Sudan University for Sciences and Technology
College of Graduate's Studies

Optimization of Skull X - Ray Exposure Factors

أمثلة عوآمل تعريض اشعة الجمجمة

A thesis submitted for partial fulfillment of M.Sc. Degree in diagnostic medical radiology

By:

Hind Babiker Abdualrhman Babiker

Supervisor:

Dr. Mohammed Elfadil Mohamed

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قال تعالى :

(اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ
(4) عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ (5) صدق الله العظيم

سورة العلق

Dedication

To my parents

Sisters and brother

My husband

My children

My grandmother Amna

My friends

Acknowledgment

I thank God for enabling me to complete this thesis.

I sincerely thank Dr. Mohammed Elfadil; the Supervisor of my thesis for his continues help supervision and guidance.

I greatly thank all those who Supported and helped me to complete this thesis.

Especially thanks for my colleagues at AL Hasahissa Hospital.

List of figures

List of abbreviations:

KV	Kilo voltage.
mA	Mille Amber
S	Second
IR	Image receptor
EAM	External auditory meatus.
BMI	Body Mass Index.
IPL	inter papillary line
OML	Orbito Meatal Line
MSP	Mid Sagittal Plane

Abstract

The main objective of this study was to optimize exposure factors which can be used to acquire skull X-ray objectively. The data of this study collected from 50 patients examined by skull X-ray in East Nile Hospital, Modern Hospital in Khartoum – Sudan in the period from September 2014 to May 2015 using Digital Philips machine. The data were collected using five variables, they includes exposure factor (Kv and MAs) patient height, weight, body mass index. The result of this study showed that there is no difference between male and female in respect to exposure factor. The Kv associated with the patient length and weight directly where the Kv increases by 0.033 Kv /cm and 0.044 kv/Kg respectively while the mAs correlated directly with patient length which is increases by 0.0001 mAs/cm. in conclusion this result gives a dynamic exposure factor attributed to body characteristics.

ملخص البحث

يتمثل الهدف الرئيسي لهذه الدراسة في تحسين نظام أشعة الرأس وذلك بإستخدام عوامل التعرض وتضمنت الدراسة عدد (50) مريضاً أخذت لهم الصور في الفترة ما بين سبتمر 2014م وحتى مايو 2015م بمستشفى شرق النيل الحديث الخرطوم السودان بإستخدام جهاز فيليب الرقمى . يتم جمع البيانات من المرضى متضمنة 5 متغيرات هي عوامل التعرض (KV + MAS) جدولت وزن المريض ، العمر ، الطول ، كتلة الجسم ، أظهرت نتيجة هذه الدراسة لا يوجد هناك فرق بين الرجال والنساء في الاستجابة لعوامل التعرض .ووجدت علاقة طردية بين الكيلو فولت وطول المريض ووزنه حيث ان الكيلو فولت يزيد بمعدل 0.033 كيلو فولت مع وحدة الطول وتزيد KV بــ 0.004 كيلوفولت مع وحدة الوزن، وتزيد ال mAs بـ 0.0001مل أمبير مع وحدة الطول.في خلاصة هذه النتيجة أعطت عوامل التعرض الديناميكي المنسوب لخصائص الجسم .

Chapter One
Introduction

A skull x-ray is a series of pictures of the bone of the skull x-ray is form of radiation ,a skull x-ray may help find head injuries ,bone fractures or abnormal growth or changes is bones, structure or size .

The skull is very complex structure composed of more than 20 different bones .although radiological survey of skull to demonstrate all anatomical feature is impractical as routine procedure as it would require too many different projections .in radiograph of skull should be illustrate so many important anatomical feature .and certain abnormalities may only be shown in radiograph.

1-1 -1Anterior cranial fossa:

The anterior fossa lodges the frontal lobes of the cerebral hemispheres it's bounded anteriorly by the inner surface of the frontal bone and in the midline is acrest for the attachment of the falx cerebri its posterior boundary is the sharp lesser wing of the sphenoid. Which articulates laterally with the frontal bone and meets the antarioinferior angle of partial bone .the medial end of the sphenoid form the anterior clinoid process on each side? Which give attachment to the tentorium cerbelli the medial part of the anterior cranial fossa is limited postriorly by the groove for the optic chiasma.the floor of the fossa of the is formed by the ridged orbital plates of the frontal bone laterally and by the cribrifrom plate of the ethmoid medially. The cirsta galli is sharp up ward projection of the ethemoidal bone in the midline for the attachment of the falx cerebri.

