بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Estimate Radiation dose during CT KUB

تقييم الجرعه الاشعاعيه للجهاز البولي للاشعه المقطعيه

A complementary Research Submitted for Partial Fulfillment of MSc Degree in Medical Physics

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الآيه

بسم الله الرحمن الرحيم

قال تعالى :

(وقل اعملو فسيري الله عملكم ورسوله والمؤمنون)

صدق الله العظيم

(سوره التوبه :105)

Dedication

To my parents

To my brothers and sisters

To my teacher

To my friends

To all the teacher who help me

To the person who give a life my wife

Acknowledgment

My full to allah in every thing

My deep thanks you my supervisor Dr. Hussain Ahmed Hassan for his great offer and patience.

I offer my regards and blessings to all of those in the center for help me and radiologist , technologist , and staff in all this centers.

Great thanks and appreciation to my friends whom that help me (Mousab Elzam and Osama), I give them my great thanks

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Abbreviation

MSv	Millisievert
ICRP	International Commission of Radiation Protection
CT	Computed Tomography
KUP	Kidney ,ureter and blader
E	Energy of photon
h	Plank constant
f	Frequency
λ	Wavelength
Gy	Gray unit of absorbed dose
J-S	Joule -Second
ev	Electron Volt
ALARA	As Low As Reasonable Achievable
R	Roentgen
ECG	Electrocardiogram
mGy	Milligray
KERMA	Kinetic Energy Release in Medium
K	Kerma
dEtr	Differentiation of Energy

dm	Differentiation of Mass
SI	System international
Sv	Sievert unit of equivalent dose ,effective dose
CAT	Computed Axial Tomography
SSP	Slice Sensitivity Profile
CTDI	CT Dose Index
CTDIvol	CT Dose Index Volume
CTDIw	CT Dose Index Weight
DLP	Dose Length Product
mAs	Mass
Kvp	kilo Voltage Peak
SRP	Society for Pediatric Radiology
DAS	Data A question System
AC	Alternating System
DC	Direct Current
CC	Conversion Coefficient
ILPI	International Law and Policy Institute

Abstract

The aim of this study compare ED with ED ICRP recommend (8 mSv). The first step preparation of patient such us drink much water or tea. The purpose of this procedure give to urine secretion and full bladder. Full bladder importance give to clear photograph and diagnosis easy. The patient must be lying down on CT table with use KUB protocol photography .

The objective is estimate radiation dose for CT scan by the 50 patients under until CT KUB with the Dual slices GE .

The patients received acceptable dose less than international effective dose (ICRB) .

The objective of this study to estimate radiation dose in CT KUB procedure .

This study included 50 patients (25 male, 25 female) all under went CT-KUB in Modern Medical Center .

The effective dose was calculated by equation following :

ED = correction factor * DLP

The main result showed by this study 4.35 mSv+_ 2 mSv

المستخلص :

الهدف من الدراسه هي مقارنه الجرعه الاشعاعيه مع الجرعه الاشعاعيه الموصي تشخيص يكون اسهل ,يلغي المريض علي طاوله CT وفقا لبروتوكول التصويربها في (الهيئه الدوليه للوقايه الاشعاعيه ICRP)(8mSv) قبل اعطاء الجرعه يحضر المريض وذلك بشرب كميه كبيره من الماء او الشاي , الهدف من التحضير هو امتلاء المثانه لان امتلائها يعطي صوره واضحه وكذلك الي ل KUB .

قدرت الجرعه الاشعاعيه ل (50) مريضا (الذكور25 والاناث 25) بواسطه جهاز CT Dual Slice GE .

اخيرا لا يوجد خطر علي المريض كما اوصي التقني بالاعتماد علي برنامج معالجه الصور في ايضاح الصوره بدلا من زياده Parameters .

Chapter one

1.1. Introduction

The quantity most relevant for estimating the dose of abdomen & pelvis(CT KUB)detriment from a CT procedure is the "effective dose. The unit of measurement for effective dose is mille-severs (abbreviated mSv). Effective dose allows for comparison of the dose estimates associated with partial or whole-body radiation exposures. It also incorporates the different radiation sensitivities of the various organs in the body.

Radiation dose from CT procedures varies from patient to patient. The particular radiation dose will depend on the size of the body part examined, the type of procedure, and the type of CT equipment and its operation. Typical values cited for radiation dose should be considered as estimates that cannot be precisely associated with any individual patient, examination, or type of CT system. The actual dose from a procedure could be two or three times larger or smaller than the assess. Facilities performing "screening" procedures may adjust the radiation dose used to levels less (by factors such as 1/2 to 1/5 for so called "low dose CT scans") than those typically used for diagnostic CT procedures. However, no comprehensive data is available to permit estimation of the extent of this practice and reducing the dose can have an adverse impact on the image quality produced. Such reduced image quality may be acceptable in certain imaging applications.

Estimates of the effective dose from a diagnostic CT procedure can vary by a factor of 10 or more depending on the type of CT procedure, patient size and the CT system and its operating technique .(Silver Spring,2016)

Computed tomography of Kidneys, Ureters, Bladder (CT KUB) is a quick non-invasive technique for diagnosis of urolithiasis. It is usually considered the initial imaging modality for suspected urolithiasis in an emergency setting.(Dr Yuranga Weerakkody,2016)

1.2. Problem of the study

Currently these is high frequency use CT scan to study unity truck to detect renal stone or other pathology ,but it give high radiation dose to the patient and special the venereal area, so it impart to estimate radiation dose received by patient .

1.3. Objectives of the study

1.3.1. General objective

To estimate radiation dose of CT scanner on K.U.B

1.3.2. Specific objectives

- To calculate Effective dose
- To calculate the kVp values
- To calculate the mAs values
- To compare dose radiation between young patients and old patients at the same parameters

1.4.Area of study

Modern Medical Center

1.5. Research overview

-Chapter One :Introduction
-Chapter Two :Literature review
-Chapter Three :Method and Material
-Chapter Four :Result
-Chapter Five :Discussion, Conclusion, Recommendations

Chapter Two
Literature review

Literature review

2.1. Unirary system

The urinary system, also known as the renal system, consists of the kidneys ,ureters , bladder , and the urethra. Each kidney consists of millions of functional units called nephrons. The purpose of the renal system is to eliminate wastes from the body, regulate blood volume and blood pressure, control levels of electrolytes and metabolites, and regulate blood pH. The kidneys have extensive blood supply via the renal arteries which leave the kidneys via the renal vein. Following filtration of blood and further processing, wastes (in the form of urine) exit the kidney via the ureters, tubes made of smooth muscle fibers that propel urine towards the urinary bladder, where it is stored and subsequently expelled from the body by urination (voiding). The female and male urinary system are very similar, differing only in the length of the urethra.

Urine is formed in the kidneys through a filtration of blood . The urine is then passed through the ureters to the bladder, where it is stored. During urination, the urine is passed from the bladder through the urethra to the outside of the body.

800–2,000 milliliters (mL) of urine are normally produced every day in a healthy human. This amount varies according to fluid intake and kidney function.

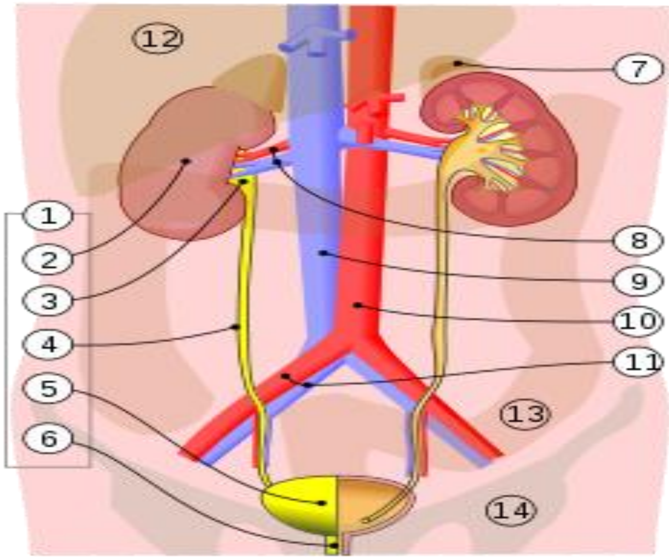

Figure (2-1): Picture of human unary system

1. Human urinary system

2. Kidney

3.Renal pelvis

4. Ureter

5. Urinary bladder

6. Urethra (Left side with frontal section)

7. Adrenal gland Vessels

8. Renal artery and vein

9.Inferior vena cava

10. Abdominal aorta

11. Common iliac artery and vein With transparency

12. Liver

13. Large intestine

14. Pelvis (wikipedia ,2016).

2.2. Photon

A photon is the quantum of electromagnetic radiation. The term quantum is the smallest elemental unit of a quantity, or the smallest discrete amount of something. Thus, one quantum of electromagnetic energy is called a photon. The plural of quantum is quanta.

The concept of photons and quanta comes from quantum mechanics and quantum theory. Quantum mechanics is a mathematical model that describes the behavior of particles on an atomic and subatomic scale. It demonstrates that matter and energy are quantized, or come in small discrete bundles, on the smallest scales imaginable. A photon propagates at the speed of light.

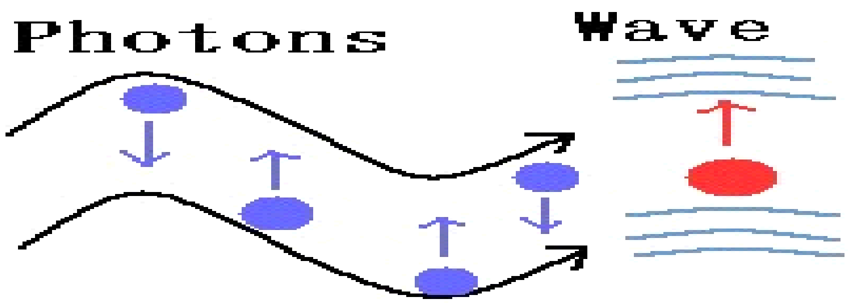

Figure (2-2): Illustration of wave-particle duality

A photon describes the particle properties of an electromagnetic wave instead of the overall wave itself. In other words, we can picture an electromagnetic wave as being made up of individual particles called photons. Both representations are correct and reciprocal views of electromagnetic waves. For example, light exhibits wave properties under conditions of refraction or interference. Particle properties are exhibited under conditions of emission or absorption of light.(study.com,2016)

2.3.Energy

The idea of quantum mechanics and photons originated from scientists' observations of the photoelectric effect. The photoelectric effect is where light striking a metal surface causes electrons to be ejected from the metal. Scientists were unable to explain this phenomenon, but eventually the explanation came from quantum theory.

What they found was that the energy in each quantum of light depends on the frequency of the light. In particular, the energy of a photon equals Planck's constant times the frequency of the radiation. Mathematically, this is given by the equation $E = hf$. Planck's constant is the fundamental constant of quantum theory that determines the scale of the small-scale world. Planck's constant = 6.63 * 10-34 joule-second (J-s). The total energy in an electromagnetic wave is the sum of the energies of each photon in the wave.

The energy of a photon is so small that we usually measure it in electron volts (eV). One eV is the potential energy of each electron in a 1-volt battery. One eV is equal to 1.6 * 10-19 joules (J). Therefore, we need to convert Planck's constant to appropriate units, which are electron volts/hertz (eV/Hz). In eV/Hz, Planck's constant is 4.136 * 1015 eV/Hz.(study.com,2016)

2.4. Exposure

Exposure: is the term used to describe the ability of x-rays to ionize a volume of air It is measured in roentgens (R).(Quizlet Inc,2016)

2.5. ALARA

Is an acronym for the phrase As Low As Reasonably Achievable. It is most often used in reference to chemical or radiation exposure levels.(ILPI,2016)

2.6. Radiation Quantity

2.6.1.Absorbed dose:

describes the amount of x-ray energy absorbed in a unit of mass.(Quizlet Inc,2016)

In terms of the older system of radiation quantities and units previously used,(1 Gy equals 100 rad, or 1mGy equals 0.1 rad).(Silver Spring,2016)

2.6.1.1. KERMA

KERMA is an acronym for "Kinetic Energy Released per unit Mass" . KERMA may also be used to describe absorbed dose. Air KERMA describes the amount of radiation absorbed in a quantity of air.It is defined by the quotient $K = dE_{tr}/dm$.

