بسم الله الرحمن الرحيم

Sudan University for Science & Technology

Collage of Graduate Studies

Study of MRI Image Artifacts

دراسة تشوهات صور الرنين المغنطيسي

Thesis Submitted for Partial Fulfillment of the Awards of Master Degree (MSC)

In Medical physics

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الآية

قَالَ تَعَالَىٰ:

﴿ لَقَدْ أَرْسَلْنَا رُسُلَنَا بِالْبَيِّنَاتِ وَأَنزَلْنَا مَعَهُمُ الْكِتَابَ وَالْمِيزَانَ لِيَقُومَ النَّاسُ بِالْقِسْطِ ۖ وَأَنزَلْنَا الْحَدِيدَ فِيهِ بَأْسٌ شَدِيدٌ وَمَنَافِعُ لِلنَّاسِ وَلِيَعْلَمَ اللَّهُ مَن يَنصُرُهُ وَرُسُلَهُ بِالْغَيْبِ ۚ إِنَّ اللَّهَ قَوِيٌّ عَزِيزٌ ﴿٢٥﴾ ﴾

صدق الله العظيم

سورة الحديد: الآية ٢٥

Dedication

To those who gave much of her life to me and made me now

My beloved mother

To the most precious thing I have in the world

My dear father

To My brothers, sister's

To My best friend's

To all who pray for me well in all my life

Acknowledgment

Firstly, I thank Allah for helping me complete my research.

Secondly, I sincerely thank my supervisor, Dr. Hussein Ahmed, for what he has done for me and for helping me in my research.

Finally, I thank everyone who provided me with support and assistance, and I thank both the modern medical center and the police hospital.

Abstract

Artifacts in Magnetic Resonance Imaging (MRI) may be confused with abnormalities or may reduce image quality, the main objective of this research is study different types of artifacts, their origin and how to eliminate them or reduce their influence in MR images.

The study was conducted in Modern Medical Center (MMC) and Rabat hospital, during the period from (2019-2020) included patients referred to MR scanning.

The machine used, GE (general electrical) (MMC). 1.5T and 0.2 in Rabat hospital, the method used is the inspection all MR study showed any artifacts and discussed the resultant images with the technologist to identify the cause of the artifacts and taking all the information about patient's data and how to reduce these artifacts.

The data were collected from all cases having artifacts in their images, the artifacts were classified average percentage of cases was calculated and their relationship to age and gender and presented in graphs and tables.

In summary, it was found that the most frequent artifacts are associated with the patients and resulting from the movement. It was also found that it is possible to reduce their occurrence by following certain steps, and there are other types that occur in small proportions like susceptibility, zipper, and magic angel artifact , which due to technical faults in the MR unit and the study showed how to reduce them.

الملخص

التشوهات في التصوير بالرنين المغنطيسي قد تتشابه مع التغيرات المرضية او قد تقلل من جودة الصور

تمت هذه الدراسة لمعرفة التشوهات الشائعة التي تحدث في صور الرنين المغنطيسي واسبابها وكيف يتم تقليلها او تقليل تأثيرها في صور الرنين المغنطيسي.

هذه الدراسة تمت في المركز الطبي الحديث ومستشفى الشرطة في الفترة بين (2019–2020) تتضمن عدد من المرضى تم تحولهم لعمل فحص رنين مغنطيسي وكانت صور فحوصاتهم تحتوي على تشوهات.

الأجهزة التي تم استخدامها في عمل تلك الفحوصات هي General Electrical قوة 1.5 تسلا قوة 0.2.

الطريقة التي استخدمت في جمع المعلومات اولا تم احصاء الصور ذات التشوهات ومناقشتها مع التقني لمعرفة الاسباب وكيفية معالجتها ومن ثم تصنفها وتم تحديد متوسط عدد الحالات وعلاقتها بالعمر والنوع وعرضها في رسوم بيانية وجداول بالنسبة المئوية

اهم نتائج الدراسة أكثر التشوهات حدوثا هي المرتبطة بالمريض والناتجة من الحركة، كما بينت امكانية تقليل حدوثها باتباع خطوات معينة منها تنبيه المريض، وهنالك أنواع أخرى تحدث بنسب اقل من الناتجة عن الحركة منها تشوهات المواد المعدنية المصطحبة مع المريض وأخرى تسببها اخطاء تقنية بالجهاز. وكما بين البحث كيفية تقليلها ومعالجتها.

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Abbreviation

CPU	Central processing unit
GEC	Echocardiogram
FID	Free induction decay
FOV	Field of view
FSE	Fast spin echo
G_F	Frequency-encoding gradient
G_P	Phase-encoding gradient
GMN	moment nulling Gradient
GER	Gradient echo
M	Magnetization
NMV	Net Magnetization vector
P_e	Peripheral
RC	Respiratory compensation
RF	Radiofrequency
SE	Spin echo
STIR	Short tall inversion recovery
T	Tasla
T_1	Recovery or relaxation time
T_2	Decay or relaxation time
TE	Echo time

Chapter One

Introduction

Chapter One

Introduction

1.1 Introduction:

Magnetic Resonance Imaging (MRI) is a medical imaging technique that does not use x-ray or any other type of harmful rays. This is done by exploiting the magnetic properties that are naturally present in the human body. In the past two or three decades the number of magnetic resonance imaging machines has increased dramatically. This device is the best and safest way to see inside the human body without cutting it.

The word artifact appeared in the 1821 edition of the Merriam Webster dictionary. The most often used definition refers to something created by humans usually for use or an activity. The second less common meaning is a product of an artifact activity. Image artifacts are associated with every radiol0ic imaging modality. Motion blurring on plain film, metallic star artifacts or detector imbalance ring artifacts on CT scan, and refraction image distortion on Ultrasound studies are but a few well. Documented examples in radiology.

In terms of the magnetic resonance MR image, an artifact is an abnormal area of signal with in the image that does not normally arise from patient anatomy or pathology. It is important to recognize artifacts for two important reasons: to eliminate diagnostic error, so that the artifact does not hide a pathologic condition, or is not mistaken for one; and because recognition of certain artifacts can indicate particular problems within the system itself so that proper service or repair can be started before major problems occur. (John A, et al ,1998)

In general, all artifacts fall into four categories:

1-those associated with patient.