Between the crista galli and crest of the bone is small aperture. The foramen cecum, for the transimission of small vien from the nasal mucosa to the superior sagittal sinus. Alongside the crista galli is narrow slit in cribriform plate for the passge of the anterior ethimoidal nerve into nasal cavity .the upper surface of cribriform plate supports the olfactory bulbs, and the small perforations is the cribriform are for the olfactory nerve.

1-1-2 Middle cranial fossa:

The middle cranial fossa consists of small medial part and expanded latral parts. The medien raised part is formed by the body of sphenoid and sxpanded latral parts form cavities on either side. Which lodge the temporal lobes of the cerebral hemispheres the sphenoid bone resembles abat having acentrlly placed body with greater and lesser wings. The sphenoid bone contains sphenoid sinuses and optic canal and superior orbital fissure and foramen rotundum, fraomen ovale and foramen spinosun, foramen lacerum, carotid canal.

1-1-3 Posterior cranial fossa:

The posterior cranial fossa is deep and lodges the part of the hindbrain, pons and medulla oblongata. Antriorly the fossa bounded by the superior border of the petrous part of the temporal bone. And postriorly it is bounded by the internal surface of the squamous part of the occipital bone. The floor of the posterior fossa is formed by basilar. Condylar and squamous part of the occipital bone and the mastoid part of the temporal bone, the foramen magnam occupies the centaral area of the floor and transmits the medulla oblongata and it is surrounding meninges, the ascending spinal parts of accessory nerve and two vertebral arteries and jugular formen.

12 Problem of the study

Skull x-ray were obtained using exposure factor chart occasionally and usually selected arbitrary according to the experience of the technologist, this situation mostly lead to unsatisfactory skull x-ray where the important details were missed; therefore if we select the exposure factor according to body characteristics; optimum exposure factors can be selected with an appropriate skull x-ray.

1-3 Objectives

The general objective was to evaluate the skull x-ray skull x-ray exposure factor to have optimized factors.

1-4 spacific objective:-

To find age, weight, height, gender , BMI, mAs, and KV

To find the significant differences between male and female in exposure factors selection

To correlate between the body characteristics and exposure factors

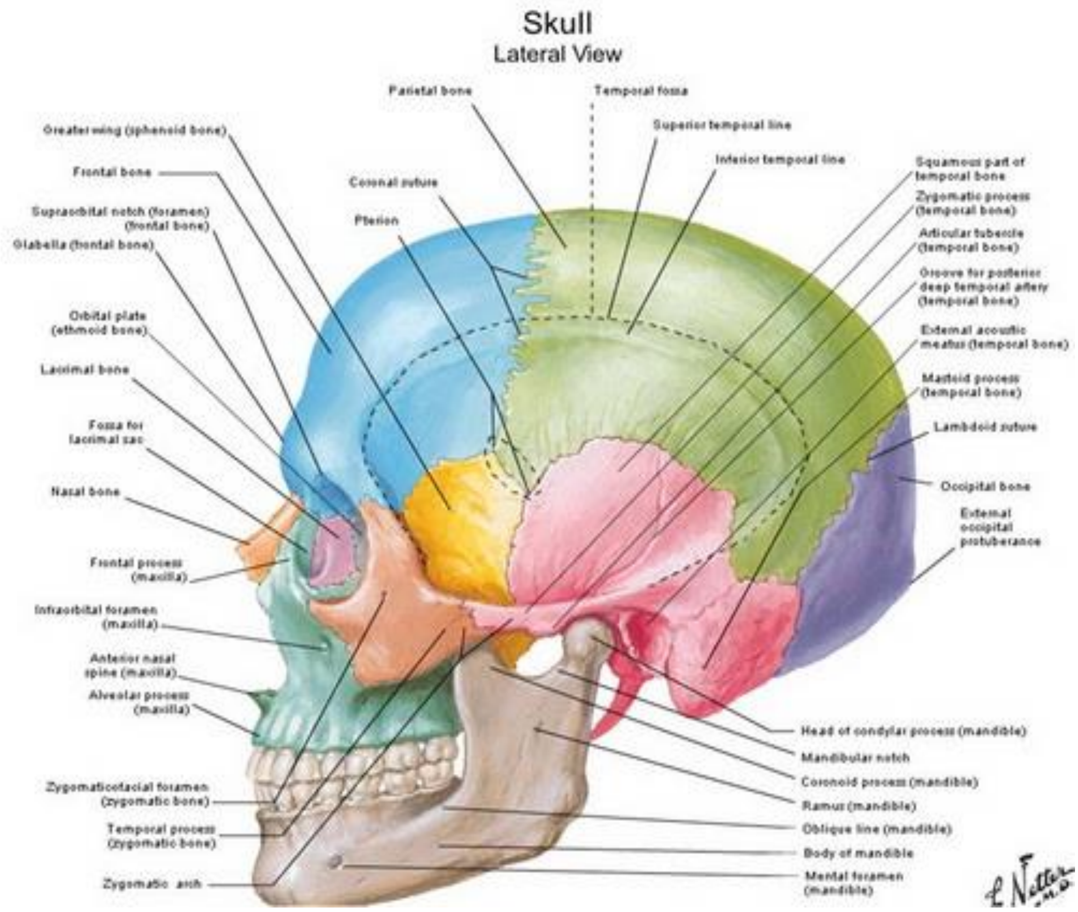
To estimate and optimized exposure factor using body characteristics

