Basic principles of mr imaging

Health & Medicine

Basic Principles Of MR Imaging

Question 1

Magnetic resonance is the technology that allows an individual to study an image of the anatomic section and the disease procedure under observation. Magnetic resonance depends on different variables like proton density. The technology also depends on longitudinal relaxation time and transverse relaxation time (T1 and T2). According to Hesselink (2010), varied image contrast is achieved using different pulse sequences and variation of the image parameters previously mentioned.

The first image contrast technology that should be mentioned is proton density, which refers to the number of protons per unit contained in the image being studied. This contrast is achieved through the transverse component of magnetization that will reflect the difference in contrast in the image. In this case, tissues with high proton density levels emit low signals, as opposed to those tissues with low proton density levels that emit low signals. T1-weighted image contrast is premised on the difference in the T1 times of the tissues in the particular region. Tissues containing fat have a short T1 time, tissues with fluid have a long T1 time and water based tissues intermediate T1 times. These differences are explored through RF pulses, where the T1 times of tissues containing fat are short, so they relax quickly into the longitudinal plane. Conversely, fluid and water-based tissues take a long time to regain their longitudinal magnetization (Hesselink, 2010).

Transverse relaxation time focuses on the T2 times of the tissues, where fat-based tissues have short T2 times, fluid-based tissues have long T2 times and water based tissues have intermediate T2 times. These results are achieved by manipulating the receiver coils to read the signals from the

muscles. In this case, fluids-based tissues always maintain transverse magnetization for a long time after an RF pulse because they have a long T2 time. Conversely, fat-based tissues decay faster after RF pulses. Because of the two factors mentioned, T2 images from fluid-based tissues look bright after high signals because of favorable transverse magnetizations, while the images from fat-based tissues look darker since the tissues lack signals and match poor transverse magnetization. However, water-based tissues emit intermediate signals when contrasted to the other two mentioned.

a) Spin echo pulse sequences and gradient amplifiers are used to achieve images with the different types of contrasts mentioned previously. Whenever an image is aligned, the pulse sequence is continuously applied to achieve a spin or Hahn echo. In this case, radio frequency pulses are used to stimulate magnetization, after which spin echoes are achieved by focusing 180° pulses on the spins and generate spin echoes. According to the Magnetic Resonance Technology Information Portal (2012), the movement in the transverse magnetization is achieved when the 90° stimulation pulse passes the magnetization of the longitude (MZ) into the x-y plane.

b) Gradient echo sequences (GRE) imaging lacks 180 degree refocusing pulses, so the T2 contrasts are referred to as T2* or de-phasing. This is because of the inhomogeneity that affects the image contrast. The TR and TE flip angles are repeatedly flipped to achieve the GRE imaging contrast.

c) Gradient echo sequences allow very fast acquisition of images since it uses a series of pulses with very short TR times. In this case, T2 weighted images are achieved by allowing the TE to continue for a long time, which allows the tissues to decay and exploit the differences in the T2 times. However, since the times are short, there is usually not enough signal

differences between the tissues, which results in white or poor contrast images. The outer region in the phantom is usually black in the spin echo because the proton density results in poor contrast. This is because the T1 and T2 weighting needs to be minimized by using short TE sequences that minimize contrast after the T2 decay effects. The imaging also uses a long TR to minimize the contrast, and as a result, there is enough T1 recovery and longer TR sequences (Hancock, 2010).

Question 2

a) Chemical shift artifact happens in the frequency-encoding direction due to the variations between the chemical environments surrounding the 1H atoms in fat and water. Fat and water are processed at different frequencies, which results in bad registration following a chemical shift, which affects the encoding of the signal from the protons in fat and water and hence, the observation of a dark rim at one edge of an object. The cellular bone marrow and interfaces between tissue and adipose are common sites for chemical cancellation. The water-fat shift is usually important in the presentation of spectral widths because it reduces or adds some of pixels in mm. spectral width is defined as when the overall width is determined in hertz to observe NMR spectrum. This width is set using a limit, which is the temporal sampling rate that must be equal to twice the maximum measurement. The duration of the sampling process can lead to the inference of how small differences in the frequencies can be separated.

b) In a case where the water fat shift is set to a unit of three, the spectral width represented when a difference is assumed is equivalent to 3. 5 ppm. This is the achieved result:-

Pixel shift =

Pixel shift = 3

= 2. 678 × 108 rad/s/T

B0 = 1. 5

NN = 256

Pixel shift/1= /

Pixel shift X =

3 = 2. 678 × 108 rad/s/T

18. 84955 = 3599. 232× 108

BW= 3599. 232× 108 / 18. 84955

BW= 19094. 524 HZ

= 19. 094 KHz

Question 3

Bo inhomogeneity is the when a disturbance occurs in the field of homogeneity as a result of magnetic material either inside or outside the patient’s body, there occurs technical problems at the edge of the field. Images acquired because of increasing from the center to the end of the coil, the homogeneity of the field seen in comparison to the imaged volume changes when the distance of the volume is increased from the center. Conversely, partial volume effect occurs when image losses contrast caused by insufficient resolution, hence one tissue type occupies the same pixel. These processes add up to chemical misregistration.

In a case, where the gradient echo images are greater than the spin echo images, the effects mentioned above are more pronounced. This is because it uses low flip angles meaning that T1 recovery will take less time and shorter TR intervals are possible, and lacks the T2 refocusing pulse.

References

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Hesselink, J. 2010. Basic Principles of MR Imaging. [Online]. Available: