Chapter one: Introduction

1.1. Introduction:

Computed tomography (CT) is a medical imaging method employing computer. Digital geometry processing is used to generate a three-dimensional image of the inside of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation. The word "tomography" is derived from the Greek tomos (slice) and graphein (to write) CT produces a volume of data that can be manipulated, through a process known as windowing, to identify various structures based on their ability to block the X-ray (Röntgen) beam. Although historically the images generated were in the axial or transverse plane (orthogonal to the long axis of the body), modern scanners allow this body of data to be reformatted in various planes or even as volumetric (3D) representations of structures. Although most commonly used in medicine, CT is also used in other fields, such as nondestructive materials testing. Another example is the DigiMorph project at the University of Texas at Austin which uses a CT scanner to study biological and paleontological specimens (Herman, 2009).

In 2007, Toshiba Medical Systems introduced the world's first dynamic volume CT system, Aquilion ONE. This 320-slice CT scanner, with its 16 cm anatomical coverage, can scan entire organs such as heart and brain, in just one single rotation, thereby also enabling dynamic processes such as blood flow and function to be observed. Whereas patients exhibiting symptoms of a heart attack or stroke have until now normally had to submit to a variety of examinations preparatory to a precise diagnosis, all of which together took up a considerable amount of time, with dynamic volume CT this can be decreased to a matter of minutes and one single examination. Functional imaging can thus be performed rapidly, with the least possible radiation and contrast dose combined with very high precision other Techniques of CT scan In axial "step and shoot" acquisitions each slice/volume is taken and then the table is incremented to the next location. In multi slice scanners each location is multiple slices and represents a volume of the patient anatomy. Tomographic reconstruction is used to generate axial images. CT scanners produce thin cross-sectional images of the human body for a wide variety of diagnostic procedures. CT is a noninvasive radiographic technique that involves the reconstruction of a tomographic plane of the body (a slice) from a large number of collected x-ray absorption measurements taken during a scan around the body's periphery. The result of a CT study is usually a set of transaxial slices, which can be mathematically manipulated to produce sagittal or coronal image slices. With isotropic imaging, an image can be reconstructed in any arbitrary plane. CT is clinically useful in a wide variety of imaging exams, including spine and head, gastrointestinal, and vascular (Brenner DJ, Hall EJ (2007).).

CT uses some of the highest doses of any diagnostic imaging method, and the fact that multislice CT has the potential to increase these doses adds to the need for some form of automatic dose control. CT manufacturers are now implementing various strategies to control dose. One such strategy is to use preprogrammed technique factors, which manufacturers are currently fine-tuning to specific patient sizes, particularly for pediatric applications. Because tube current directly affects the patient dose and the image quality, manufacturers have various methods to control tube current during the exposure. One method varies the tube current based on the scout view. At least one scout view is normally collected before a scan begins and is acquired by fixing the x-ray tube while moving the patient through the scanner. From the scout view, it is possible to calculate the tube current needed for each slice. The simplest dose-control system uses just one scout view, although some systems can use two views. A more advanced dose-control method uses real-time information about the patient's anatomy derived from the beam signal received by the detectors as the scan is progressing. Obtaining such feedback is possible because of the faster electronics on today's CT scanners. The user sets the desired image-quality level, and the scanner adjusts the tube current as needed. Studies with patients suggest that dose savings of up to 50% may be possible using these systems.

1.4. The problem:

There is controversy, imaging brain with axial scan produce high quality images, but axial scanning is more sensitive to motion, but volumetric scanning reduce motion artifact and produce image poor in quality compared to image acquired by axial scan.

1.2. Objectives of the study:

1.2.1. General Objective:

The general objective of this study is to assess Motion artifact in Brain CT Images in Pediatric Patients comparison of volumetric and axial CT Methods.

1.2.2. Specific Objectives:

- To address the controversy whether the quality of volumetric Brain CT (BCT) images is as good as that of axial.

- To address the effect of artifact on image quality.

1.5. Thesis outlines:

This study falls into five chapters, chapter one, which is an introduction , objectives of the study, chapter two Literature review and theoretical background, chapter three material and method , chapter fours results and chapter five discussions, conclusion , recommendations, then references.

Chapter two

Literature Review

2.1. Computed Tomography:

2.1.1. Overview of CT:

Wilhelm Roentgen first discovered ionizing radiation in the form of x-rays in 1895, while performing experiments with cathode rays. Shortly after his discovery, the possible applications of x-rays for medical purposes began to be explored in several countries, including the USA, England and France. (Flohr, 2009). In the 1970s, CT was introduced as an innovative x-ray imaging tool. This technology was invented by electrical engineer Godfrey N. Hounsfield of Central Research Laboratories (London) in 1972, along with physicist Allan M. Cormack of Tufts University (Massachusetts), who was simultaneously working on image reconstruction theory. Also in 1972, the first CT head scanner was developed, and the first commercial unit of this prototype was installed in the USA, in 1973. Between 1974 and 1976, CT scanners began to be installed and used in medical institutions. By 1977, several manufacturing companies were marketing more than 30 models of CT scanners, and by May 1980, there were more than 1,000 operational CT homographs in the USA (Hendee, 2002).

Spiral CT scanners entered the market in 1989, and the first step towards multi-slice acquisition was the Elscint TWIN two-slice CT scanner, introduced in 1993. By 1998, all major CT manufacturers had a multi-slice SCT scanner model and, in 2004, the next-generation versions of those multi-slice CT systems – with 32, 40, and 64 simultaneously acquired slices

– were available on the market. 64-slice CT systems are now operational in numerous medical institutions, and yet new tomographs, with more slices acquired simultaneously, are being developed. In 2007, Phillips introduced a scanner capable of measuring 256 slices simultaneously, using a RX cone-beam, and Toshiba announced a new 320-slice scanner (Flohr, 2009).

Computed Tomography (CT) builds on developments in two fields - X-ray imaging and computing. X-rays were discovered in 1895 and within a few years were an established medical tool. By the 1930s, tomography was being developed, enabling the visualization of sections through a body. By the 1960s, several researchers had worked independently on cross-sectional imaging, culminating in Hounsfield's work at EMI developing computed tomography (CT) for the EMI Scanner. This device relied on the reconstruction of image data by computer, the data being acquired from multiple X-ray transmissions through the object under investigation. (Eur-J-RADiol, 2004).

Following the first clinical scan in 1971, the patient with the suspected frontal lobe tumor was operated on. The surgeon performing the operation is reported to have remarked that "it looks exactly like the picture" shown above. The successful demonstration of the worth of CT lead to further demonstration systems being installed in London, Manchester and Glasgow in the UK and at the Mayo Clinic and Massachusetts General Hospital in the USA. The first clinical scan in the USA was performed at the Mayo Clinic in 1973. (O.W.Linton et al , 2003)

Papers relating to the first commercial scanner to be installed, the EMI Head CT Scanner at the Manchester Royal Infirmary, and of later EMI scanners installed in Manchester, are held in the Papers of Ian Isherwood collection at the John Rylands University Library, Manchester.

By 1975, EMI were marketing a body scanner, the CT5000, the first of which was installed at Northwick Park Hospital in London. The first body scanner in the USA was installed at the Mallinkrodt Institute and had its first clinical use in October 1975. By this time scan time had been reduced to 20 seconds, for a 320 x 320 image matrix.The mid-1970s were a time of rapid development in CT: 1976 saw 17 companies offering scanners, with scan times down to 5 seconds in some cases. By 1978, there was an installed base of around 200 scanners in the USA, image matrix sizes were up to 512 x 512 and some models of scanner had the capability of ECG-triggered scans. It was also around this time that the ImPACT group was established at St George's Hospital in London, with funding from the UK Department of Health and tasked with evaluating CT scanners for the UK By the end of the 1970s the importance of CT scanning to medicine was clear: Hounsfield and McCormack received the Nobel Prize for Medicine in 1979, for the independent work on developing the theory and technology of CT scanning, and in 1981 Hounsfield received a knighthood for his work.(E.L.Nic Koloff et al, 2003)

The 1980s saw incremental development of CT scanner technology: shorter scan times and increased matrix sizes, until by the late 1980s scan times were down to only 3 seconds and matrix sizes were up to 1024 x 1024. Development continued through the 1990s, with the introduction of spiral (continuous) scanning in the early 1990s and the development of multi-slice scanners, with 4-slice scanners and 0.5 second scan times being 'state-of-the-art' by the end of the century.(D.J. Brenner et al, 2002)

Development of CT scanner technology continued through the early years of the 21st century, particularly with multi-slice scanners. At the time of writing, high-end scanners were offering up to 320 slices, dual-source and dual-energy x-ray sources and iterative reconstruction techniques.CT is not the only cross-sectional modality in use in medical imaging today. Magnetic Resonance Imaging (MRI) was introduced commercially in 1980, a few years after the introduction of the PET scanner. Each device has its advantages: PET gives functional information whereas MRI and CT give structural information. The PET/CT scanner, which combines information from a PET scan and a CT scan in a single device, was introduced in 2000(Herman, 2009)

2.2. Applications of CT Imaging:

CT is a radiologic, anatomical imaging technique that provides valuable clinical information for the detection and differentiation of several diseases. In fact, CT is the primary diagnostic tool for a wide range of clinical indications, being also used as a complement for other imaging modalities. A CT system produces cross-sectional images of selected regions of the body, which can be used for different diagnostic and therapeutic purposes. The images obtained can help diagnose or rule out different diseases and abnormalities, also being often used as a reference for therapy planning and monitoring (FDA. 2010).