2- Those associated with physiology.

3- Those associate with the hard ware and soft of the imaging system.

4- Those inherent in the principles of magnetic resonance imaging MRI.

As newer pulse sequences continue to be developed, new artifacts can be produced and known artifacts can result from multiple cause making the precise classification of these eccentricities more difficult.

Artifacts associated with the patient are normally due to random movement or metallic objects (either external or internal) that distort the image and physiological artifacts are produced by breathing, cardiac or peristaltic motion, and blood flow. The imaging system produces artifacts that result either from the basic physical principles of MRI (chemical shift and flow) or from instrumental factors (radiofrequency (RF) gradients, shims, or computer hardware). (John A, et al 1998)

1-2 Problem of the study:

there are many MRI artifacts their causes are unknown in the study there is a trial to know some of them.

1- 3 Objectives of the study:

1-3-1: General to objectives:

To study the artifacts in the MRI.

1-3-2: Specific objectives:

To determine the MRI artifacts

Important of considerate image quality.

Chapter Tow

Literature Review and Theoretical

Chapter Tow

Literature Review and Theoretical

2-1 The MR component

2-1-1 the magnet:

MRI systems use three basic types of magnets are permanent and Resistive magnets and superconducting magnet. (Moriel Ness, 1996)

2-1-1-1 Permanent Magnets

Are used for field strengths up to 3T they can have several designs.

A permanent magnets is just that permanent .The magnetic field is always

There thread always at full strength. Therefore .Its costs nothing to maintain the filed .A major drawback is that these magnets are extremely heavy sometime many tons .some strong fields would need magnets so heavy they would be difficult to construct. (Moriel Ness, 1996)

2-1-1-2 Resistive Magnets

Resistive magnets are made from many coils of wire wrapped around a cylinder through which an electric current is passed .This generates a magnetic field .When the electricity is shut off ,The magnetic field dies. These magnetic are lower in cost to make than a superconducting magnet, but need huge amounts of electricity to operate because of the natural resistance of wire .The electricity can get expensive when higher power magnets are needed. (Moriel Ness, 1996)

2-1-1-3 Superconducting Magnet

Superconducting magnets are by far the most commonly used in MRIs. Superconducting magnets are somewhat similar to resistive magnets – coils of wire with a passing electrical current create the magnetic field.

The important difference is that in a superconducting magnet the wire is continually bathed in liquid helium (at a cold 452.4 degrees below zero).This almost unimaginable cold drops the wires resistance to zero , dramatically reducing the electricity requirement for the system and making it much more economical to operate . (Catherine West book et al 1998)

2-1-2The Coils:

2-1-2-1 Shim Coils

Shim coils provide auxiliary magnetic field in order to adjust the homogeneity of a magnetic field. Its use prior to the operation of the magnet.

Localization of the MRI signal requires good homogeneity within the local magnetic field. In other words, the more uniform the magnetic field the better. However, placement of an object (including a patient) within the main B0 field creates local susceptibility effects and reduce homogeneity. Shimming refers to adjustments made to the magnet to improve its homogeneity. Shimming can be passive or active. Passive shimming is achieved during magnet installation by placing sheets or little coins of metal at certain locations at the edge of the magnet bore (close to where the RF and gradient coil lie). Active shimming provides additional field correction around an object of interest through the use of shim coils, which are activated by electric currents controlled by the host computer, under the guidance of the scanner application software and the operator. Homogeneity of and hence variation in B0 is quoted in parts per million (ppm), that is a fraction, of the static magnetic field over a specified spherical volume. For a 1 T system with a homogeneity of 1 ppm over 40 cm, no two points within 20 cm of is center differ by more than 0.000001 T.

2-1-2-2 Gradient coils

The gradient coils are the three sets coils within magnet housing.

Gradient coils create a secondary magnetic field, which slightly distorts the main magnetic field in a predictable manner .This allow spatial encoding of the MR signal.

An MRI system uses three gradient coils, each affects a different plane,

The XY, YZ, XZ plane, as it is turned on and off at different points in a pulse sequence. How all three are used depends on the scan plane and the pulse sequence being used, the system calculated this automatically. (Catherine West book et al 1998)

2-1-2-3 RF coils

MRI machines come with many different coils designed for different part of the body: wrists, shoulders, knees, head necks and so on.

RF coils, so named because the frequency of electromagnetic energy generated by them lies within the megahertz range, are mounted inside the gradient coils and lie concentric to them and to each other. They may be thought of as the (antenna) of the MRI system and according they have two main purposes: to transmit RF energy to the tissue of interest and to receive the induced RF signal back from the tissue of interest.

Some RF coils perform the dual role of transmission and reception of RF energy whereas others transmit or receive only. For neuroimaging, a separate RF receiver coil that is tailored to maximize the signal from the brain is usually applied around the patients head to detect the emitted MR signals.

The RF field is also referred to as the B1 field. When switched on, the B1 field combines with B0 to generate MR signals that are spatially localized and encoded by the gradient magnetic fields to create an MRI .The output signal picked up by the receive coil is digitized and then sent to reconstruction computer processor to yield the image after complex mathematical manipulation. (Catherine West book et al 1998)

2-1-3 the computer systems

Computer can be divided into central processing unit (CPU), consisting of instruction , interpretation and arithmetic unit pulse fast access memory, and peripheral devices such as bulk date storage and input and output devices(including, via the interface, the spectrometer). The computer controls the RF pulse and gradient necessary to acquire date, and process the date to produce spectra or images. (Device such as the spectrometer may themselves incorporate small computers).

2-2 Physics of MRI

It is the function of protons spin density and relaxation time.

The MRI consists generally of three parts input devices and output devices and central processing unit (Catherine west book et al, 1998)

2-2-1 the input devices:

Primary magnet

RF Tran-receiver coil

Gradient coil

In addition to the ordinary computer unit that use to reconstruct the MRI image and display it on the screen or store it in a disk (Catherin west book et al 1998).

2-2-2 Physical principal

Magnetic resonance technology takes advantage of magnetic properties that are already present in the human body. But what and where are the magnetic properties inside the human body the answer is positively charged protons. These properties can be further enhanced and strengthened within the MRI machine. Protons are found in the atoms of elements in the human body, such as hydrogen, carbon and oxygen atoms …etc. Since the human body is 70 percent water, we choose the protons of the hydrogen atom in an MRI. The magnetic resonance signal used in the medical field depends on the amount of hydrogen. It is found in abundance in most tissues and components of the body.

These are two properties that a proton has that make it behave like a magnet: a proton has a positive charge. The proton moves in a spin motion called spin.

Although there is a magnetic field for protons inside the human body, their magnetic sum is equal to zero. This is because the direction of their magnetic fields are scattered and cancel the effect of each other. (Catherine West book et al 1998)

When placing protons in an external magnetic field, we have a vector that represents the magnetic outcome of all protons that are in the direction of the external magnetic field. This vector is called longitudinal magnetization

*LARMOR Frequency

The LARMOR frequency can be calculated with this formula

$$\omega_{\circ}=\Upsilon B_{\circ}$$

Where:

$\omega_{\circ}$ =Processional or Lamar frequency. (MH_Z)

Υ =Gyro magnetic Radio. (MH_Z/T)

$B_{\circ}$ =Magnetic field strength. (T). (Catherine West book et al 2005)

LARMOR frequency is important to calculate because it defines the operating frequency of the MRI. MRI system with 1.5 T has LARMOR frequency 42.57×1.5 = 63.85 MHz The resonant frequency is also known as LARMOR frequency. The sum of all the tiny hydrogen magnet gives a net magnetization in the direction of applied magnetic field (Bo). Net magnetization is denoted by a vector M_Z which is directed along the Z-axis. Z-axis always points in the direction of main magnetic field (Bo) and X and Y axis are at right angled to Z-axis. Net magnetization is also known as longitudinal magnetization.

2-2-3 Excitation:

The excitation of protons can be excited by RF radio waves. Radio waves are energy that is given to these protons so that they are able to change the direction of their magnetic conductors from longitudinal magnetization to transverse magnetization. Radio waves are sent at a specific frequency so that only protons with the same frequency excite a phenomenon called resonance. Protons that do not have the same radio wave frequency are not excited. Thus, we can excite the desired protons by knowing their frequency.

2-2-4 Relaxation

During relaxation hydrogen nuclei give up absorbed RF energy and the NMV returns to $B_{0.}$ At the same time but independently the magnetic moments of hydrogen lose coherency due to de-phasing. Relaxation results in recovery of magnetization in longitudinal plane and decay of magnetization in the transverse plane.

The recovery of longitudinal magnetization is caused by a process termed T1 recovery.

The decay of transverse magnetization is caused by process termed T2 decay.

2-2-4- T1Relaxation:

The protons want to go back to their original situation. They do by releasing the absorbed energy in the shape of (very little) warmth and RF waves.

The net magnetization rotates black to align itself with the Z-axis.

T1 relaxation is also known as spin- Lattice relaxation, because the energy is released to the surrounding tissue.T1 happens to the protons in the volume that experienced the 90 – excitation pulse.

T1 is defined as the time it takes for the longitudinal magnetization.

2-2-4-2 T2 and T2* Relaxation:

T1 and T2 are two independent processes. T2 relaxation describes what happens in X-Y plane phase and phase coherence.

Transverse relaxation describes the process whereby protons fall out of phase in X-Y plane and transverse magnetization decreases and disappears. There are two cause for this loss of phase coherence. The first, T2 relaxation results from slowly fluctuating magnetic field variations (inhomogeneity) within the local tissue. That is, the magnetic spin of protons is influenced by small magnetic field from neighboring nuclei. This results in the random fluctuation of the LARMOR frequency of individual protons causing an exchange of energy between proton spins, which leads to loss phase coherence across a population of protons. The internal inhomogeneity of spins (protons) influencing other neighboring spins have led to the term spin-spin relaxation also being used for T2 relaxation.

The second cause of loss of phase coherence is due to inhomogeneity within B0.Magnetic field variations result in slightly different LARMOR frequencies for protons at different locations within the field. Unlike the random process of T2 relaxation, this de-phasing is caused by a constant and is potentially reversible. T2*(T2 star) relaxation is the name given to describe the effects that result from the combination of T2 relaxation and de-phasing that from inhomogeneity in B0. T2* relaxation determines the actual rate of decay observed when measuring a free induction decay (FID) signal.

T2 is a constant describing the time taken for transverse magnetization to decay to e^{-1}, or about 37% of its initial value. Spin-spin interaction governs the speed of T2 relaxation and hence influences the T2 values for different tissues. Free water, comprising rapidly moving small molecules that are relatively far apart, will have less spin-spin interaction and therefore longer T2 values compared with water- based tissues that have a large macromolecular content(grey matter), giving them more time to interact or, chat with each other.

In contrast to T1 relaxation, where energy transfer from the spin system must occur, T2 relaxation may process with or without overall energy loss. For human tissue transvers relaxation is typically a much faster process than longitudinal relaxation, hence, T2 values are always less than or equal to T1. For biological tissues, T1 is approximately 5-10 times longer than T2 (300-2000 m sec, 30 -150 m sec, respectively). (Catherine West book et al 1998)

2-2-5 Acquisition

During the relaxation processes the spins shed their excess energy, which they acquired form the 90^0 RF pulse, in the shape of radio frequency waves. In order to produce an image we need pick up these waves before they disappear into the space. This can be done with a receive coil. If we assume we have a 100% homogeneous magnetic field then all the protons in the body would spin at the LARMOR frequency. (Catherine West book et al 1998)

2-2-6 Signal coding:

The MR signal is localized in three dimensions using three separate magnetic field gradients termed ; Slice-selection gradient, phase-encoding gradient (G_P), and frequency- encoding gradient (G_F). (Catherine West book et al 1998)

2-2-6-1: Slice-selection gradient:

Slice localization is achieved by using gradient coils to generate a gradient field orientated a long a chosen axis. This gradient field alters the strength of B_0 in the chosen direction, so that protons within the gradient field have different LARMOR frequencies.

Typically, the RF pulse is applied as a small range of frequencies (bandwidth) rather than as a single frequency. This excites a slice of a certain thickness. Slice thickness can be altered in two ways: (1) by changing the bandwidth of the RF pulse or (2) by changing the steepness of the gradient field.

With a given slice electively excited, the signals arising from each slice element (pixel) within that section need to be spatially encoded. This is achieved using phase and frequency-encoding gradients.

2-2-6-2 Phase Encoding Gradient

Following an excitatory RF pulse, the protons in phase. Appling a new gradient magnetic field will make some of the protons process faster than others depending on their position within the gradient. When the gradient is switched off, all protons will emit the same signal but they will no longer be in phase and this allows the protons to be differentiated. The gradient applied is called the G_P and the direction of application is termed the phase-encoding direction. Thus, spin phase will vary linearly over the phase-encode direction. (Catherine West book et al 1998)

2-2-6-3 Frequency-encoding gradient:

The G_F is applied following and perpendicular to the phase-encoding gradient. It causes the protons to rotate at different frequencies according to their relative position along the gradient, permitting differentiation of the signal in a third plane.

Two additional gradient pulses are typically used in this three-step process, one immediately after the slice-selection gradient and the other immediately before the G_F. These pulses are used to counteract any de-phasing of the transverse magnetization that may be caused by the imaging gradients and ensures that maximum echo (sampling signal) is achieved.

It should be emphasized that RF pulses excite all protons in a slice simultaneously that a signal echo signal is recorded from the entire slice for one phase-encoding step. Thus, to acquire sufficient phase-encoding information for a signal to be assigned to each location within the slice, the pulse sequence (comprising slice selection, frequency encoding and phase encoding) is repeated many times. During each repetition, the same slice selecting and frequency encoding are performed but the strength of the phase-encoding gradient is increased by equal increments. Each repetition of the phase-encoding step generates a signal echo that is digitized and stored in a raw matrix called ‘k - space‘. Data points in K-space represent the spatial frequencies content of an MRI. Data in K- space are converted into an image using a mathematical tool called Fourier transform.

2-3: MRI artifacts

An MRI artifacts is a visual artifact (an anomaly seen during visual representation) in magnetic resonance imaging (MRI). It is a feature appearing in an image that is not present in the original object. Many different artifacts can occur during MRI, some affecting the diagnostic quality, while others may be confused with pathology. . (Catherine West book et al 1999)

Artifacts can be classified as patient -related, signal processing - dependent and hardware (machine) - related. (Erasmus L J,2004)

The most common types of artifact seen in MR images are:

2-3-1: Phase misshaping (Motion):

Phase misshaping or ghosting caused by anatomy moving between each application of the phase encoding gradient, and by motion along the phase encoding gradient during the acquisition of data .The reason for mainly affecting data sampling in the phase-encoding direction is the signification difference in the time of acquisition in the frequency and phase- encoding directions. Frequency- encoding sampling in all the rows of the matrix (128,256, or 512) takes place during a single echo (milliseconds) phase-encoded sampling takes several seconds or even minutes, owing to the collection of all the K-space lines to enable Fourier analysis.

Pulsatile motion of vessels, movement of the chest wall during respiration and cardiac motion are the most common sources of this artefact. Involuntary movement such as cardiac motion are discussed under Patient care and safety.

Phase miss mapping is reduced by one or more of the following:

* swapping the phase axis so that the artefact dose not interfere with the area under examination (only moves the artefact);

* Placement of spatial prostration pulses between the origin of the artefact and the FOV.

* using respiratory compensation (RC) (see Gating and respiratory compensation techniques).

* using echocardiogram (ECG) gating or peripheral (Pe) gating (see gating respiratory compensation techniques).

* selecting GMN. (Catherine West brook, 2008)

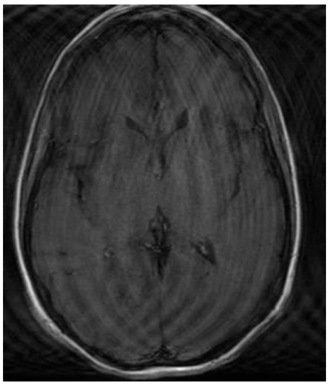

Figure (2-1) axial T_1 weight image of brain showed (motion artifact) (WWW.radio paedia.org)

2-3-2: Aliasing:

Aliasing artifact also known as a wrap-around artifact, is occur when anatomy that lies within the boundaries of the receiver coil (and therefore produces signal) exists outside the FOV. If the data from the signal received are under-sampled by the system, there is a duplication of frequency and phase values so that anatomy that exists outside the FOV is allocated a pixel position within the FOV. This anatomy is therefore 'wrapped' into the image.

Aliasing can occur along both the frequency encoding axis (frequency wrap) and the phase encoding axis (phase wrap). Filter out signal originating outside the FOV. Phase wrap is reduced by:

* increasing the FOV to the boundaries of the coil

* Over-sampling in the phase direction

* placing spatial prostration pulses over signal-producing anatomy. (Catherine West brook, 2008)

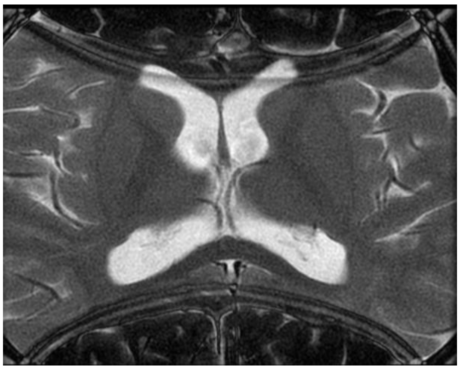

Figure (2-2) Axial T_2 image brain showed (Aliasing artifact)(WWW.radio paedia org)

2-3-3: Chemical shift:

Chemical shift artifact caused by the dissimilar chemical environments of fat and water. This results in a processional frequency difference between the magnetic moments of fat and water and is called chemical shift .Its magnitude significantly increases at higher field strengths. Chemical shift artifact causes a displacement of signal between fat and water along the frequency axis. It is reduced by:

* Scanning with a low field-strength magnet.

* Removing either the fat or water signal by the use of STIR/chemical/spectral presentation, the Dixon technique (see Chemical Miss Registration below).

* Broadening the receive bandwidth.

