MRI Lab

Introduction

Magnetic Resonance Imaging, or **MRI**, is a method of imaging the interior of structures noninvasively. An MRI device consists of a magnet, magnetic gradient coils, an RF (radio frequency) transmitter and receiver, and a computer that controls the acquisition of signals and computes the MR images.

Lab Procedure:

Overview:

Magnetic resonance angiography is used to generate pictures of arteries to evaluate them for potential ruptures or for abnormal narrowing. Many different specific methods are now used. The strength of the magnetic field can be changed electronically from top to bottom using a series of gradient electric coils, and, by changing the local magnetic field by these small increments, various parts of the body will resonate as different frequencies are applied on them. When we switch off the radiofrequency source the magnetic vector returns to its resting state, and which causes a signal to be emitted. It is this signal which is used to create the MR images. Receiver coils are used around the body part which improves the detection if the emitted signals. Then the received signal is plotted on a grey scale and cross-sectional images are built up.

Setup:

- First the patient must be relaxed and should not have any kind of metal ornaments wear on.
- They will have instructed to be calm and not move while doing test.
- The MRI coils that will used are based on which part of the body that will goanna be scanned.
- The MRI room should be totally isolated and shut down properly that the radiation does not affect by the outside sources.

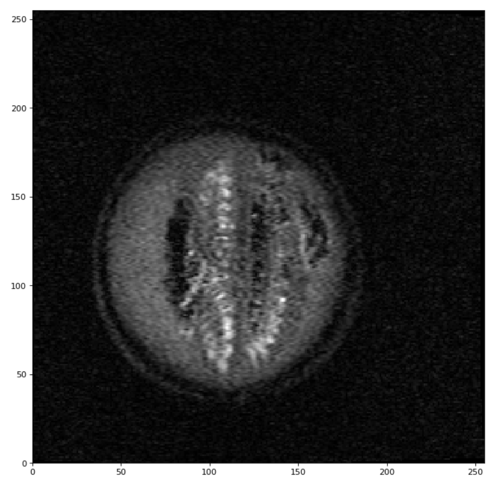
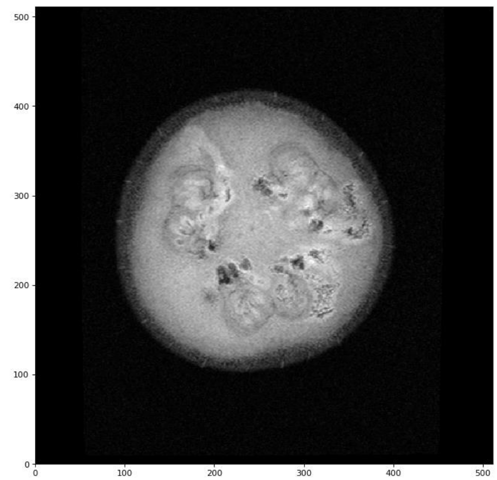
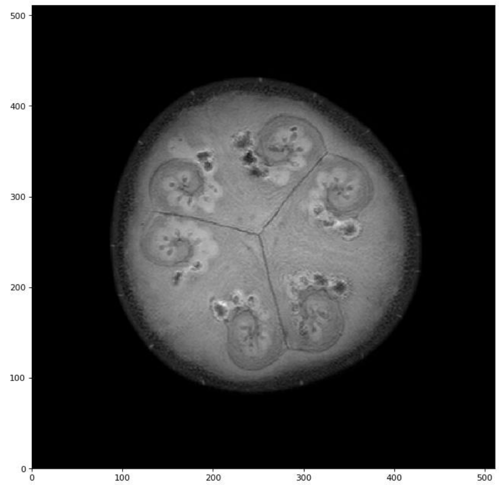
Imaging:

When the radiofrequency pulse is switched off the different emphasis occurs because different tissues relax at different rates. The time taken for the protons to relax is measured in two ways. The first is the time taken for the magnetic vector to return to its resting state and the second is the time needed for the axial spin to return to its resting state. The first is called T1 relaxation, the second is called T2 relaxation. An MRI examination is thus created by the series of pulse sequences. Different tissues have different relaxation times and can be identified separately.