For instance, one of the fields where CT is most widely used is Neuroradiology. It is highly useful in the examination of the brain, being frequently indicated for neurologic examinations such as the evaluation of acute head trauma, suspected intracranial hemorrhage, and vascular lesions. Also in Neurology, CT might be a suitable alternative when MRI is deemed contraindicated. Other advanced applications of CT imaging include the visualization of specific anatomical structures and tissues using CT perfusion, volumetry, angiography, and venography (FDA. 2010).

2.3. Basic Principles of CT Imaging:

In CT imaging, anatomic cross-sectional (or “slice”) images of body tissues and organs are produced. These images represent the x-ray attenuation properties of the different tissues: the x-ray photons, generated within an x-ray tube, are attenuated in the patient’s tissues and organs. The interaction between x-ray and matter depends on the x -ray photons energy, and matter’s thickness and electron density. Thicker and denser materials, such as bone, attenuate more X-rays photons than less dense, thinner tissues like muscle or fat, and these differences in attenuation will result in correspondent contrast variations, in the final image (Suetens, 2009).

Thin x-ray beams scan the desired anatomical region, and this process is repeated for different angle directions. The actual attenuation at each particular location inside the body is then reconstructed from all those attenuation measurements, through sophisticated mathematical algorithms, which reconstruct data information of the x-ray attenuation coefficients determined for the different anatomical structures (Suetens, 2009).

The intensity of the x-ray beam before it reaches the body is measured by an x-ray detector, as well as its final intensity, in order to compute the μ values of the different tissues the x-ray beam interacts with . The x-ray detector area is constituted by a radiation-sensitive material (such as cadmium tungstate or gadolinium-oxide), which converts x-rays into visible light. This light interacts with a silicon photodiode and is converted into an electrical current, which is later amplified and converted into a digital signal. The data from the detector array is then reconstructed to obtain images of the internal structures of the body region scanned (Suetens, 2009).

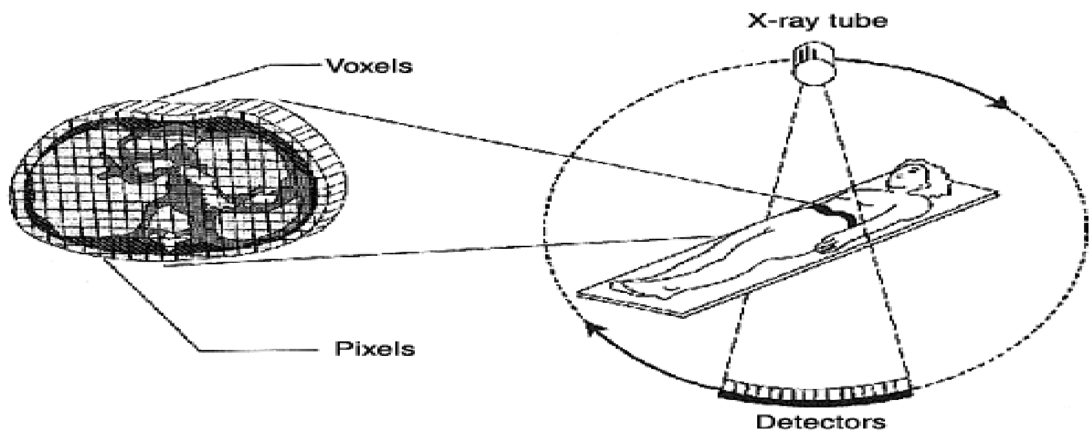

Figure (2.1) shows the Anatomical structures within the patient's body are reconstructed from the x-ray transmission data. Adopted from (Lima,2010)

2.4. The CT scanner Components:

The general structure of CT equipment can be divided in four principal elements:

The Data Acquisition and Transfer System, which encompasses the gantry, the patient's table, the PDU and a data transfer unit: The gantry is a central opening where the patient is moved into during the examination, in which are assembled the x-ray tube source, where electrons are generated in a cathode and accelerated towards an anode (the target) producing x-ray photons; the detector area, diametrically opposed to the x-ray source in the gantry; a collimation system, which determines the slice width; a filtering system to remove the low energy component of the x-ray beam; a refrigerating system and a power source for the x-ray tube and detectors rotation (Lima,2010).