* Reducing the size of the FOV. (Catherine West brook, 2008)

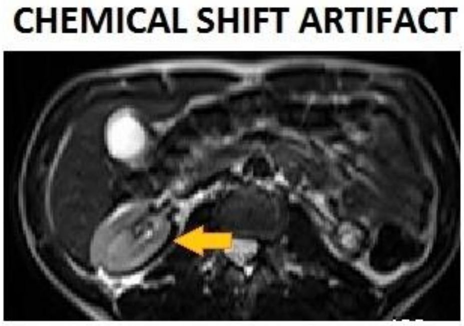

Figure (2-3) (Chemical shift artifact)

2-3-4: Chemical Miss Registration:

Chemical misregistration is also caused by the difference in processional frequency between fat and water. However, this occurs because as fat and water are processing frequencies, they are in phase with each other at certain times and out of phase at other. When the signals from both fat and water are out of phase, they cancel each other out so that signal loss results. This artifact mainly occurs along the phase axis and causes a dark ring around structures that contain both fat and water. It is most prevalent in GRE sequences and it can be used positively to reduce the signal from fat (Dixon technique). To reduce chemical misregistration:

* Use SE or FSE pulse sequences.

* Use a TE that matches the periodicity of fat and water so that the echo is generated when fat and water are in phase. The periodicity depends on the field strength (approximately 4.2ms at 1.5T and 7ms at 0.5T). The Dixon technique involves selecting TE at half the periodicity so that fat and water are out of phase. In this way the signal from fat is reduced. This technique is mainly effective in areas where water and fat co-exist in a voxel. (Catherine West brook, 2008)

2-3-5: Truncation:

Truncation artifacts, also known as Gibbs artifacts or Gibbs ringing artifacts are caused by under-sampling of data at the interface of high and low signal. It occur along the phase axis and produces a dark band running through a high signal area. It is most commonly Truncation is mainly reduced by increasing the number of phase encoding steps. (Catherine West brook, 2008)

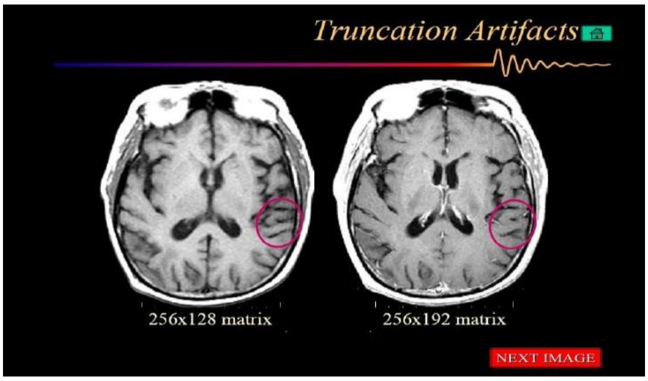

Figure (2-4) image brain showed **(**Truncation artifact)

2-3-6: Magnetic susceptibility:

Magnetic susceptibility artifact occurs because all tissues magnetize to a different degree depending on their magnetic characteristics. This produces a difference in their individual processional frequencies and phase.

With a very difference magnetic susceptibility, and signal loss results. It is commonly seen on GRE sequences when the patient has a metal prosthesis in situ but is also visualized at the interface of the petrous bone and the brain on coronal incoherent (spoiled) GRE image. Magnetic susceptibility can be used advantageously when investigating hemorrhage has blood products, as the presence of this artifact suggests that bleeding has recently occurred. Magnetic susceptibility is reduced by:

* Using ES or FSE pulse sequences.

* Removing all metal items form the patient before the examination. (Catherine West brook, 2008)

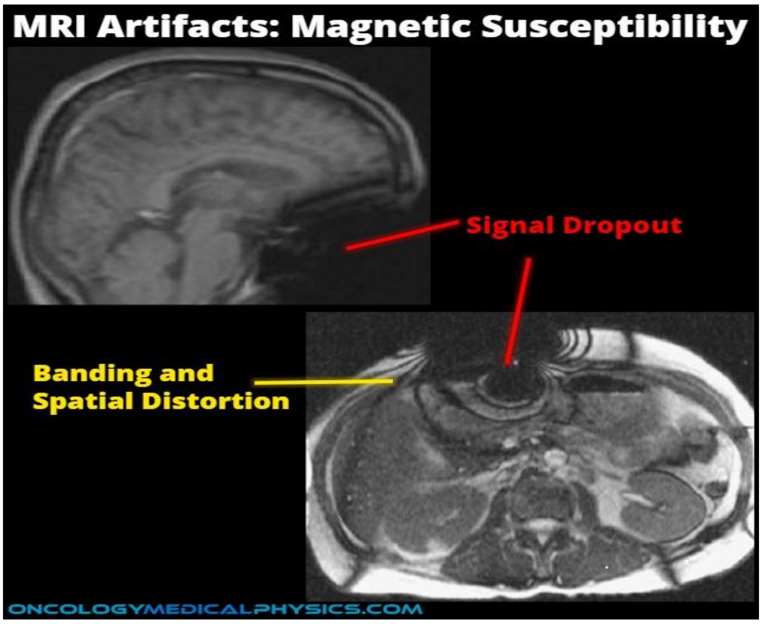

Figure (2-5) showed (magnetic susceptibility)

2-3-7: RF inhomogeneity:

variation in intensity across the image may be due to the failure of the RF coil , non-uniform B1 field , non-uniform sensitivity of the receive only coil (spaces between wire in the coil , uneven distribution of wire) ,or presence of non-ferromagnetic material in the imaged object .(Erasmus L J ,2004)

2-3-8: Shading artifact:

Appearance this produces difference in signal intensity across the imaging volume. Its main cause is the uneven excitation of nuclei with in the patient and due to RF pulses applied at flip angles other that 90^0 and 180^0. Shading is also caused by abnormal loading on the coil or by coupling of the coil at one point. Shading can also by cased in homogeneities in main magnetic field.

Remedy: Always ensure that the coil is loaded correctly and that patient is not touching the coil at any point .and the use of foam pads or water bags between the coil and patient will usually suffice.

