

Magnetic Resonance Imaging (MRI)

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Abstract—Magnetic Resonance Imaging (MRI) is basically a medical imaging technique most commonly employed in radiology to visualize the structure and function of the body. It is a helpful tool in the field of medicine especially in these days when it becomes necessary to diagnose the most complicated diseases. This paper presents some basic information about what the MRI is? It's brief history. How does it work? Why MRI scan is done? Is an MRI scan dangerous? Finally I'll present my conclusions.

I. INTRODUCTION

I have a sister and eight years ago she suffered from pain in her back and the doctors at that time spent two months doing medical tests trying to find out the cause. They tried all the possible tests and they were not sure whether it was cancer or TB in the spine until they decided to do the MRI scan. With the help of the clear image they got from the MRI they got to know that it was TB in the spine. The MR Image also gave information about where exactly the fluid was. This incident has motivated me to pick this topic.

II. WHAT IS MRI?

Magnetic Resonance Imaging (MRI) is an imaging technique, which produces high quality images of the inside of the human body in any plane. It is most commonly used in radiology. MRI is based on the principles of Nuclear Magnetic Resonance (NMR), which is a spectroscopic technique used by scientists in obtaining microscopic chemical and physical information about molecules. Due to the negative meaning associated with the word nuclear in the late 1970's the technique was named as Magnetic Resonance Imaging (MRI) instead of Nuclear Magnetic Resonance Imaging (NMRI). Initially MRI started out as a tomographic imaging technique, that is it produced an image of the NMR signal in a thin slice through the human body. However in the recent years MRI has advanced from a tomographic imaging technique to a volume imaging technique [1].

III. HISTORY OF MRI

MRI is a relatively new technology and has been in use from over 3 decades when compared to X-ray radiography, which has been in use for over 11 decades. In 1937, Professor Isidor Isaac Rabi of Columbia University recognized that the atomic nuclei show their presence by absorbing radio waves when exposed to a sufficiently strong magnetic field [2]. This was the key to professors and Scientists who came after him. However the first MR Image was published in 1973 [3].

The first study on a human was performed in 1977. Dr. Raymond Damadian, a physician and scientist, along with his colleagues worked for seven long years to produce the first image of a human part. During its early days it used to



Fig. 1. Dr. Raymond Damadian with his original machine

take almost five hours to produce one image. However those images were, by today's standards, contained fewer details. Dr. Raymond named his original machine as "Indomitable" [4].

Dr. Raymond Damadian with his original machine is shown in Fig. 1.

IV. HOW DOES MRI WORK?

As the name itself implies the MRI scan makes use of magnetic and radio waves, meaning there is no exposure to X-rays or any other harmful radiation.

The patient is made to lie inside a large, cylindrically shaped magnet. The passage of radio waves, which are 10,000 to 30,000 times stronger than the magnetic field of the earth through the body affects the body's atoms, forcing the nuclei into a different position. As the body's atoms move back into place they transmit their own radio waves. The scanner picks up these radio wave signals and conveys them to a computer, which converts them into a picture. These pictures are based on the location and strength of the incoming signals [5].

Our body consists mainly of water, which in turn contains hydrogen atoms. For this reason, the nucleus of the hydrogen atom is often used to create an MRI scan in the way described above [5].

Using an MRI scanner, it is possible to make pictures of almost all the tissue in the human body. It can produce precise 2-D or even 3-D images of the tissues. The tissue such as bones that has the least hydrogen atoms looks darker in the scan, while the fatty tissue that has many hydrogen atoms looks much brighter in the scan [5].

An MRI Scanner is shown in Fig. 2.