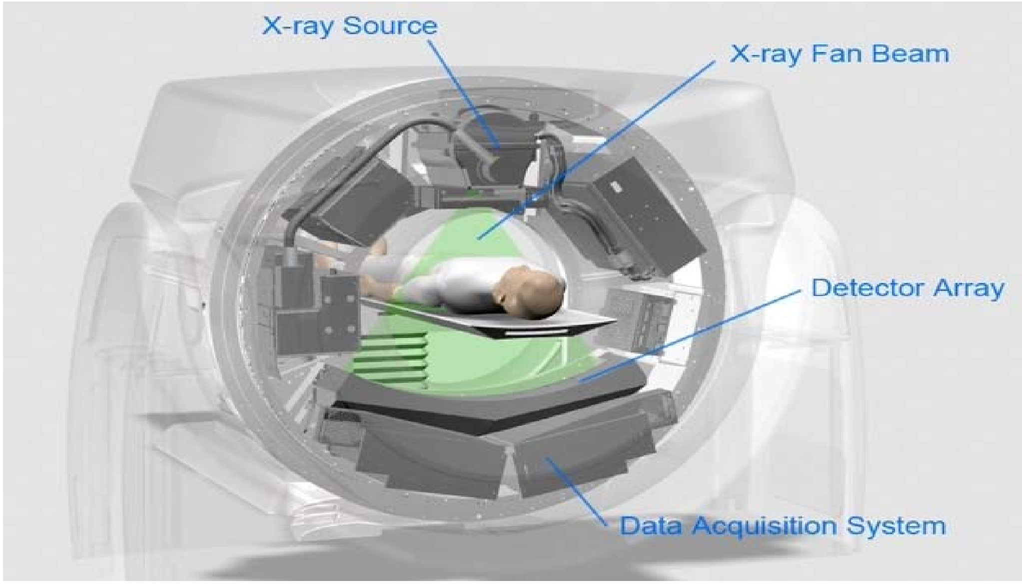

Figure (2.2) shows the x-ray tube and the detector array are oppositely placed, inside the gantry. Adopted (Thorsten,1965)

The table is where the patient is positioned (lied down), and it moves through the gantry. The patient's table and the gantry constitute CT scanner itself. The Power Distribution Unit (PDU) supplies power to the gantry, the patient's table and the computers of the Computing System, which is localized in a separate room, as will be explained next. The PDU is a separate, independent unit, generally in the same room as the gantry and table. (Thorsten, 1965). In the data transfer unit, ADCs (Analog-to-Digital Converters) convert the electrical signal from the detectors in the gantry into a digital signal.(Reddinger.1997)

The computing system (or operator's console) is installed in separate room, making it possible for the operator (technician) to control the acquisition process, introducing patient. (Thorste.1965). The image reconstruction system receives the x-ray transmission data information from the data transfer unit, in a digital format . This gathered data is then corrected using reconstruction algorithms, and later registered in a CD or a DVD. Generally, all exam data is additionally recorded in the medical institution's PACS (Thorsten.1965). A second operator's console, for independent image editing and post-processing is also necessary , so it is possible to analyze and review previous exam data, without interfering with the current examinations taking place(Reddinge,1997).

2.5. Types of machines:

Spinning tube, commonly called spiral CT, or helical CT in which an entire X-ray tube is spun around the central axis of the area being scanned. These are the dominant type of scanners on the market because they have been manufactured longer and offer lower cost of production and purchase. The main limitation of this type is the bulk and inertia of the equipment (X-ray tube assembly and detector array on the opposite side of the circle) which limits the speed at which the equipment can spin. Some designs use two X-ray sources and detector arrays offset by an angle, as technique to improve temporal resolution. (Herman, 2009).

Electron beam tomography (EBT) is a specific form of CT in which a large enough X-ray tube is constructed so that only the path of the electrons, travelling between the cathode and anode of the X-ray tube, are spun using deflection coils. This type had a major advantage since sweep speeds can be much faster, allowing for less blurry imaging of moving structures, such as the heart and arteries. Fewer scanners of this design have been produced when compared with spinning tube types, mainly due to the higher cost associated with building a much larger X-ray tube and detector array and limited anatomical coverage. Only one manufacturer (I matron, later acquired by General electric) ever produced scanners of this design. Production ceased in early 2006.In multislice computed tomography

(MSCT), a higher number of tomographic slices allow for higher-resolution imaging.

2.6. CT Scan Room:

When you enter the CT scan room, you will be asked to lie on the CT table. If you need an IV, the technologist will start one at this time. The technologist will explain the procedure to you, instruct you on holding still, breathing, and any sensations you may experience. Once you are correctly positioned you will be asked to relax and not move. Positioning straps may be placed to ensure proper position is maintained through the scan. The technologist will leave the room and begin the scanning procedure from the computer console. The technologist can see and hear you at all time--each of you can communicate with each other via an intercom system. (Paterson A, 2001).

Depending upon the type of scan, the table may move in increments or one continuous movement. The total examination time is usually less than 15 minutes. The technologist will check on you after the scan is completed, and remove the intravenous if one was started. You may leave the scan room at this time and return to normal activities unless otherwise instructed. The technologist will give you easy to follow instructions if required. (Paterson A, 2001).

There are several advantages that CT has over traditional 2D medical radiography. First, CT completely eliminates the superimposition of images of structures outside the area of interest. Second, because of the inherent high-contrast resolution of CT, differences between tissues that differ in physical density by less than 1% can be distinguished. Finally, data from a single CT imaging procedure consisting of either multiple contiguous or one helical scan can be viewed as images in the axial, coronal, or sagittal planes, depending on the diagnostic task. This is referred to as multiplanar reformatted imaging. (herman,2009)

CT is regarded as a moderate- to high-radiation diagnostic technique. The improved resolution of CT has permitted the development of new investigations, which may have advantages; compared to conventional radiography, for example, CT angiography avoids the invasive insertion of a catheter. CT colonography (also known as virtual colonoscopy or VC for short) may be as useful as a barium enema for detection of tumors, but may use a lower radiation dose. CT VC is increasingly being used in the UK as a diagnostic test for bowel cancer and can negate the need for a colonoscopy. (herman,2009)

The radiation dose for a particular study depends on multiple factors: volume scanned, patient build, number and type of scan sequences, and desired resolution and image quality. In addition, two helical CT scanning parameters that can be adjusted easily and that have a profound effect on radiation dose are tube current and pitch. Computed tomography (CT) scan has been shown to be more accurate than radiographs in evaluating anterior inter body fusion but May still over-read the extent of fusion. (ASRT,2013)

2.7. Adverse effects:

2.7.1. Cancer:

The radiation used in CT scans can damage body cells, including DNA molecules, which can lead to cancer. According to the National Council on Radiation Protection RP and Measurements, between the 1980s and 2006, the use of CT scans has increased six fold (600%). The radiation doses received from CT scans are 100 to 1,000 times higher than conventional X-rays. A study by a New York hospital found that nearly a third of its patients who underwent multiple scans received the equivalent of 5,000 chest X-rays. (Redberg,2003)

Some experts note that CT scans are known to be "overused," and "there is distressingly little evidence of better health outcomes associated with the current high rate of scans." (Redberg,2003)

Early estimates of harm from CT are partly based on similar radiation exposures experienced by those present during the atomic bomb explosions in Japan during the Second World War and those of nuclear industry workers. A more recent study by the National Cancer Institute in 2009, based on scans made in 2007, estimated that 29,000 excess cancer cases and 14,500 excess deaths would be caused over the lifetime of the patients. Some experts project that in the future, between three and five percent of all cancers would result from medical imaging. (Redberg,2003)

An Australian study of 10.9 million people reported that the increased incidence of cancer after CT scan exposure in this cohort was mostly due to irradiation. In this group one in every 1800 CT scans was followed by an excess cancer. If the lifetime risk of developing cancer is 40% then the absolute risk rises to 40.05% after a CT. (Redberg,2003)

A person's age plays a significant role in the subsequent risk of cancer. Estimated lifetime cancer mortality risks from an abdominal CT of a 1-year-old are 0.1% or 1:1000 scans. The risk for someone who is 40 years old is half that of someone who is 20 years old with substantially less risk in the elderly. The International Commission on Radiological Protection estimates that the risk to a fetus being exposed to 10 mGy (a unit of radiation exposure, see Gray (unit)) increases the rate of cancer before 20 years of age from 0.03% to 0.04% (for reference a CT pulmonary angiogram exposes a fetus to 4 mGy). A 2012 review did not find an association between medical radiation and cancer risk in children noting however the existence of limitations in the evidences over which the review is based. (Shelton, J,2011)

CT scans can be performed with different settings for lower exposure in children with most manufacturers of CT scans as of 2007 having this function built in. Furthermore, certain conditions can require children to be exposed to multiple CT scans. Studies support informing parents of the risks of pediatric CT scanning. (Baysson H,2012)

2.7.2. Contrast:

In the United States half of CT scans involve intravenously injected radio contrast agents. The most common reactions from these agents are mild, including nausea, vomiting and an itching rash; however, more severe reactions may occur. Overall reactions occur in 1 to 3% with nonionic contrast and 4 to 12% of people with ionic contrast. Skin rashes may appear within a week to 3% of people. (Larson DB,2007). The old radio contrast agents caused anaphylaxis in 1% of cases while the newer, lower-osmolar agents cause reactions in 0.01–0.04% of cases. Death occurs in about two to 30 people per 1,000,000 administrations with newer agents being safer. When deaths do occur it is more typically in those who are female, elderly or in poor health and is secondary to either anaphylaxis or acute renal failure. (james,2005).

The contrast agent may induce contrast-induced nephropathy. This occurs in 2 to 7% of people who receive these agents, with greater risk in those who have preexisting renal insufficiency, preexisting diabetes, or reduced intravascular volume. People with mild kidney impairment are usually advised to ensure full hydration for several hours before and after the injection. For moderate kidney failure, the use of iodinated contrast should be avoided; this may mean using an alternative technique instead of CT. Those with severe renal failure requiring dialysis require less strict precautions, as their kidneys have so little function remaining that any further damage would not be noticeable and the dialysis will remove the contrast agent; it is normally recommended, however, to arrange dialysis as soon as possible following contrast administration to minimize any adverse effects of the contrast. (Thorsten,1965)

In addition to the use of intravenous contrast, orally administered contrast agents are frequently used when examining the abdomen. These are frequently the same as the intravenous contrast agents, merely diluted to approximately 10% of the concentration. However, oral alternatives to iodinated contrast exist, such as very dilute (0.5–1% w/v) barium sulfate suspensions. Dilute barium sulfate has the advantage that it does not cause allergic-type reactions or kidney failure, but cannot be used in patients with suspected bowel perforation or suspected bowel injury, as leakage of barium sulfate from damaged bowel can cause fatal peritonitis. (Thorsten,1965)

2.7.3. Motion artifact:

Motion (patient, cardiac, respiratory, bowel) causes blurring and double images, as well as long range streaks. The streaks occur between high contrast edges and the X-ray tube position when the motion occurs. Faster scanners reduce motion artifact because the patient has less time to move during the acquisition. This can be accomplished with faster gantry rotation or more X-ray sources. More detector rows allows a greater volume to be imaged in a single gantry rotation, thus increasing the distance between step-off artifacts from motion on coronal or sagittal reformats. Rigid body motion artifacts (mainly a problem with head CT, as shown in can be reduced using special reconstruction techniques. Respiratory motion in cone-beam CT with slow gantry rotation can be estimated and corrected, thus reducing artifacts. With a very fast scanner, the heart can be scanned during diastole within a single heartbeat, significantly reducing cardiac motion, thus allowing evaluation of the coronary arteries Alternatively, with ECG gating ,projection data are acquired over multiple cardiac cycle, and then reconstructed from data acquired during specific phases of the cardiac cycle .Thiscanbeusedtomake3Dmoviesofabeatingheart.Withcurrentscanners,evaluation is suboptimal at higher heart rates, and for images obtained during systole. Temporal resolution in cardiac CT can be improved using new techniques that work with limited Projection data.(CT artifact:causes and reduction techniques –Boas and Flesich mann)

2.8. CT Image Quality:

Fundamentally, image quality in CT, as in all medical imaging, depends on 4 basic factors: image contrast, spatial resolution, image noise, and artifacts. Depending on the diagnostic task, these factors interact to determine sensitivity (the ability to perceive low-contrast structures) and the visibility of details. (Jucius RA, Kambic GX, 1977)

2.9. Radiation safety in CT:

Radiation doses in CT are relatively high. For example, the effective dose of a head scan is 2 mSv, of the thorax 10 mSv and of the abdomen 15 mSv.

This is a factor 10 to 100 higher than radiographic images of the same region, but the diagnostic content of the CT images is typically much higher. Some scanners use a lower tube current and a higher voltage to reduce the dose. However, there is still some risk to a developing fetus. CT scans are therefore not recommended during pregnancy. (Thorsten, 1965).

2.10. Diagnostic use:

Since its introduction in the 1970s, CT has become an important tool in medical imaging to supplement x-rays and medical ultrasonography. It has more recently been used for preventive medicine or screening for disease, for example CT colonography for patients with a high risk of colon cancer, or full-motion heart scans for patients with high risk of heart disease. A number of institutions offer full-body scans for the general population although this practice goes against the advice and official position of many professional organizations in the field. (Thorsten, 1965).

2.11. Pediatric CT:

Pediatric health care professionals have an important role in the use of CT on children. The health care professional ultimately decides whether a CT examination is necessary. With this important role comes a responsibility to recognize both the value of CT and its risks, which, as described previously, it is reasonable to assume are very small but real. (Frush DP,2004).

