

Salwa Ak1



بسم الله الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني



Salwa Akl



جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
على هذه الأقراص المدمجة قد أعدت دون أية تغييرات



Salwa Akl



بعض الوثائق الأصلية تالفة
وبالرسالة صفحات لم ترد بالأصل



ROLE OF MRI IN DIAGNOSIS OF SUPRATENTORIAL TUMOURS

THESIS

B18388

*Submitted in Partial Fulfillment for M.D. Degree in
Radiodiagnosis & Imaging*

BY

Noha Roshdy Mokhtar Khalil

M.B.B.Ch., M.Sc. in Radiodiagnosis & Imaging

SUPERVISORS

Prof. Dr.

Mahmoud Abd El Aziz Dawoud

*Prof. & Head of Radiology & Imaging Department
Faculty of Medicine
Tanta University*

Dr.

Emad Abou Zied Mashaly

*Assistant Prof. of Radiodiagnosis & Imaging
Faculty of Medicine
Tanta university*

FACULTY OF MEDICINE

TANTA UNIVERSITY

2001



Acknowledgment

*First of all thanks to **ALLAH** who allowed & helped me to accomplish this work.*

*I wish to convey my sincere appreciation, deep thanks & gratitude to Prof. Dr. **Mahmoud Abdel Aziz Dawoud**, Professor & Head of Radiodiagnosis & Imaging Department, Faculty of Medicine, Tanta University for instructive supervision, valuable advise, constructive criticism & continuous encouragement.*

*I am more than grateful to Dr. **Emad Abou Zied Mashaly**, Assistant Prof. of Radiodiagnosis & Imaging, Faculty of Medicine, Tanta University for his kind supervision, unlimited support & helpful instructions.*

*My Profound gratitude to Dr. **Salim Maamoun El Shiekh**, Lecturer of Radiodiagnosis, Medical Military Academy for his immense help, most valuable advice & guidance.*

My heartfelt thanks to all the staff members of the Radiology Departments of Alexandria Armed Forces Hospital & Tanta University Hospital for their kind support & cooperation.

CONTENTS

Page

***Introduction & Aim Of The Work.....1**

***Review Of Literature**

-Basic principles of magnetic resonance imaging.....2

-Supratentorial Anatomy.....25

-Supratentorial Neoplasms.....73

***Patients & Methods.....112**

***Results116**

***Disussion.....193**

***Summary & Conclusion220**

***Refrences224**

***Arabic Summary**

INTRODUCTION
&
AIM OF THE WORK

**REVIEW
OF
LITERATURE**

BASIC PRINCIPLES OF MAGNETIC RESONANCE IMAGING

The basic principles of MRI form the foundation for further understanding of this complex subject (*Westbrook & Kaut, 1998*)⁽⁷⁾.

Atomic structure

All matter, of course consist of molecules and atoms. The atom consists of a central nucleus and orbiting electrons. The nucleus contains protons which are positively charged and the neutrons have no charge. The electrons are negatively charged. The atomic number is the sum of protons in the nucleus and the mass number is the sum of protons and neutrons in the nucleus (*Villafana, 1999*)⁽⁸⁾.

The atom is electrically stable if the number of negatively charged electrons equals the number of positively charged protons. Atoms that are electrically unstable due to deficit, or an excess number of electrons, are called ions (*Villafana, 1999*)⁽⁸⁾.

Motion within the atom

Three types of motion are present within the atom. These are:

1. electrons spinning on their own axis,
2. electrons orbiting the nucleus,
3. the nucleus itself spinning about its own axis.

MRI is based on the spinning motion of a specific kind of nuclei present in biological tissues. These are called MR active nuclei (*Wehrli, 1992*)⁽⁹⁾.

MR active nuclei

MR active nuclei are characterised by their tendency to align their axis of rotation to an applied magnetic field.

The physical property responsible for this alignment is called the total magnetic moment of the nucleus. It is the vector sum of the individual magnetic moments of all the protons in the nucleus.

Due to the laws of quantum mechanics only nuclei with an odd number of protons have a total magnetic moment and can interact with

an external applied magnetic field (*English and Moore, 1995*)⁽⁴⁾.

The strength of the total magnetic moment is specific to every nucleus and determines its sensitivity to magnetic resonance. Important examples of MR active nuclei, together with their atomic number, are listed below.

Hydroge	1	Carbon	13
Nitrogen	15	Oxygen	17
Fluorine	19	Sodium	23
Phosphorus	31		

The number after each element is its atomic number, which is equal to the number of protons in the nucleus. All these elements have an odd number of protons in their nuclei, they are therefore, MR active (*Westbrook and Kaut, 1998*)⁽⁷⁾.

The hydrogen nucleus

The hydrogen nucleus is the MR active nucleus used in MRI. The hydrogen nucleus contains a single proton (atomic number 1). It is used because it is very abundant in the human body, and because its solitary proton gives it a large magnetic moment (*Villafana, 1999*)⁽⁸⁾.

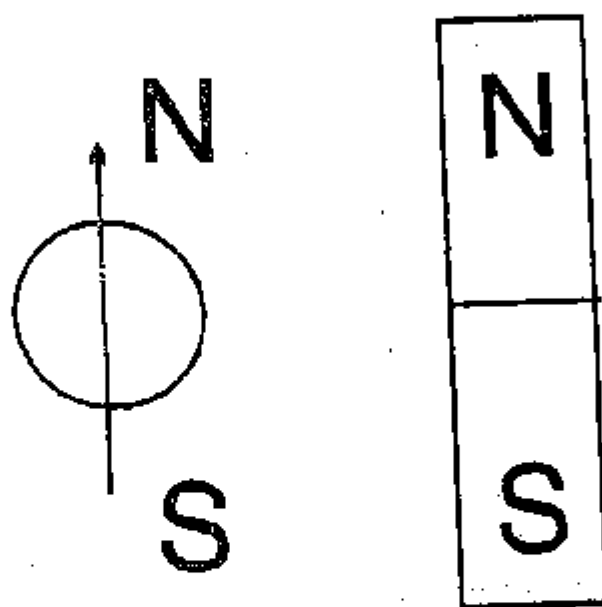
The hydrogen nucleus as a magnet

The laws of electromagnetism state that a magnetic field is created when a charged particle moves.

The hydrogen nucleus contains one positively charged proton that spins, i.e. it moves. Therefore the hydrogen nucleus has a magnetic field induced around it, and acts as a magnet (*Westbrook & Kaut, 1998*)⁽⁷⁾.

The magnet of the hydrogen nucleus has in effect a north and a south pole of equal strength. The north/south axis of each nucleus is represented by a magnetic moment (*fig.1*). The magnetic moment of each nucleus has vector properties, i.e. it has size and direction and is denoted by an arrow. The direction of the arrow designates the direction of the magnetic moment, whereas the length of the arrow designates the size of the magnetic moment (*Wehrli, 1992*)⁽⁹⁾.

In the case of a spinning nucleus, the vector is aligned perpendicular to the plane of spin, as seen in any time one vector in one particular



(fig 1): The magnetic moment of the hydrogen nucleus (Westbrook & Kaut, 1998)⁽⁷⁾

direction cancels with another one oriented in the exact opposite direction. As a result, the overall medium does not have an external magnetic field because all the nuclei cancel each other within that medium (*Villafana, 1999*)⁽⁸⁾.

Alignment

In the absence of applied magnetic field the magnetic moments of the hydrogen nuclei are randomly oriented. When placed in a strong static external magnetic field (usually referred to as the B_0 field) however, the magnetic moments of the hydrogen nuclei align with this magnetic field. Some of the hydrogen nuclei align parallel with the magnetic field (in the same direction), whereas a smaller number of nuclei align anti-parallel to the magnetic field (in the opposite direction) (*fig.2*) (*English & Moore, 1995*)⁽⁴⁾

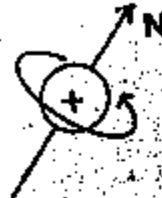
The factors affecting which hydrogen nuclei align parallel and which align anti-parallel are determined by the strength of the external magnetic field and the thermal energy level of the nuclei. Low thermal energy nuclei do not possess enough energy to oppose the magnetic field. High thermal energy nuclei do possess enough energy to oppose this field, and as the strength of the magnetic field increases, fewer nuclei have enough energy to do so. The thermal energy of the nucleus is determined by the temperature of the patient that can not be significantly altered and so the emphasis is towards stronger magnetic fields (*Westbrook and Kaut, 1998*)⁽⁷⁾.