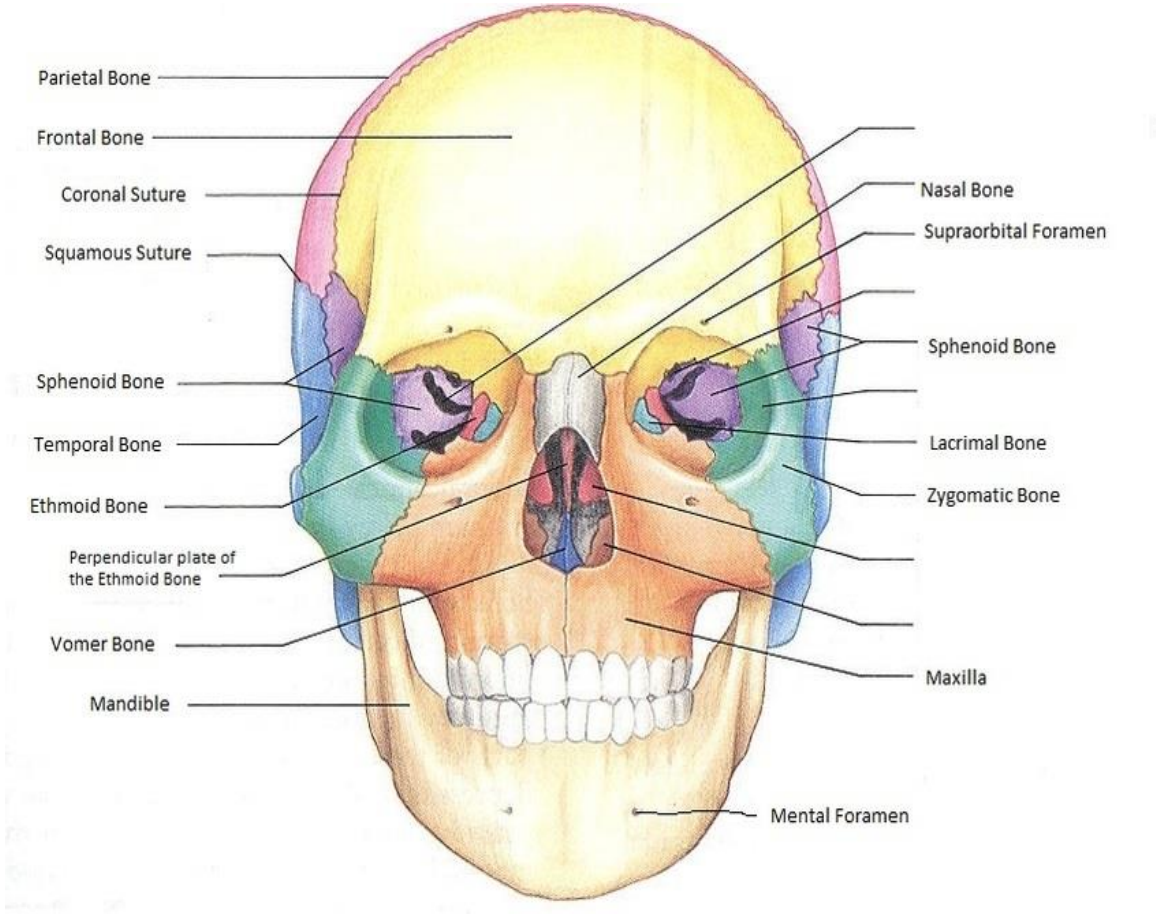
Chapter two
Background and literature review