The health care professional should also be able to discuss these risks in a manner that is informative and understandable to patients and families. One must recognize that the decision regarding a CT examination will often depend on the combination of the interaction with consultants, such as radiologists, and the family. There is a vast pool of information available on the Internet, much of which may be confusing with respect to CT, radiation, and cancer. (Frush DP,2004)

The pediatric health care professional should be in a position to be able to answer questions and address concerns. (Frush DP,2004)

The pediatric health care professional is usually the first, and often the only, source of direct communication with the child and the family. This relationship carries with it an opportunity to inform and educate the family. (Jacob K,2004)

Recent reviews that covered CT technology and its role in the imaging armamentarium. Are salient for pediatric health care professionals. CT has an increasingly recognized role as the first, if not only, imaging examination for a wide variety of disorders that affect infants and children. What is most important to realize is that the use of CT is not infrequent in children and that the frequency of CT examinations is increasing. A recent review summarized investigations indicating that CT use has increased substantially over the last 1 to 2 decades, including estimates of at least 10% growth per year. (Paterson A,2001)

Currently, approximately 11% of CT examinations are performed on children,4 which could account for more than 7 million pediatric CT examinations per year in the United States. The use of CT for common problems such as trauma (closed head injury, skeletal evaluation including cervical spine assessment, and blunt abdominal trauma), appendicitis, and renal calculi has increased the frequency of CT examinations in adult and pediatric populations. Most clinicians believe that CT studies on children prevent hospitalization for head injuries and that negative findings in patients with acute onset of abdominal pain can obviate surgical explorations. These studies provide information that leads to earlier and more definitive diagnosis. . (Jacob.2004)

This increased use, however, must be based on a firm understanding that the CT study is the best study for the clinical situation being evaluated and that the possibility of a very small risk of cancer is considered when making the decision to order the study. The possible cancer risk is not clearly understood by many health care professionals, as concluded by 2 recent investigations. In the first investigation, Lee ET al15 surveyed emergency department patients, physicians, and radiologists. The results indicated that only 7% of patients indicated that there was any discussion outlining the radiation risks and benefits from an abdominal CT examination. In addition, only 9% of emergency department physicians believed that the lifetime risk of cancer was potentially increased by CT scanning. Moreover, 75% of physicians surveyed underestimated the accurate range for the equivalent number of chest radiographs for a CT examination in another recent investigation, Jacob et al surveyed physicians in the United Kingdom and found that only 12.5% were aware of the potential association of CT radiation and cancer. Less than 20% correctly identified the relative radiation dose of CT examinations. These studies support a continued and compelling need for radiation safety education for health care professionals and the public. (Jacob,2004)

The pediatric health care professional should also be able to provide summary information to families on local practice patterns of radiology colleagues. It is reasonable to have information immediately available from the radiology practice in addition to that stated above. This information should include:

Additional expertise of the practice (pediatric radiology fellowship training, American Board of Radiology Certificate of Added Qualification, and current Maintenance of Certification in pediatric radiology);

Appropriate pediatric head and body CT protocols consisting of size- or age-based adjustments in scanner settings; and American College of Radiology accreditation of the CT scanners and the radiologists who interpret those studies in the practice.An important role of the pediatric health care professional is to communicate with the radiologist to decide whether CT is the best study to perform. This consultation will vary from practice to practice, but it should be the goal of both parties to facilitate discussions on imaging strategies. (Paterson,2001)

These discussions provide an opportunity to share information, such as the number of studies using ionizing radiation to which the patient has been exposed. In addition to the pediatric health care professionals and radiologists, the integration of other care providers, such as surgical consultants or emergency department physicians, in decisions regarding pediatric CT policy or practice should also be fostered. Other imaging techniques such as ultrasonography or MRI may be suitable alternatives to CT examination, and they do not use ionizing radiation. If the CT examination is indicated and the radiology department uses a low-dose technique, another way to reduce CT dose is to limit the number of times (or phases) the child is scanned for the individual examination. It is very common for adult CT protocols to involve multiple scans through the same body part, which can double or triple the radiation dose to the patient. For most indications for pediatric CT scans, a single pass through the body part of interest is usually sufficient for diagnostic purposes. (Donnelly LF,2003).

Chapter Three

Material and Method

3.1. Material:

3.1.1 Patients:

A total of 10 patients (male , female) with average age 6years , five patients for brain examination volumetric CT scan and five to patients for brain examination axial CT scan .

3.1.2. Machine:

Table (3.1)show the specification of ct machine used in this study.

center	manufacter	Date manufacter	Max KV	Max mA
64	Toshiba	2012	135	400
Dual	General electric	2001	140	160

3.2. Methods:

3.2.1. Technique:

3.2.1.1. Axial scan:

Table (3.2) shows the exposure factors and slice thickness used in axial scan.

Slice thickness	KVP	mAs	Scan time (sec)

(mm)			
3-7	120	60-100-130	35

3.2.1.2. Volumetric scan:

Table (3.3) shows the exposure factors and slice thickness used in volumetric scan.