The SI unit of KERMA is the gray (Gy) (or joule per kilogram), the same as the unit of Absorbed dose.(Quizlet Inc,2016) , (Wikipedia, 2016)

2.6.2. Equivalent dose:

The biological effects of an absorbed dose of a given magnitude are dependent on the type of radiation delivering the energy (i.e., whether the radiation is from x rays, gamma rays, electrons (beta rays), alpha particles, neutrons, or other particulate radiation) and the amount of radiation absorbed. This variation in effect is due to the differences in the manner in which the different types of radiation interact with tissue.

The variation in the magnitude of the biological effects due to different types of radiation is described by the "radiation weighting factor" for the specific radiation type. The radiation weighting factor is a dimensionless constant, the value of which depends on the type of radiation. Thus the absorbed dose (in Gy) averaged over an entire organ and multiplied by a dimensionless factor, the radiation weighting factor, gives the equivalent dose. The unit for the quantity equivalent dose is the sievert (Sv). Thus, the relation is equivalent dose (in Sv) = absorbed dose (in Gy) x radiation weighting factor In the older system of units, equivalent dose was described by the unit rem and 1 Sv equals 100 rem or 1 mSv equals 0.1 rem.

For x rays of the energy encountered in CT, the radiation weighting factor is equal to 1.0. Thus, for CT, the absorbed dose in a tissue , in Gy , is equal to the equivalent dose in Sv.(Silver Spring,2016)

2.6.3. Effective dose

Effective dose accounts for the type of tissue that the radiation is deposited in. Different tissues are assigned weighting factors based on their individual radiosensitivity. Effective dose approximates the relative risk from exposure to ionizing radiation. It is measured in sieverts (Sv).(Quizlet Inc,2016).

Table [2-1]: radiation dose comparisons

Diagnostic Procedure	**Typical Effective Dose (1 mSv)**
Chest x-ray (PA film)	0.02
Lumbar spine	1.5
I.V. urogram	3
Upper G.I. exam	6
Barium enema	8
CT head	2
CT chest	7
CT abdomen	8
calcification CT	3
angiogram	16

2.7. Computed Tomography (CT)

Although based on the variable absorption of x rays by different tissues, computed tomography (CT) imaging, also known as "CAT scanning" (Computerized Axial Tomography), provides a different form of imaging known as cross-sectional imaging. The origin of the word "tomography" is from the Greek word "tomos" meaning "slice" or "section" and "graphe" meaning "drawing." A CT imaging system produces cross-sectional images or "slices" of anatomy, like the slices in a loaf of bread. The cross-sectional images (Figure 2) are used for a variety of diagnostic and therapeutic purposes.(Silver Spring, 2016)

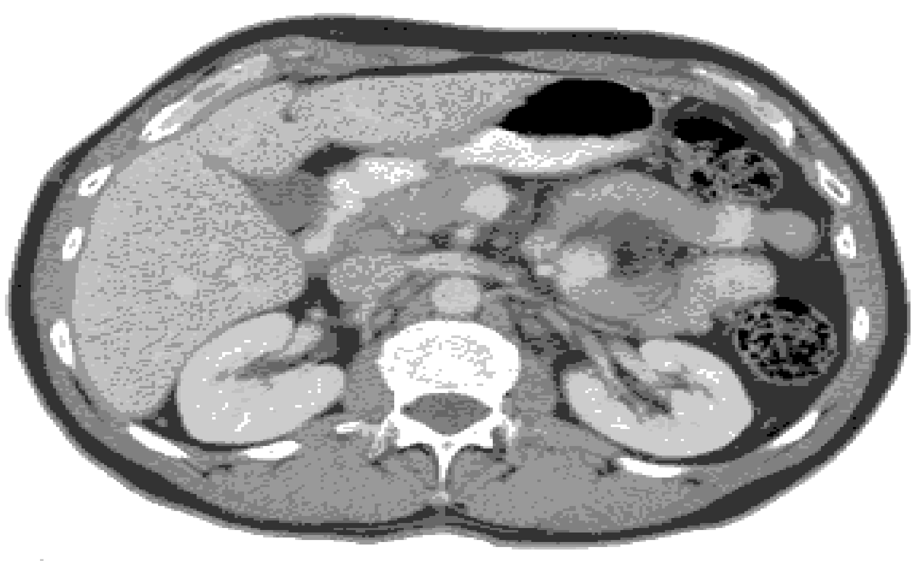

Figure (2-3): The cross-sectional images

2.7.1 .Quantities specific to CT:

2.7.1.1.Slice sensitivity profile (SSP):

used to describe the reconstructed CT section.

The section of tissue exposed to ionizing radiation, or dose profile, is greater in width than the SSP.(Quizlet Inc,2016)

2.7.1.2. Dose profile:

The accurate calculation of CT patient radiation dose must take this fact into account.(Quizlet Inc,2016)

2.7.1.3. The CT dose index (CTDI):

Is an approximate measure of the dose received in a single CT section or slice. CTDI is calculated for the central slice in a series that is surrounded by seven slices on each side.

CTDI is measured by performing: Is a fixed measurement taken with a 100-mm-long pencil ionization chamber and makes no reference to a specific number of slices. CTDI (100).

CTDIw is an internationally accepted, weighted dose index. It is calculated by summing two-thirds of the exposure recorded at the periphery of the field with one-third of the centrally recorded dose. This weighting yields a more accurate dose approximation .CTDI(vol) is used to approximate the radiation dose for each section obtained during a helical scan. CTDI(vol) Axially acquired CTDI(w) divided by the helical pitch As the pitch increases, the dose per section (CTDIvol) decreases. As the pitch increases...

CTDIw approximates dose along the x- and y-axes of the acquired CT image. CTDIvol also includes the dose along the z-axis of the scan acquisition; it is given in units of milligrays (mGy). CTDI(vol) also includes the dose along..