Also ensure that appropriate pre-scan parameters have been obtained before the scan, as these determine the correct excitation frequency and amplitude of the applied RF pules. (Catherine West brook, 2005)

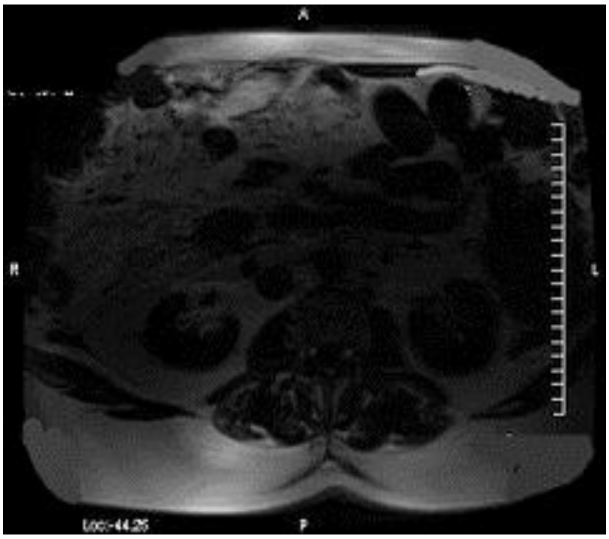

Figure (2-6) image showed (Shading artifact)

2-3-9: Magic angle artifact:

The magic angle artifact refers to the increased signal observed when MRI sequences with short echo time (TE), are used to image tissues with well-ordered collagen fibers in one direction. This artifact occurs when the angle such fibers.

This is caused when structures that contain tightly bound fibers lie at an angle of 55^o 0f to the main field, altering its signal intensity.

Remedy: Alter the angle of the structure or change the TE. (Catherine West brook, 2005)

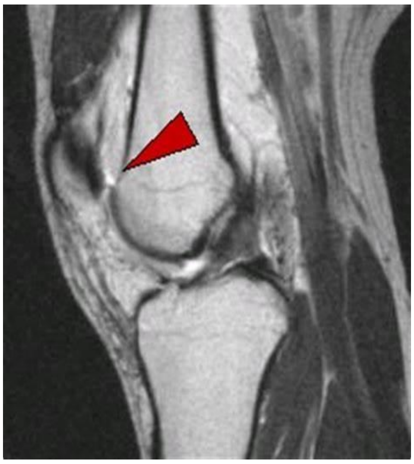

Figure (2-7) image showed (Magic angle artifact)

2-3-10: Zipper artifacts:

Although less common, zipper are bands through the image center due to an imperfect Faraday cage, with RF pollution in, but originating from outside, the cage. Residual free induction decay stimulated echo also causes zippers. (Catherine West brook, 2005)

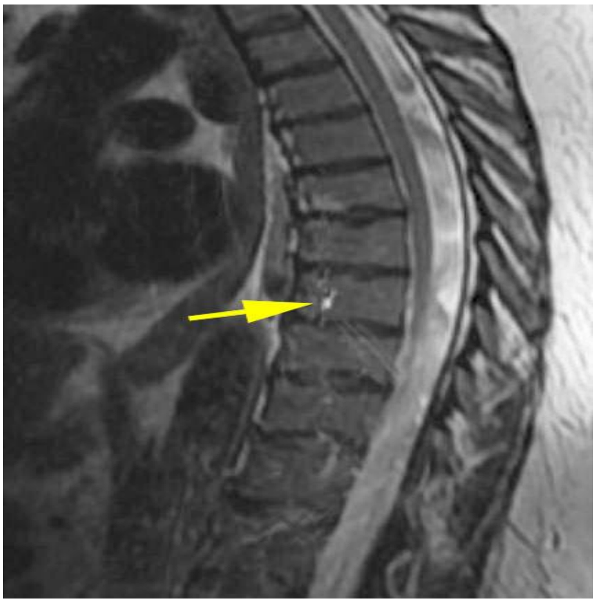

Figure (2-8) sagittal T_2 weight image of lumber showed (Zipper artifacts) WWW.radio paedia.org)

2-4: Previous studies:

There are two previous studies, the first done by ZOHAL Mubarak Ali, showed that the most common Artifacts are motion, Aliasing, Zipper, metallic, cross Artifact. But the motion artifact record high percentage 65% the second common Artifacts was metallic Artifacts17%, then Aliasing Artifacts 7%, cross Artifacts 6%, and Zipper was 5%.

The second done by AL-MOTASEM BELLAH YAGOUB, showed that the most common Artifacts is motion record high percentage 63%, the second common Artifacts was phase MISMMAPING 30% then Truncation 7%.

Previous studies have been concerned about artifacts affecting the MRI image in general, that artifacts affect the quality of the MRI image subsequently give a wrong diagnosis .It found that most of them occur as a result of patient movement and can be reduced by following certain steps .

In this study we will address the artifacts that occur in the form of magnetic resonance as a result of the presence of metal materials accompanied with the patient and how to deal with them.

Form previous studies the researchers recommended that MRI centers include the inclusion of mineral substances in cosmetics in examination protocols.

Chapter Three

Material & Method

Chapter Three

Material & Method

3-1 Material

3-1-1 Machine

Center	Magnet type	Magnet power	Coils
A	Superconducting	1.5 Tasla	RF coils
B	Superconducting	1.5 Tasla	RF coils

3-1-2: Area and duration:

-Area Modern medical center and polices hospital

-Duration (2019-2020)

3-2: Method of data collection:

3-2-1: Data sheet:

Data was collected by observation and recording of MR image details in data sheet has common artifacts.

3-2: Data analysis:

statistic package of Social sciences (SPSS).

Chapter Four

Result

Chapter Four

Result

The common artifacts which usually appear in concerned centers. This study has been done in MRI department at MMC and polices hospital, For 46 subjects.

Table (4-1):Distribution of subjects by Type of artifacts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	motion	24	52.2	52.2	52.2
	susceptibility	10	21.7	21.7	73.9
	RF inhomogeneity	3	6.5	6.5	80.4
	metallic	2	4.3	4.3	84.8
	zipper	2	4.3	4.3	89.1
	poor calibration	2	4.3	4.3	93.5
	MAGIC ANGLE	1	2.2	2.2	95.7
	chemical shift	1	2.2	2.2	97.8
	bright linear	1	2.2	2.2	100.0
	Total	46	100.0	100.0	

Table(4-2):Type of exam

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	brain	33	71.7	71.7	71.7
	cervical	6	13.0	13.0	84.8
	vertebral chain	1	2.2	2.2	87.0
	breast	1	2.2	2.2	89.1
	foot	2	4.3	4.3	93.5
	neck	1	2.2	2.2	95.7
	knee	2	4.3	4.3	100.0
	Total	46	100.0	100.0	