Slice thickness (mm)	KVP	mAs	Scan time(sec)
3-5	120	200	11

3.3. Image evaluation:

all image of brain is a visually evaluated for quality, Resolution ,SNR , by 50 technologist, by using four score scale excellent, very good, good, acceptable, poor.

Chapter four

The Result

Table (4.1) shows the score of visual evaluation of volumetric brain images quality.

N of image		Image Quality				
		Ecxellent	Very good	Good	Acceptable	Pad
1	Resolution	13	07	12	08	10
	SNR	10	11	09	14	16
2	Resolution	12	03	08	17	10
	SNR	22	09	11	08	00
3	Resolution	02	08	10	13	17
	SNR	03	11	05	12	19

4	Resolution	06	14	15	15	00
	SNR	08	12	13	17	00
5	Resolution	08	06	08	08	20
	SNR	07	13	06	04	20

Table (4.2) shows the score average values and percentages of the resolution for the volumetric image and axial images.

	Excellent		Very good		good		acceptable		Poor	
	volum	axial	volum	axial	volum	axial	volum	axial	volum	axial
Resolution	8.2	13.6	7.6	11.6	10.6	11.2	12.2	5.4	7.8	8.2

Percentage	16.4%	27.2%	15.2%	23.2%	21.2%	22.4%	24.4%	10.8%	15.6%	16.4%

Figure(4.1) shows the percentages of the resolution for the volumetric image and axial images.

Table (4.3) shows the score visual evaluation of axial brain images quality.

N of image		Image Quality				
		Ecxellent	Very good	Good	Acceptable	Pad
1	Resolution	18	18	04	04	06
	SNR	19	20	02	05	04

2	Resolution	04	12	23	11	00
	SNR	05	06	11	18	10
3	Resolution	09	11	15	07	08
	SNR	23	04	16	03	04
4	Resolution	21	05	06	01	17
	SNR	19	08	08	04	11
5	Resolution	16	12	08	04	10
	SNR	12	12	06	10	10

Table (4.4) shows the average values and percentages of the noise for the volumetric image and axial images.

	Excellent		Very good		good		acceptable		Poor	
	volum	axial	volum	axial	volum	axial	volum	axial	volum	axial
Noise	10	15.6	11.2	10	8.8	8.6	11	8	11	7.8
Percentage	20%	31.2%	22.4%	20%	17.6%	17.2%	22%	16%	22%	15.6%

Figure(4.2) shows the percentages of the Noise for the volumetric image and axial images.

Chapter five

Discussion, Conclusion and Recommendation

5.1. Discussion:

This study was performed in Khartoum state, to assessment of Motion artifact in Brain CT Images in pediatric patients and comparison between volumetric and axial CT Methods, The study showed that the CT axial images are better than the CT volumetric image in the overall quality assessment. The study showed for the CT axial brain image the assessment of resolution 27.2% in the range of excellent, 23.2% in the range of very good, 22.4 % in the range of good, 10.8% in the range of good, 16.4% in the range of poor. CT axial brain image the assessment of noise 31.2% in the range of excellent, 20% in the range of very good, 17.2% in the range of good, 16% in the range of good, 15.6% in the range of poor. And for the CT volumetric brain image the assessment of resolution 16.4% in the range of excellent, 15.2% in the range of very good, 21.2 % in the range of good, 24.4% in the range of good, 15.6% in the range of poor. CT volumetric brain image the assessment of noise 20% in the range of excellent, 22.4% in the range of very good, 17.6 % in the range of good, 22% in the range of good, 22% in the range of poor. The final results showed that the quality of Axial images is better than the quality of volumetric images this is due to the way of acquisition, in axial image the attenuation measurement is taken at the same slice plane, while in volumetric acquisition the attenuation measurement were taken in different plane , due to patient movement which lead to in accurate measurement of attenuation values of the tissue which make up the slice. The final Assessment of Motion artifact in Brain CT Images in Pediatric Patients is more in volumetric than axial CT.

5.2. Conclusion:

Image quality is important factor in diagnostic radiology. In this study The final results showed that the quality of Axial images is better than the quality of volumetric images. The final Assessment of Motion artifact in Brain CT Images in Pediatric Patients is more in volumetric than axial CT.

5.3 Recommendation:

The use of positioning aids is sufficient to prevent voluntary movement in most patients. However, in some cases (eg, pediatric patients), it may be necessary to immobilize the patient by means of sedation.

Artifacts originate from a range of sources and can degrade the quality of a CT image to varying degrees. Design features incorporated into modern scanners minimize some types of artifact, and some can be partially corrected by the scanner software. However, there are many instances where careful patient positioning and the optimum selection of scan parameters are the most important factors in avoiding image artifacts.

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