CTDIvol is similar in principle to an older term used for conventional step-and-shoot scanning, multiple scan average dose (MSAD).(Quizlet Inc,2016)

2.7.1.4. MSAD [Multiple Scan Average Dose]:

Is a calculation of the average cumulative dose to each slice within the center of a scan consisting of multiple slices. (Quizlet Inc,2016)

2.7.1.5. Dose length product (DLP) :

Is an internationally accepted measure of CT patient dose.(Quizlet Inc,2016)

*Note

Optimized on the basis of the individual patient's size and/or weight. Regardless of age, the CT protocol should be:

mA, kVp, and pitch Patient size-based protocols should be developed for each specific CT system to include adjustments in:

The Image Gently campaign was developed by the Alliance for Radiation Safety in Pediatric Imaging and sponsored by the Society for Pediatric Radiology (SPR). The widely recognized campaign offers guidelines to help reduce pediatric radiation exposure from CT imaging.

a- mA and kVp should be "child-sized."

b- One single-acquisition phase is often enough.

c- Only the indicated area should be scanned.(Quizlet Inc,2016)

2.7.2.Helical CT :

Helical ("spiral") CT image acquisition was a major advance on the earlier stepwise ("stop and shoot") method.

With helical CT, the patient is moved through a rotating x-ray beam and detector set. From the perspective of the patient, the x-ray beam from the CT traces a helical path. The helical path results in a three-dimensional data set, which can then be reconstructed into sequential images for a stack.

Helical CT allows a scan to be performed in a single breath-hold.

Most modern CT protocols use helical acquisition due to its speed and because it reduces misregistration from patient movement or breaoministered during helical acquisition depends on the speed of the patient through the scanner, also known as the pitch.(Dr Matt A,2016)

2.7.3.Main components of a CT scanner :

2.7.3.1. Gantry

The gantry is the 'donut' shaped part of the CT scanner that houses the components necessary to produce and detect x-rays to create a CT image. The x-ray tube and detectors are positioned opposite each other and rotate around the gantry aperture. Continuous rotation in one direction without cable wrap around is possible due to the use of slip rings.

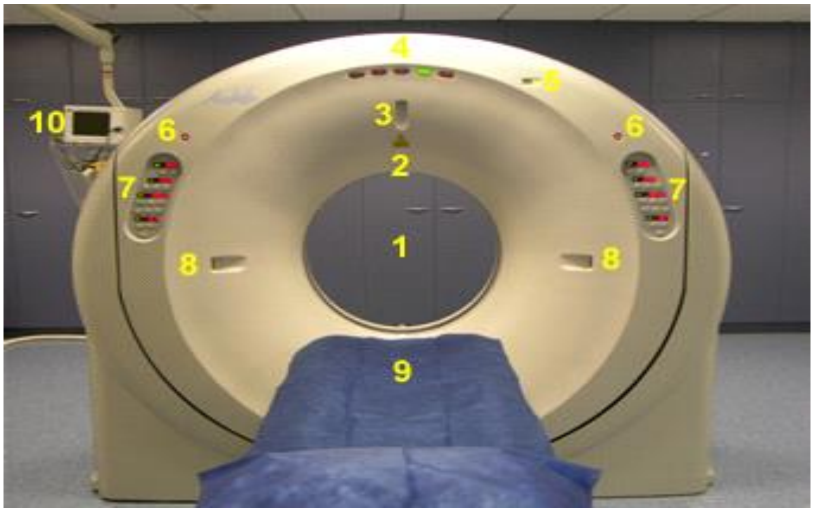

Figure (2-4): CT Gantry External View

1.gantry aperture (720mm diameter)
2.microphone
3.sagittal laser alignment light
4.patient guide lights
5.x-ray exposure indicator light
6.emergency stop buttons
7.gantry control panels

8.external laser alignment lights
9.patient couch
10.ECG gating monitor

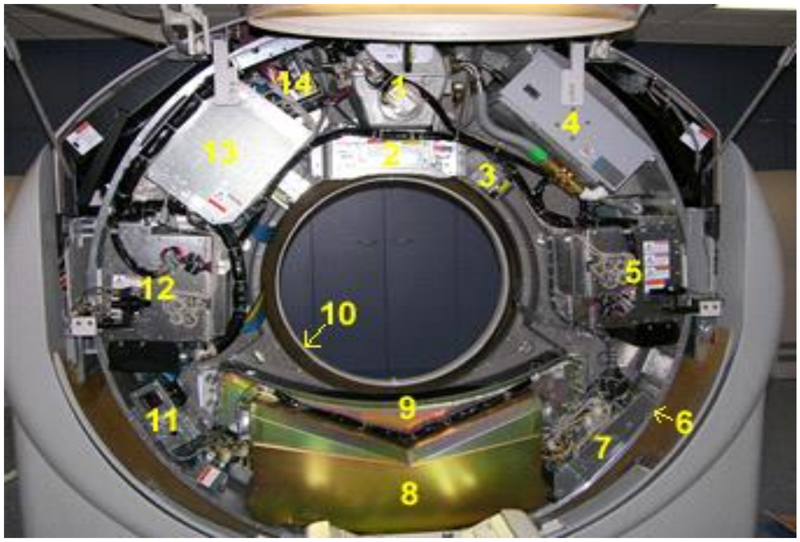

Figure (2-5): CT Gantry Internal View

1.x-ray tube
2.filters, collimator, and reference detector
3.internal projector
4.x-ray tube heat exchanger (oil cooler)
5.high voltage generator (0-75kV)
6.direct drive gantry motor
7.rotation control unit
8.data acquisition system (DAS)
9.detectors
10.slip rings
11.detector temperature controller
12.high voltage generator (75-150kV)
13.power unit (AC to DC)
14.line noise filter

Figure (2-6): CT Gantry Control Panel

1.gantry tilt (+/-30 degrees)

2.laser alignment lights on/off

3.couch in/out

4.free (manual) couch movement

5.zero couch position

6.couch up/down

7.home button (couch out & down).(wikiRadiography,2016)

2.7.3.2. Data Acquisition for Computed Tomography (CT):

Tomography originates from Greek, with the meaning 'recording slices'. The process has been developed in answer to the emerging interest in learning the inner structure of objects and beings. Simple X-ray radiography only delivers integrated information on layers of materials along a line, but the change of absorption in two or three dimensions can not be determined. The essence of CT is that from the results of projections taken at different angles, the image of the inner structure of an object can be (re-)constructed, namely the distribution of the absorption coefficient 8. The more detailed image we would like to obtain the more angles we need to take. A common X-ray system can be used for imaging layers envisaged by the physicist Gusztáv Grossmann. The idea is that during the imaging both the source and the film cassette are moved in the opposite direction simultaneously and the image will only be sharp in a single layer. With the parameters of moving the X-ray tube and the film the position of the layer can be selected.(Medical Imaging, 2016)

2.8. Effective dose calculation :

The most common method of estimating the effective dose when machine-based parameters from a CT scan are available involves multiplying the dose-length-product (DLP), a product of the volume computed tomography dose index (CTDIvol) and the scanning length, by a conversion coefficient. The DLP is available by referencing the dose report generated by most commercial scanners at the end of the CT scanning procedure. Conversion coefficients have been derived using Monte Carlo simulations and experimental measurements.