Fig. 2. An MRI Scanner

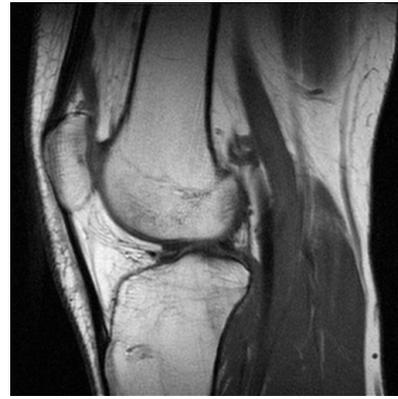


Fig. 3. MR Image of the knee

V. WHY MRI SCAN IS DONE?

MRI scan is done for many reasons. It is used to find problems such as tumors, bleeding, injury, blood vessel diseases, or infection.

Some of the body parts on which an MRI scan can be done include [6]:

Head-MRI can look at the brain for tumors, bleeding in the brain, nerve injury, and other problems, such as damage caused by a stroke. MRI can also find problems of the eyes and optic nerves, and the ears and auditory nerves.

Chest-MRI of the chest can look at the heart, the valves, and coronary blood vessels. It can show if the heart or lungs are damaged. MRI of the chest may also be used to look for breast or lung cancer.

Blood vessels-The process of looking at blood vessels and the flow of blood through them using MRI is called Magnetic Resonance Angiography (MRA). It can find problems of the arteries and veins, such as an aneurysm, a blocked blood vessel, or the torn lining of a blood vessel (dissection). Sometimes contrast material is used to see the blood vessels more clearly.

Abdomen and pelvis-MRI can find problems in the organs and structures in the belly, such as the liver, gallbladder, pancreas, kidneys, and bladder. It is used to find tumors, bleeding, infection, and blockage. In women, it can look at the uterus and ovaries. In men, it looks at the prostate.

Spine-MRI can check the discs and nerves of the spine for conditions such as spinal stenosis, disc bulges, and spinal tumors.

An MR Image of the knee is shown in Fig. 3.

VI. IS AN MRI SCAN DANGEROUS?

MRI scan neither has any known dangers nor any side effects. One cannot feel the test as it is not painful. If needed the procedure can be repeated since radiation is not used. Since there is a small theoretical risk to the fetus in the first 12 weeks of pregnancy therefore MRI scans are not performed on pregnant women during this time [5].

Some people get claustrophobic during the test as they are made to lie inside a large cylinder while the scans are being made. Patients who suffer from claustrophobia should talk to the doctor beforehand so that they are given some medication, which will help them relax [5].

The MRI machine also makes a banging noise while it is working, which might be unpleasant [5].

VII. CONCLUSION

In the early 1970's there were a handful of MRI scanners in the entire United States. Today there are thousands of MRI scanners worldwide. For example, in 2003, there were about 10,000 MRI units worldwide, and about 75 million MRI scans were performed per year. As the field of MRI continues to grow, so do the opportunities in MRI [1].

For example the need for Radiology Practitioner Assistants and Radiology Physician Assistants trained in MRI to read the magnetic resonance images will always be there [1].

There is need for imaging scientists to develop algorithms for post processing of magnetic resonance images, and intelligent code for identifying and diagnosing pathology. There is need for computer scientists to design user friendly efficient Graphical User Interfaces (GUI) for newly developed software [1].

Also there is a need for architects to design safe and efficient MRI centers and clinics [1].

REFERENCES

- [1] Joseph P. Hornak, "The Basics of MRI", <http://www.cis.rit.edu/htbooks/mri/>
- [2] "Isidor Isaac Rabi", <http://www.britannica.com/EBchecked/topic/487952/Isidor-Isaac-Rabi>
- [3] Paul C. Lauterbur, "Image Formation by Induced Local Interactions: Examples of Employing Nuclear Magnetic Resonance".
- [4] Todd A. Gould, "How MRI Works", <http://www.howstuffworks.com/mri.htm>
- [5] Dr Sarah Burnett and Dr John Pillinger, "MRI Scan", http://www.netdoctor.co.uk/health_advice/examinations/mriscan.htm
- [6] "MRI-Information and Resources", <http://www.webmd.com/a-to-z-guides/magnetic-resonance-imaging-mri>