Table (4-3): Association between Type of artifacts * gender

Crosstab					
			gender		**Total**
			Male	Female	
Type of artifacts	motion	Count	11	13	24
		% of Total	23.9%	28.3%	52.2%
	susceptibility	Count	6	4	10
		% of Total	13.0%	8.7%	21.7%
	RF inhomogeneity	Count	3	0	3
		% of Total	6.5%	.0%	6.5%
	metallic	Count	1	1	2
		% of Total	2.2%	2.2%	4.3%
	zipper	Count	0	2	2
		% of Total	.0%	4.3%	4.3%
	poor calibration	Count	2	0	2
		% of Total	4.3%	.0%	4.3%
	MAGIC ANGLE	Count	0	1	1
		% of Total	.0%	2.2%	2.2%
	chemical shift	Count	0	1	1
		% of Total	.0%	2.2%	2.2%
	bright linear	Count	0	1	1
		% of Total	.0%	2.2%	2.2%
Total		Count	23	23	46
		% of Total	50.0%	50.0%	100.0%

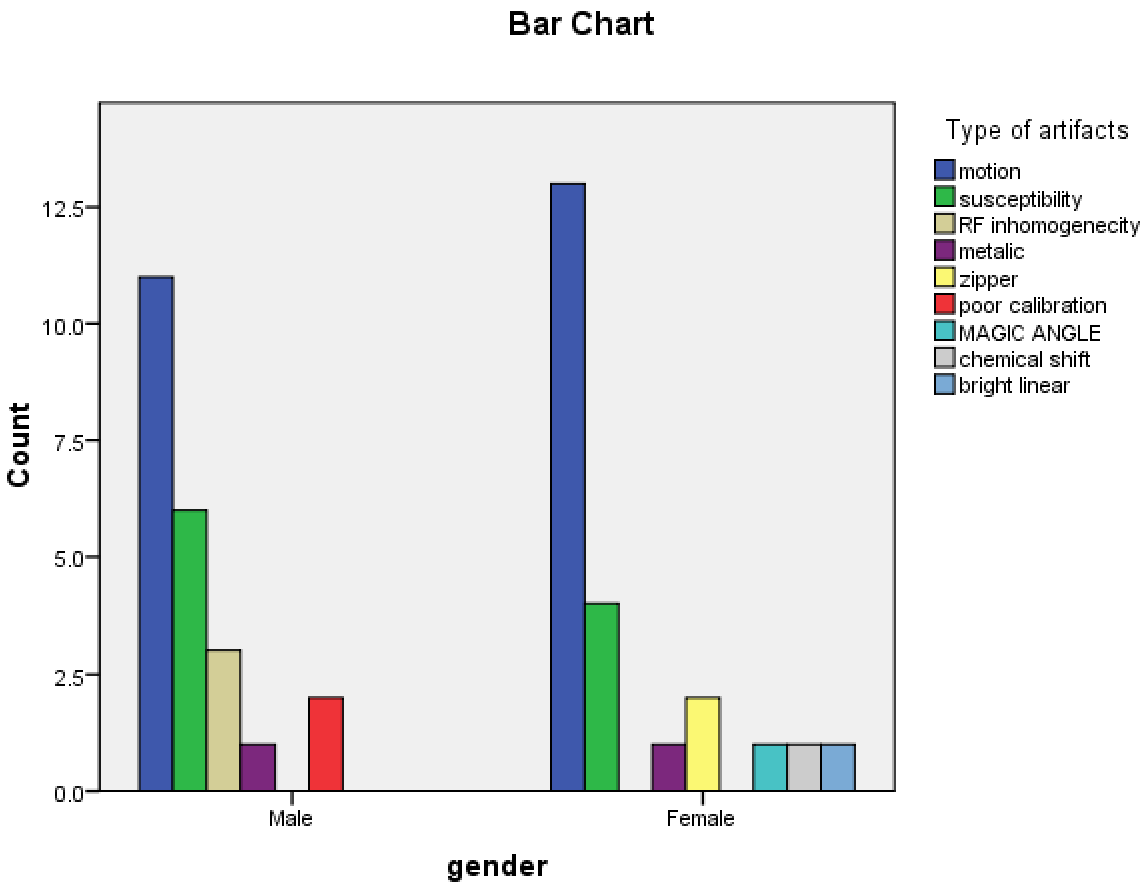
Bar Chart
Count
12.5
10.0
7.5
5.0
2.5
0.0
Male
Female
gender
Type of artifacts
motion
susceptibility
RF inhomogenecity
metalic
zipper
poor calibration
MAGIC ANGLE
chemical shift
bright linear

Fig (4-1):

Table (4-4): Association between Age group * Type of artifacts

Crosstab												
			Type of artifacts									Total
			motion	**susceptibility**	**RF inhomogeneity**	**metallic**	**zipper**	**poor calibration**	**MAGIC ANGLE**	**chemical shift**	**bright linear**	
Age group	below 18	Count	8	3	1	1	0	0	0	1	0	14
		% of Total	17.4%	6.5%	2.2%	2.2%	.0%	.0%	.0%	2.2%	.0%	30.4%
	18-30 yrs	Count	2	1	1	0	0	0	0	0	0	4
		% of Total	4.3%	2.2%	2.2%	.0%	.0%	.0%	.0%	.0%	.0%	8.7%
	31-40	Count	3	0	1	0	1	0	0	0	0	5
		% of Total	6.5%	.0%	2.2%	.0%	2.2%	.0%	.0%	.0%	.0%	10.9%
	41-50 yrs	Count	3	1	0	0	1	0	1	0	0	6
		% of Total	6.5%	2.2%	.0%	.0%	2.2%	.0%	2.2%	.0%	.0%	13.0%
	51-60 yrs	Count	3	2	0	1	0	1	0	0	0	7
		% of Total	6.5%	4.3%	.0%	2.2%	.0%	2.2%	.0%	.0%	.0%	15.2%
	above 60 yras	Count	5	3	0	0	0	1	0	0	1	10
		% of Total	10.9%	6.5%	.0%	.0%	.0%	2.2%	.0%	.0%	2.2%	21.7%
Total		Count	24	10	3	2	2	2	1	1	1	46
		% of Total	52.2%	21.7%	6.5%	4.3%	4.3%	4.3%	2.2%	2.2%	2.2%	100.0%