Commercial CT scanners provide an estimate of the DLP in the dose report generated at the end of a scanning procedure. The DLP is derived from the CTDIvol which is measured using a 32-cm diameter acrylic cylinder and a 100-mm long pencil shaped ionization chamber. The chamber provides the dosimetry measurements at the center of the cylinder (c) and on the periphery (p) of the cylinder from which the weighted CTDI (CTDIw) is calculated using

CTDIw=23CTDIp+13CTDIc......(1)

CTDIvol is calculated by considering both the CTDIw and the pitch of the machine given by

CTDIvol=CTDIwpitch...............(2)

where pitch is the table increment travelled per complete rotation of the x-ray tube. DLP is the product of the CTDIvol and the scan length.

DLP = CTDIvol×scan length......(3)

Effective dose, the primary outcome measure of our study, can be calculated from the CT machine-based parameters and is the product of the DLP (mGy cm) and specific conversion coefficients (CC) (mSv mGy-1 cm-1), using

E=DLP×CC.................................(4)(Robert D Prins,2016)

2.9.Digital Image Processing :

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.(wikipedia ,2016)

2-.10. Previous studies :

In this study by Khalid Alzimami 2014, calculated effective dose of CT scanner on abdomen at Nielein Medical Diagnostic Centre on Sudan by used helical scanner Dual Slice, this study performed on study group about (30 patient) Khalid found that effective dose is (1.8 mSv).

In other study by Elsevier Masson SAS All rights reserved 2013, calculated effective dose of CT scanner on abdomen at Science Direct on France , this study performed on study group about (21 patient)

Elsevier Masson found that effective dose is (6.8 mSv).

In other study by Sonia Isabe 2012, calculated effective dose of CT scanner on abdomen at Radiologia Brasileira on Portugal , this study performed on study group about (59 patient).

Sonia found that effective dose is (13.25 mSv).

In other study by Julian EM Thomson....etc 1997, calculated effective dose of CT scanner on abdomen at Australian Radiation Laboratory on Australia , this study performed on study group about (78 patient)

Julian found that effective dose is (6.6 mSv).

Chapter Three
Material & Method

3.1.Material :

3.1.1. Study group (population):

This study performed to study group about (50 cause) for assess radiation dose on KUB The range of ages distribution for this cases about more than [60 year] and less than [19 year]

3.1.2.Machine used :

[CT/e Dual] GE (General Electric) installed 2004. The slice thickness option [1,2,3,4,5,6,7,8,9,10 mm]. The range of Kv between [20—140 kv] and range of mAs between [20—200 mAs]

3.2. Method :

3.2.1. Technique :

The technique useful in this study called (CT KUB abdomen)with think slice 3mm with number of slice 8 mm.

3.2.2. Dose assessment :

To assessment radiation dose of CT scan on KUB must be calculate effective dose (ED). This effective dose can be calculate by two ways by DLP or by CTDIvol. In this study l used DLP to calculate ED. ED evaluate with DLP multiple by correction factor.

A conversion factor originally known as unity bracket method, is a mathematical tool for converting between units of measurement. It is sometimes referred to as a unit multiplier, and consists of a fraction in which the denominator is equal to the numerator.

A conversion factor is used to change the units of a measured quantity without changing its value. Because of the identity property of multiplication, the value of a number will not change as long as it is multiplied by one. The correction factor of KUB is 0.015 mSv/ (mGy·cm)

Lastly I calculate mean or average effective dose by low of mean [total amount of ED for cases over number of cases]

Chapter four
Results

Results

Table [4-1]: show age distribution in frequency and percentage for two sex.

Percentage	Frequency	Age
6%	3	Less than 20
52%	26	20 to 40
24%	12	41 to 60
18%	9	More than 60
100%	50	Total

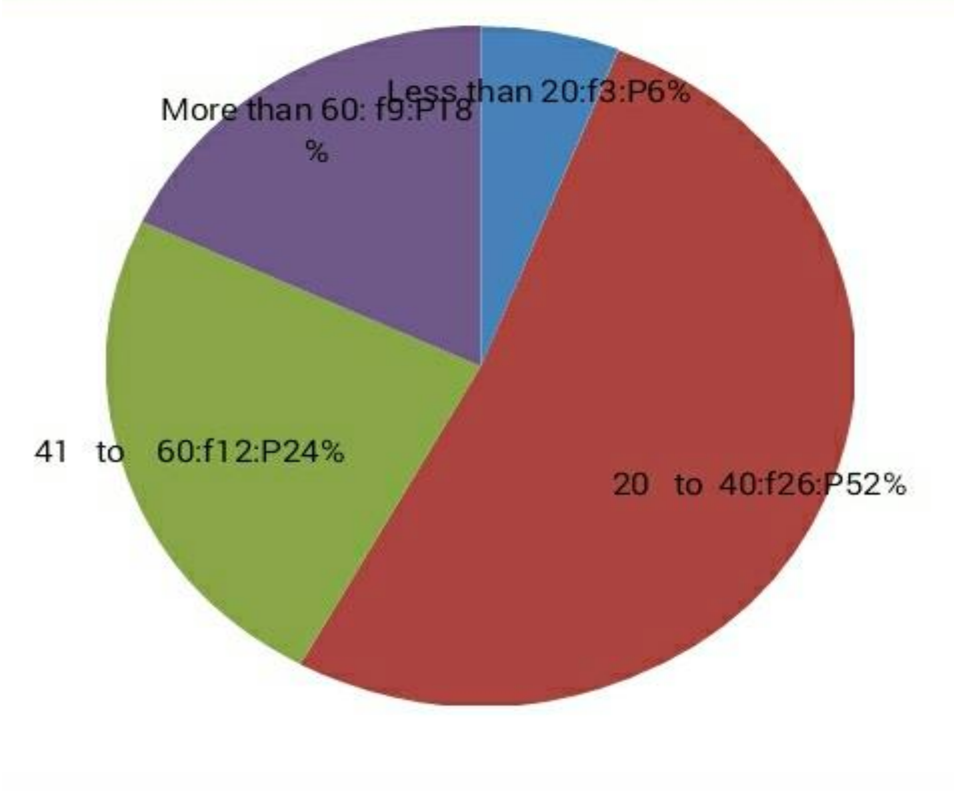

Figure (4-1): show age distribution in frequency and percentage for two sex.

