres and accounts for about 60 % of the total brain volume. Histologically, the white matter contains nerve fibers, supporting cells, interstitial space and vascular structures. White matter consists mostly of axons with their envelope of myelin, along with two types of neuroglia-oligodendrocytes and astrocytes. Axons are extensions of neurons that reside within the gray matter of the brain, spinal cord and ganglia. The myelin is produced and maintained by oligodedrocytes . Myelin functions as an insulator of axons, and its structure facilitates rapid transmission of impulses *(Valk et.al.,1989).*

The white matter includes:

- Association (arcuate) fibers connecting different cortical areas in the same hemisphere; some are collaterals of the projection and commissural fibers but most are main axons.

- Projection fibers, connecting the cerebral cortex with the corpus striatum, diencephalon, brainstem and the spinal cord in both directions.
- Commissural fibers, linking corresponding or homotopic loci and heterotopic loci in both hemispheres *(Martin.,2003)*

Association (Arcuate) Fibres:

Association (arcuate) fibers, confined to one hemisphere and are grouped as short, connecting adjacent gyri, or long, connecting more widely separated gyri (fig.1,2).

Short arcuate fibres: may be entirely intracortical but many pass subcortically between adjacent gyri, some merely from one wall of a sulcus to the other.

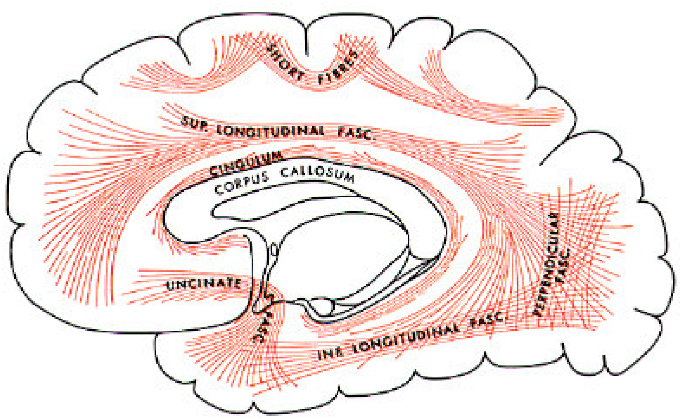
Long arcuate fibres :The following large fasciculi can usually be distinguished: the uncinate fasciculus, the cingulum, the superior longitudinal fasciculus, the inferior longitudinal fasciculus, the fronto-occipital fasciculus.

- *The uncinate fasciculus*: connects the motor speech area and orbital gyri of the frontal lobe with the cortex in the temporal pole; the fibers follow a sharply curved course across the stem of the lateral sulcus. .
- *The cingulum*: a long, curved fasciculus starting in the medial cortex below the rostrum, then lies in the gyrus cinguli and follows its curve. Inferiorly it enters the parahippocampal gyrus and spreads into the adjoining temporal lobe. From its convexity fibers enter and leave in groups, giving it a spiked irregular appearance when dissected.
- *The superior longitudinal fasciculus:* largest of the arcuate bundles, commences in the anterior frontal region and arches back above the insular area and lateral to the massive cortical projection fibers of the internal capsule (corona radiate) . Contributing fibers to the occipital cortex (areas 18 and 19), it curves down and forwards behind the insular area to spread out in the temporal lobe.
- The inferior longitudinal fasciculus: commences near the occipital pole, its fibers derived perhaps mostly from areas 18 and 19. They sweep forwards, separated from the lateral ventricle's posterior cornu by the optic radiation and commissural tapetal fibres and, after being crossed by the

superior longitudinal fasciculus, are then distributed throughout the temporal lobe.