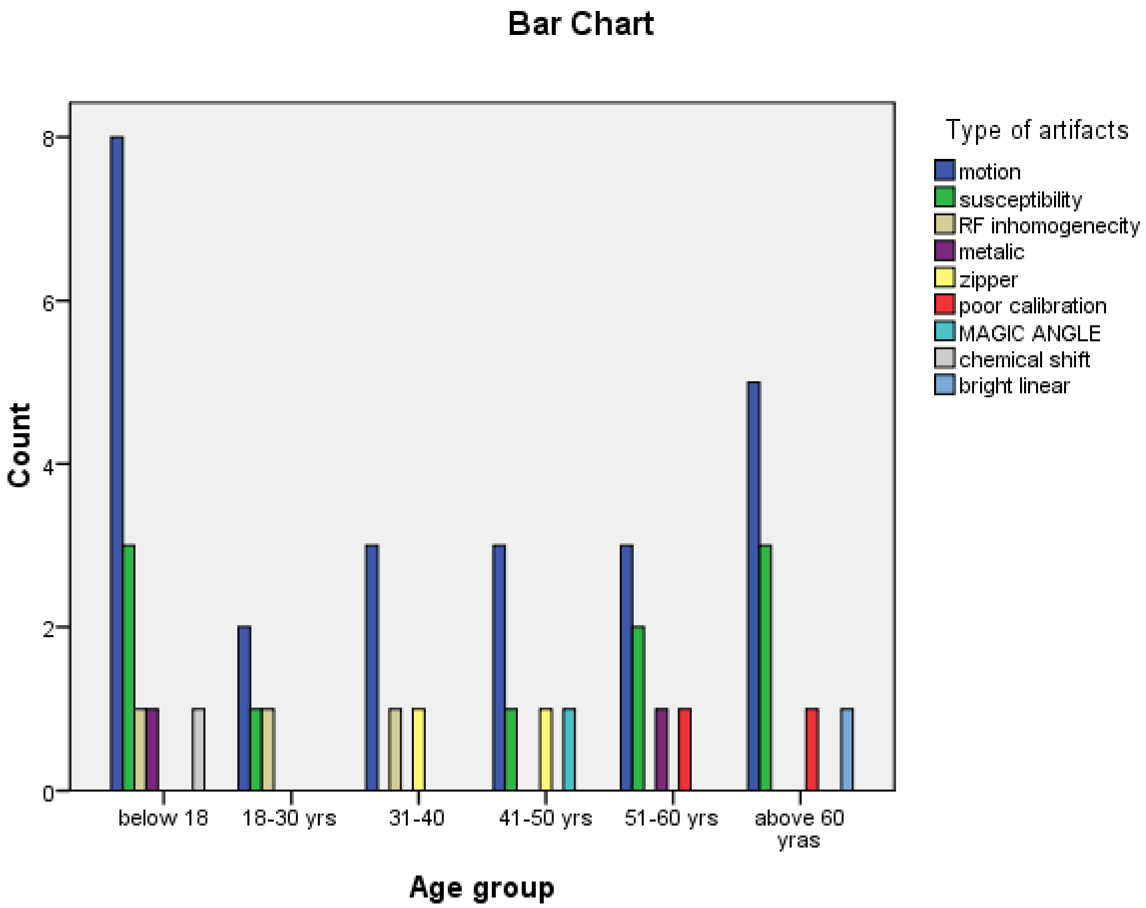

Fig (4-2): Association between Age group * Type of artifacts

Chapter Five

Discussion, Conclusion and Recommendations

Chapter Five

Discussion, Conclusion and Recommendations

5-1 Discussion:

Artifacts in MRI, as in different Radiologic imaging modalities are common and lead to misdiagnosis or least decrease the image quality. The causes are different and as result there are many types Artifacts.

Table (4-1) is showed calculate to average artifacts in tow centers. We found the motion artifact has the highest ratio 52.2% because voluntary and involuntary movement, then susceptibility artifact 21.7%, RF artifact 6.5%, metallic and zipper, poor calibration has the same reading 4.3% and magic angle, chemical shift, bright linear has the same reading 2.2%.Table (4-2) showed type of exam, it was found more organ have multiplied artifacts e.g. the brain lacks the patients cooperation and then the breathing. It also the artifacts appears in the: cervical, vertebral chain, breast, foot, neck, and knee.

Table (4-3) is showed Association between Type of artifacts and gender, No significant association was observed. Local oil in females' hair and cosmetics and hair dyes which contains a lot of iron in the importance factor which caused susceptibility artifact.

Table (4-4) is showed association between type of artifacts and age. But no significant association was observed. All the Examination in the centers is done on Adults 69.6 because of the lack of the Anesthetic for children 30.4%.

5-2 Conclusion:

The result analysis showed the type of common artifacts and association between type of artifacts and gender and association between type of artifacts and age.

The most common Artifacts (motion) that is common causes of patient motion are: phobia, unconscious patients, pain (especially in spine exam) and long scan time.

Flowed by susceptibility artifact that causes of ferromagnetic material in body human, and RF artifact and zipper, poor calibration has the same reading and magic angle, chemical shift, bright linear has the same reading.

The most cases which has high ratio of Artifacts are Brain, cervical, the artifacts which caused by in voluntary motion controlled by software and hardware and accessories added to the MR machine, and voluntary motion controlled by technologists.

High power of magnet play main role in improves image quality.

Accessories added to machines reduced the ratio of Artifacts. And also skills of technologists play important role to avoid and treat many type of artifacts.

There is a traffic artifact which affects the MR image, and fortunately found the MR examination room, support with shielding to prevent RF coming from round traffic and position of MR room in the center.

5-3 Recommendations:

*MR machine must be supported by essential accessories (PERU) such as (respiratory compensation, cardiac and peripheral gating) to avoid involuntary motion.

*MR machine with magnet power (1.5T to above) should be available in the centers.

*The coils should be used according to the organs, and close the clips tightly during the preparation of used the patient for examination.

*Technologists must take care to close door of MR examination room tightly during the examination to prevent extraneous RF entering the room.

* MRI centers should include the inclusion of mineral substances in cosmetics in examination protocols.

*continues education should be help for technologist.

*FSE pulse sequence mast be used as standard technique.

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