2-1 Anatomy of Skull

The skull is supported on the summit of the vertebral column, and is of an oval shape, wider behind than in front. It is composed of a series of flattened or irregular bones which, with one exception (the mandible), are immovably jointed together. It is divisible into two parts: (1) the cranium**,** which lodges and protects the brain, consists of eight bones, and (2) the skeleton of the face**,** of fourteen, as follows:

Skull, 22 bones *Cranium,* 8 bones Occipital. Two Parietals, Frontal, Two Temporals, Sphenoidal, Ethmoidal. *Face*, 14 bones Two Nasals. Two Maxillæ, Two Lacrimals, Two Zygomatics, Two Palatines. Two Inferior Nasal Conchae, Vomer, Mandible.





In the Basle nomenclature, certain bones developed in association with the nasal capsule. The inferior nasal conchæ, the lacrimals, the nasals, and the vomer, are grouped as cranial and not as facial bones. The hyoid bone, situated at the root of the tongue and attached to the base of the skull by ligaments, is described in this section.

2-2 Cranial Bones

2-2-1 Occipital Bone

The occipital bone, situated at the back and lower part of the cranium, is trapezoid in shape and curved on itself. It is pierced by a large oval aperture, the foramen magnum, through which the cranial cavity communicates with the vertebral canal. The curved, expanded plate behind the foramen magnum is named the squama; the thick, somewhat quadrilateral piece in front of the foramen is called the basilar part, whilst on either side of the foramen is the lateral portion.

2-2-2 Parietal Bone

The parietal bones form, by their union, the sides and roof of the cranium each bone is irregularly quadrilateral in form, and has two surfaces, four borders, and four angles.

2-2-3 Frontal Bone

The frontal bone resembles a cockle-shell in form, and consists of two portions—a vertical portion, the squama**,** corresponding with the region of the forehead; and an orbital or horizontal portion, which enters into the formation of the roofs of the orbital and nasal cavities.

2-2-4. Temporal Bone

The temporal bones are situated at the sides and base of the skull. Each consists of five parts, the squama, the petrous, mastoid, and tympanic parts, and the styloid process.

2-2-5 Sphenoid Bone

The sphenoid bone is situated at the base of the skull in front of the temporals and basilar part of the occipital. It somewhat resembles a bat with its wings extended, and is divided into a median portion or body, two great and two small wings extending outward from the sides of the body, and two pterygoid processes which project from it below.

2-2-6. Ethmoid bone

The ethmoid bone is exceedingly light and spongy, and cubical in shape; it is situated at the anterior part of the base of the cranium, between the two orbits, at the roof of the nose, and contributes to each of these cavities. It consists of four parts: a horizontal or cribriform plate, forming part of the base of the cranium; a perpendicular plate, constituting part of the nasal septum; and two lateral masses or labyrinths

2-3 Facial Bones

2-3-1 Nasal Bones

The nasal bones are two small oblong bones, varying in size and form in different individuals; they are placed side by side at the middle and upper part of the face, and form, by their junction, "the bridge" of thenoseEach has two surfaces and four borders.

2-3-2. Maxillae (Upper Jaw)

The maxillæare the largest bones of the face, excepting the mandible, and form, by their union, the whole of the upper jaw. Each assists in forming the boundaries of three cavities, viz., the roof of the mouth, the floor and lateral wall of the nose and the floor of the orbit; it also enters into the formation of two fossæ, the infratemporal and pterygopalatine, and two fissures, the inferior orbital and pterygomaxillary. Each bone consists of a body and four processes-zygomatic, frontal, alveolar, and palatine

2-3-3 Lacrimal Bone

The lacrimal bone, the smallest and most fragile bone of the face, is situated at the front part of the medial wall of the orbit. It has two surfaces and four borders