- The fronto-occipital fasciculus: starts from the frontal pole, passing back deep to the superior longitudinal fasciculus but separated from it by the projection fibers in the corona radiata . It is lateral to the caudate nucleus and therefore near the central part of the lateral ventricle. Posteriorly it fans out into the occipital and temporal lobes, lateral to the posterior and inferior ventricular cornua and the criss-crossing fibers of the tapetum *(Snell,2001).*

Fig1: A diagram showing The principle system of the arcuate fibers *(Gray, 1989).*



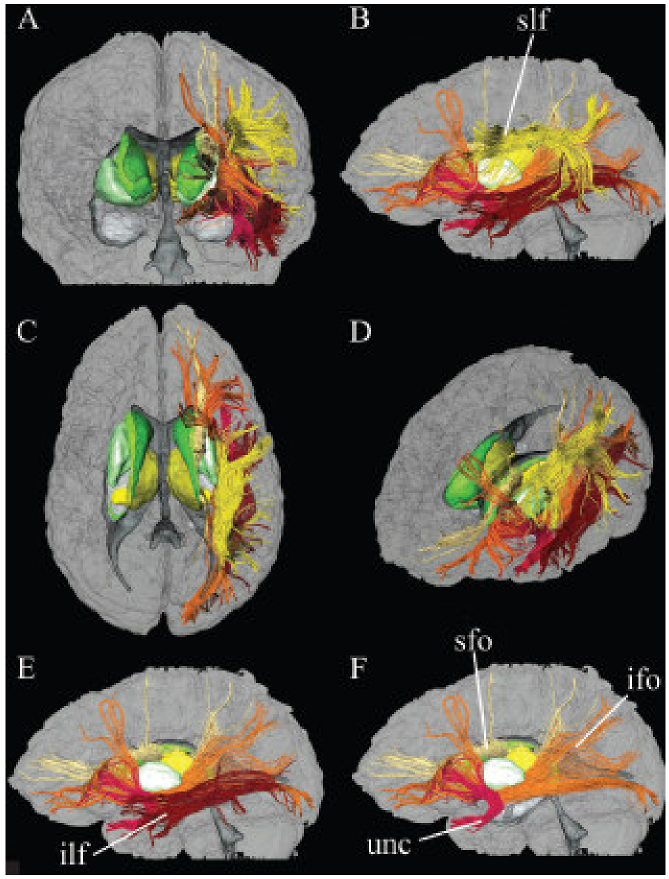


Fig2: Four viewing angles of 3D depictions of association fibers created on basis of high-spatial-resolution diffusion tensor magnetic imaging *A,* Anterior view; *B,* left lateral view; *C,* superior view; *D,* oblique view from right anterior angle. Reconstructed fibers are superior longitudinal fasciculus (*slf,* yellow), inferior longitudinal fasciculus (*ilf,* brown), superior fronto-occipital fasciculus (*sfo,* beige), inferior frontooccipital fasciculus (*ifo,* orange), and uncinate fasciculus (*unc,* red). *E,F,* Left lateral views without superior longitudinal fasciculus *(E)* and inferior longitudinal fasciculus *(F) (Wakana 2003).*

Projection Fibres:

Projection fibres connect the cerebral cortex with lower levels in the brain and spinal cord; they are corticofugal and corticopetal. Projection fibres converge from all directions to the corpus striatum , mostly (but not exclusively) medial to association fibres, and intersect commissural fibres of the corpus callosum and anterior commissure. At the periphery of the corpus striatum, they form the corona radiata; its medial aspect is, however, separated from the lateral ventricle by the fronto-occipital fasciculus and its lateral aspect covered by the superior longitudinal fasciculus. It is continuous with the internal capsule, a curved zone including almost all the projection fibers *(Fitzgerland & Curran 2002).*

Internal Capsule

In horizontal cerebral section the internal capsule is seen as a broad white band, with a lateral concavity adapted to the convex medial aspect of the lentiform nucleus(fig3,4) . It has an anterior limb, genu, posterior limb, retrolentiform and sublentiform parts . Both limbs are, of course, medial to the lentiform nucleus; medial to the anterior limb is the head of the caudate nucleus and medial to the posterior limb the thalamus. Fibres of the capsule continue to converge as they descend, the frontal fibres tending to pass