Table [4-2]: show sex distribution in frequency and percentage for two sex.

Percentage	Frequency	Sex
50%	25	Male
50%	25	Female
100%	50	total

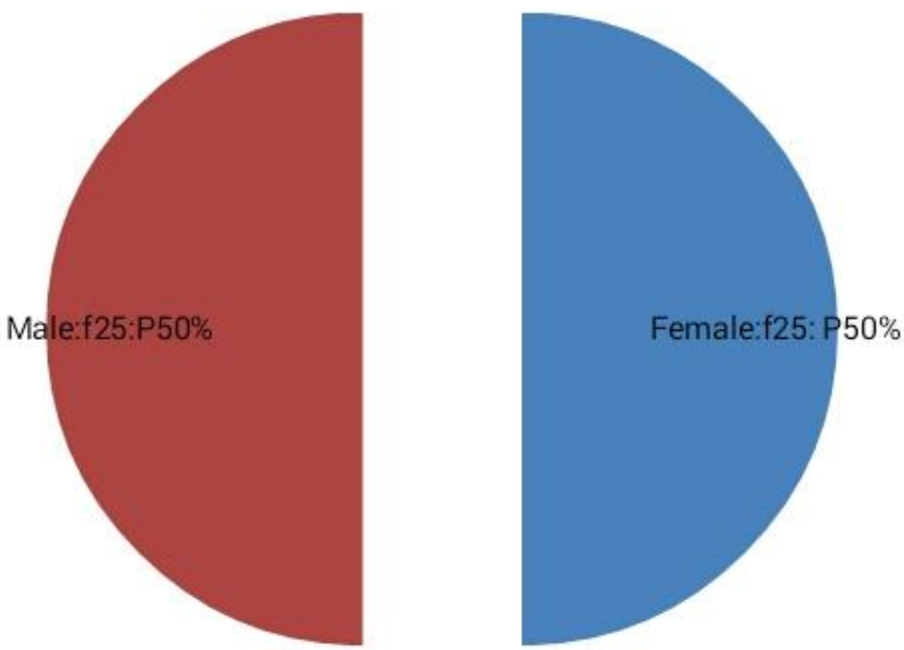

Figure (4-2): show sex distribution in frequency and percentage for two sex.

Table [4-3]: show average DLP at the same parameters and different parameters for all cases in percentage.

Percentage	Average DLP	No.of cases	Parameter
46 %	287.722	23	Same parameters
54%	293.321	27	Different parameters
100%	581.043	50	total

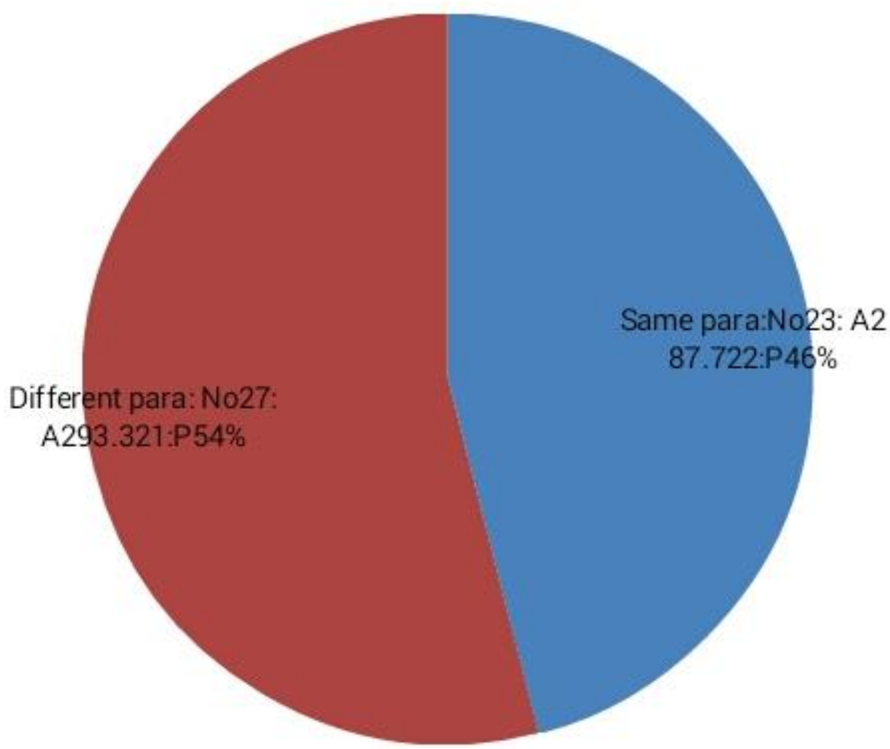

Figure (4-3): shows average DLP at the same parameters and different parameters for all cases in percentage.

Table [4-4]: show average ED at the same parameters and different parameters for all cases in percentage.

Percentage	Average ED[mSv]	No.of cases	Parameter
45 %	4.286956522	23	Same parameters
55%	4.388888889	27	Different parameters
100%	4.34	50	total

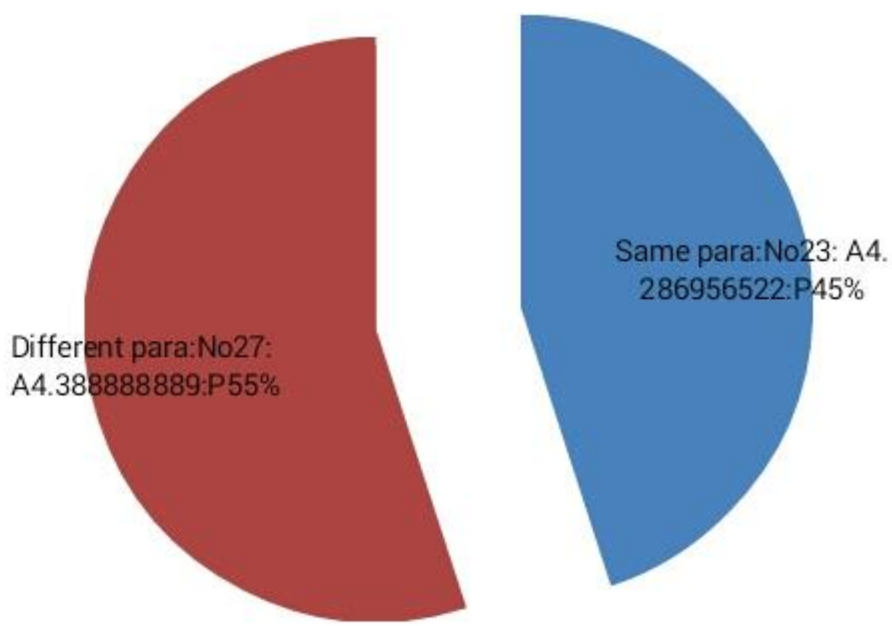

Figure (4-4): show average ED at the same parameters and different parameters for all cases in percentage.

Table [4-]: show comparison between average DLP for 7cases scan by (130mAs) and average DLP for 7cases scan by (100mAs) in percentage.

Percentage	Average DLP[mGy]	Parameter
53%	306.25	130mAs ,120kVp
47 %	271.58	100mAs ,120kVp

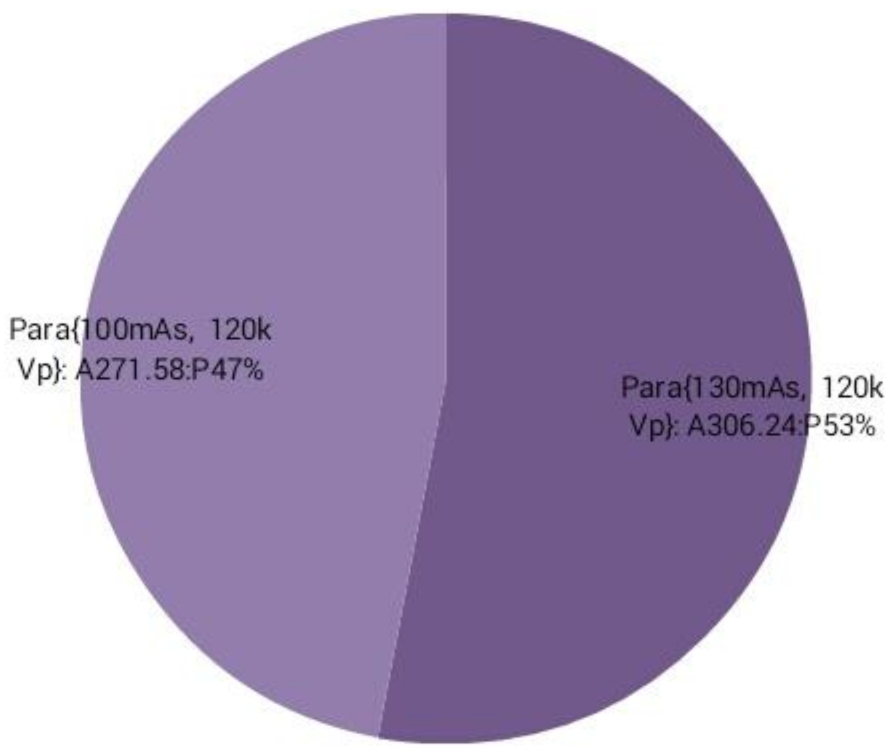

Figure (4-5): show comparison between average DLP for 7cases scan by (130mAs) and average DLP for 7cases scan by (100mAs) in percentage.

Table [4-6]: show comparison between average ED of 7cases scan by (130mAs) and average ED of 7cases scan by (100mAs) in percentage.

Percentage	Average ED[mSv]	Parameter
53%	4.64	130mAs ,120kVp
47 %	4.06	100mAs ,120kVp

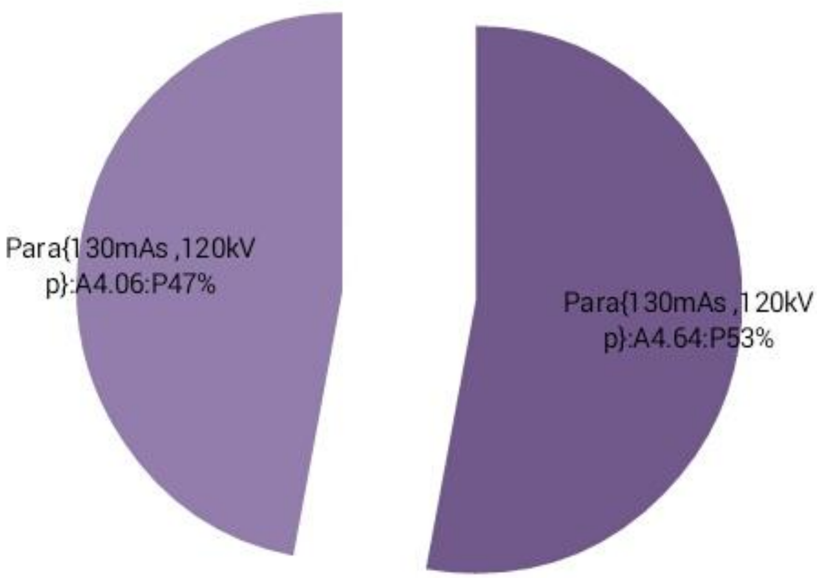

Figure (4-6): show comparison between average ED of 7cases scan by (130mAs) and average ED of 7cases scan by (100mAs) in percentage.

Table [4-7]: show calculate the average DLP with average ED of old patients (over 39 years) and the average DLP with average ED of youth patients (15 to 35 years) at the same parameters in percentage.