In thermal equilibrium the magnetic moments of the nuclei aligned parallel to the magnetic field cancel out the smaller number of magnetic moments aligned antiparallel producing a net magnetic moment (*fig.3*).

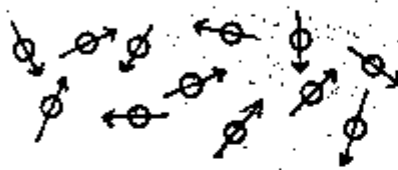
- The magnetic moment of the hydrogen is called the Net Magnetisation Vector (NMV).
- The static external magnetic field is called B_0 .
- The interaction of the NMV with B_0 is the basis of MRI.
- The unit of B_0 is tesla or gauss. 1 tesla (T) is equivalent of 10 000 gauss (G) (*Wehrli, 1992*)⁽⁹⁾.

When a patient is placed in the bore of the magnet, the hydrogen nuclei within the patient align parallel and antiparallel to B_0 . A small excess of hydrogen nuclei (only about 1-3 excess parallel aligned protons

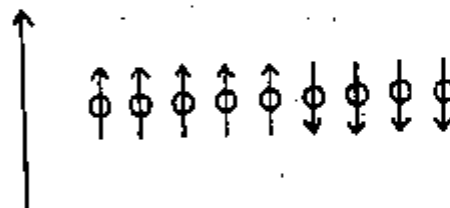
A
MAGNETIC FIELD OF A NUCLEUS



B
RANDOM ORIENTATION OF NUCLEI



C
EXTERNAL MAGNETIC FIELD PRESENT



(fig.2):

(A) Individual nucleus possessing spin manifests a magnetic field directed perpendicular to the plane of spin. This defines a magnetic dipole with north and south poles, and it is said that the nucleus has a magnetic moment or vector.

(B) In a medium, individual nuclei with their individual magnetic vectors align randomly. There is no net external magnetic field since they will all cancel each other.

(C) When an external magnetic field (B_0) is present, the nuclei of the hydrogen line up either in the same direction as B_0 (parallel) or in the opposite direction of B_0 (antiparallel). There is only a slight excess aligned in the parallel direction (Villafana 1999)⁽⁸⁾.

for every million protons) align parallel to B_0 and constitute the NMV of the patient (Villafana, 1999)⁽⁶⁾.

Precession

Each hydrogen nucleus that makes up the NMV is on its axis. The influence of B_0 produces an additional spin around B_0 . This secondary spin is called precession and causes the magnetic moments to follow a circular path around B_0 . This path is called precessional path and the speed at which the NMV wobbles around B_0 is called the precessional frequency. The unit of the precessional frequency is the megahertz (MHz) (fig.4) (Westbrook and Kaut, 1998)⁽⁷⁾.

The Larmor equation

The value of precessional frequency is governed by the Larmor equation. The Larmor equation states that:

$$\text{The precessional frequency} = B_0 \times k$$

Where B_0 = the magnetic field strength of the magnet.

K = the gyromagnetic ratio which is a constant for each different nucleus and is defined as the precessional frequency of a specific nucleus at 1.0 T).

The gyro-magnetic ratio of hydrogen is 42.57 MHz/T. Other MR active nuclei have different gyromagnetic ratios, and therefore have different precessional frequencies at the same field strength. In addition, hydrogen has a different precessional frequencies at different field strength. For example:

At 1.5 T the precessional frequency of hydrogen is 63.86 MHz
(42.57 MHz x 1.5 T)

At 1.0 T the precessional frequency of hydrogen is 42.57 MHz
(42.57 MHz x 1.0 T)

At 0.5 T the precessional frequency of hydrogen is 21.28 MHz
(42.57 MHz x 0.5 T)

The precessional frequency is often called Larmor frequency, because it is determined by the Larmor equation. As the gyro-magnetic ratio is a constant of proportionality, B_0 is proportional to the Larmor frequency.