Results:

The MRI lab where we did the MRI experiment on the Egg, Watermelon and chicken. This experiment takes around one our where we changes the MRI frequency and voxels .

Ans 1:

Ans 2: The metadata from the notebook :

Some parameters that observed from the MRI test:

- The image is 256x256 pixels: Which explain the resolution of the signal
- The image was encoded with 12 bits : Which means the MRI data is recorded by 12 Bits/samples binary file.
- The manufacturer is Philips Medical Systems and the model is Achieva
- The image was made on 2017-11-15
- The patient imaged is Male
- The patient's name is res_watermelon

- **Spin echo pulse sequence**

  The MR sequence is "Spinning Echo". The two main parameters for these are:

  1.TE or Echo time - When the intensity of the pulse reaches from minimum to maximum the time take for that is know as Echo time.

  2.TR or Relaxation time - The time between the two successive excitation pulses.

The spin echo pulse sequence is the most commonly used pulse sequence. The pulse sequence timing can be adjusted to give T1-weighted, Proton or spin density, and T2-weighted images. Dual echo and multi echo sequences can be used to obtain both proton density and T2-weighted images simultaneously.

The two variables of interest in spin echo sequences are the repetition time (TR) and the echo time (TE).A spin echo sequence has two essential parameters: TR and TE.
TR is the time interval between two successive 90° RF waves.

- **Inversion recovery pulse sequences**

Inversion recovery pulse sequences are used to give heavy T1-weighting. The basic part of an inversion recovery sequence is a 180 degree RF pulse that inverts the magnetization followed by a 90 degree RF pulse that brings the residual longitudinal magnetization into the x-y or transverse plane where it can be detected by an RF coil.

- **Saturation recovery**

This pulse sequence is the simplest sequence in magnetic resonance. It is also called 'saturation recovery' pulse sequence. If at time zero, the equilibrium magnetization M_0 is exposed to a 90° pulse, it will be tipped down into the x'-y' plane. After a delay time, called *repetition time* (TR), the spin system is exposed to a second 90° pulse which brings the magnetization down in the x'-y' plane where the FID can be monitored.

- **Echo planer imaging**

Single shot EPI requires high performance gradients to allow rapid on and off switching of the gradients. The basic idea is to fill k-space in one shot with readout gradient during one T2* decay or in multiple shots (multishift EPI) by using multiple excitations. Single shot EPI allows oscillating frequency-encoding gradient pulses and complete k-space filling after a single RF pulse. Increased data processing speeds have allowed EPI to become clinically widespread, and it is used in fMRI.

- **FAST SPIN ECHO (FSE)**

A fast spin echo pulse sequence characterized by a series of rapidly applied 180° re-phasing pulses and multiple echoes, changing the phase encoding gradient for each echo.

Ans 3:

Acquisition Matrix: US: [0, 256, 128, 0] : Acquisition matrix-the total number of data samples in the frequency and phase direction. 256 X 128 data image.

The pixel information is 512 x 512 in row Which is not matching to our metadata. we can conclude that as per the definition of acquisition matrix it states that the number of non-dependent bit values in every direction can gives garbage values in any direction. Pixel information does not change while reconstructing the image while the acquisition image may change.

Ans 4:

Imaging Frequency: DS: '127.753969' : 127 Hz For different scanners the value of frequency in the metadata will vary. The value of the frequency varies with the magnetic field of the scanner.

Discussion:

Ans 5:

In conclusion, The MRI imaging needs hardware and software setup as per what kind of information one needs from the testing. That varies by the patient to patient. In the laboratory, we saw different coils for the MRI of different objects with varied sizes, there were serval coils and with sizes according to the shape of the body or patient. The observations which we observed are:

- The size of the coil matters as per the shape of the object of study, if the coil doesn't fit the shape of the object the observation may differ.
- The diameter of the coil is a important factor for the measurement as the object should not be greater then the size of the coil's diameter or else it will show the result of the area which is only covered under the coil.
- Even in software part, we should decide the voxel size and dimension as per the scanning layer and the grayscale is depends on how you decide the scanning frequency and penetration depth.

Reference:

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