Percentage	Average ED[mSv]	Average DLP[mGy]	Patient
51 %	4.305	288.82	old
49 %	4.115	288.71	Youth

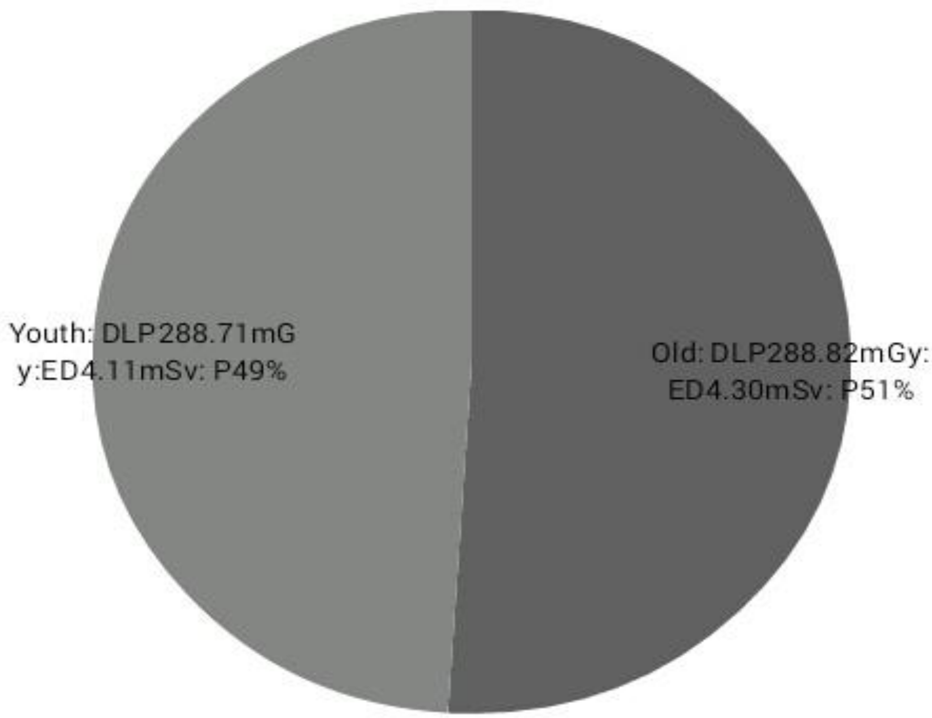

Figure (4-7): show calculate the average DLP with average ED of old patients (over 39 years) and the average DLP with average ED of youth patients (15 to 35 years) at the same parameters in percentage.

Chapter five

Discussion, Conclusion and Recommendation

5-1 Discussion

This study showed that the effective dose was 4.34 mSv for CT-KUB compared to international effective dose it was less (8 mSv), while in other study by Khalid is large (1.8 mSv) because the old scan (single slice) but by the others person is low because that use modern scan .

Also the study showed that reduction in mAs and also reduce the dose . The main parameter that control to radiation dose is mAs , for that to reduce over dose of CT machine must be reduce mAs according to ALARA principle (As Low As Reasonable Achievable). Also to reduce effective dose must be reduce mAs because ED have proportional relation with DLP and mAs. table [4—6] ,figure (4-6) >table [4—7] ,figure (4-7) .

Then the old patients more sensitive to radiation than youth patients because young tissues have more resistant than old tissues. table [4—7] ,figure (4-7) .

5-2 Conclusion

CT-KUB in Modern Medical Center has less effective dose compared to International Commission on Radiological protection (ICRP).

- Reduction in mAs reduce the effective dose.

5-3 Recommendation

-The typical range of kVp must be not less and increase than 120 kVp.

-The typical mAs must be less than 130 mAs.

-The technologist depended more to image processing not increase the parameters

-The technologist also use radiation protection facilities for decrease to CT radiation risks.

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Appendix (A):

Data collection sheet(Male):

No	Sex	Age	Kvp	mAs	CTDI	DLP	ED
1	M	65	120	130	7.63	309.13	4.6
2	M	18	120	100	7.63	295.39	4.4
3	M	35	120	80	5.95	225.05	3.4
4	M	28	120	120	9.16	337.98	5
5	M	75	120	100	7.02	265.44	3.9
6	M	44	120	80	6.11	269.29	4
7	M	70	120	100	7.63	316	4.7
8	M	23	120	120	6.64	265.99	4
9	M	33	120	100	7.63	343.48	5.1
10	M	23	120	115	6.03	233.36	3.5
11	M	50	120	110	6	234.30	3.5
12	M	23	120	130	8.55	315.45	4.7
13	M	31	120	100	7.40	273.20	4.1
14	M	33	120	130	6.62	285.78	4.3
15	M	28	120	130	6.46	374.81	5.6
16	M	32	120	130	8.85	326.72	4.9
17	M	33	120	130	8.50	315.50	4.7
18	M	53	120	100	7.63	342.50	5.1
19	M	30	120	145	7.79	294.29	4.4
20	M	31	120	100	7.62	316.40	4.7
21	M	35	120	130	7.17	245.38	3.7
22	M	37	120	90	7.63	324.40	4.9
23	M	54	120	100	6.50	234.50	3.5
24	M	36	120	100	7.63	343.40	5.1
25	M	20	120	80	6.11	335.70	5

Appendix (B):

Data collection sheet(Female):

No	Sex	Age	Kvp	mAs	CTDI	DLP	ED
1	F	70	120	100	7.63	261.05	3.9
2	F	18	120	100	7.50	265.05	4
3	F	55	120	130	6.62	250.05	3.8
4	F	50	120	100	7.56	272.04	4
5	F	22	120	100	7.63	3.16	4.7
6	F	15	120	115	5.65	213.51	3.2
7	F	60	120	115	7.50	345.40	5.2
8	F	45	120	100	7.63	288.52	4.3
9	F	48	120	100	5.19	233.61	3.5
10	F	20	120	100	7.63	273.20	4.1
11	F	60	120	80	7.50	336.60	5
12	F	60	120	80	7	336.50	5
13	F	70	120	100	7.63	309.13	4.6
14	F	30	120	80	6.95	208.60	4.6
15	F	22	120	80	7.42	273.20	4.1
16	F	31	120	60	8.50	285.30	4.3
17	F	20	120	100	7.63	302.26	4.5
18	F	23	120	100	7.63	267.91	4
19	F	55	120	100	7.63	295.39	4.4
20	F	45	120	100	7.63	316	4.7
21	F	27	120	80	6.11	307.60	4.6
22	F	41	120	80	6.11	274.78	4.1
23	F	55	120	100	7.62	280	4.2
24	F	60	120	130	8.90	295	4.4
25	F	34	120	100	4.93	307.14	3.1