2-3-4 Zygomatic Bone

The zygomatic bone is small and quadrangular, and is situated at the upper and lateral part of the face: it forms the prominence of the cheek, part of the lateral wall and floor of the orbit, and parts of the temporal and infratemporal fossae. It presents a malar and a temporal surface; four processes, the frontosphenoidal, orbital, maxillary, and temporal; and four borders

2-3-5 Palatine Bone

The palatine bone is situated at the back part of the nasal cavity between the maxilla and the pterygoid process of the sphenoid. It contributes to the walls of three cavities: the floor and lateral wall of the nasal cavity, the roof of the mouth, and the floor of the orbit; it enters into the formation of two fossæ, the pterygopalatineand pterygoidfossæ; and one fissure, the inferior orbital fissure. The palatine bone somewhat resembles the letter L, and consists of a horizontal and a vertical part and three outstanding processes, the pyramidal process, which is directed backward and lateralward from the junction of the two parts, and the orbital and sphenoidal processes, which surmount the vertical part, and are separated by a deep notch, the sphenopalatine notch.

2-3-6 Inferior Nasal Concha

The inferior nasal concha extends horizontally along the lateral wall of the nasal cavity and consists of a lamina of spongy bone, curled upon itself like a scroll. It has two surfaces, two borders, and two extremities.

2-3-7 The Vomer

The vomeris situated in the median plane, but its anterior portion is frequently bent to one or other side. It is thin, somewhat quadrilateral in shape, and forms the hinder and lower part of the nasal septum; it has two surfaces and four borders.

2-3-8 Mandible (Lower Jaw)

The mandible, the largest and strongest bone of the face, serves for the reception of the lower teeth. It consists of a curved, horizontal portion, the body, and two perpendicular portions, the rami, which unite with the ends of the body nearly at right angles. The cranial cavity contains the brain and its surrounding meninges, portions of cranial nerves, arteries, veins, and venous sinuses.

2-4 Vault of the skull:

The internal surface of the vault shows the coronal, sagittal groove are several small pits (called granular pits) which lodge the latrallacunare and archnoid granulation –several narrow grooves are present for anterior and posterior division of middle meningeal vessel and they pass up the side of skull to the vault.

2-5 Base of the skull:

The anterior of the base of the skull is divided into three cranial fossae anterior and middle and posterior. The anterior cranial fossa is separated from the middle cranial fossa by the lesser wing of the sphenoid, and the middle cranial fossa is separated from the posterior cranial fossa by the petrous part of the temporal bone.

2-6 Anterior cranial fossa:

The anterior fossa lodges the frontal lobes of the cerebral hemispheres its bounded antriorly by the inner surface of the frontal bone and in the midline is acrest for the attachment of the falxcerebri its posterior boundry is the sharp lesser wing of the sphenoid. Which articulates laterally with the frontal bone and meets the antarioinferior angle of partial bone .the medial end of the sphenoid form the antriorclinoid process on each side. Which give attachment to the tentorium cerbelli the medial part of the anterior cranial fossa is limited postriorly by the groove for the optic chiasma.the floor of the fossa of the is formed by the ridged orbital plates of the frontal bone laterally and by the cribrifrom plate of the ethmoid medially. The cirstagalli is sharp upward projection of the ethemoidal bone in the midline for the attachment of the falxcerebri. Between the crista galli and crest of the bone is small aperture. The foramen cecum, for the transimission of small vien from the nasal mucosa to the superior sagittal sinus. Alongside the crista galli is narrow slit in cribriform plate for the passge of the anterior ethimoidal nerve into nasal cavity .the upper surface of cribriform plate supports the olfactory bulbs, and the small perforations is the cribriform are for the olfactory nerve.

2-7 Middle cranial fossa:

The middle cranial fossa consists of small medial part and expanded lateral parts. The median raised part is formed by the body of sphenoid and sxpandedlatral parts form cavities on either side. Which lodge the temporal lobes of the cerebral hemispheres the sphenoid bone resembles abat having acentrlly placed body with greater and lesser wings. The sphenoid bone contain sphenoid sinuses and optic canal and superior orbital fissure and foramen rotundum, fraomenovale and foramen spinosun, foramen lacerum, carotid canal.

2-8 Posterior cranial fossa:

The posterior cranial fossa is deep and lodges the part of the hindbrain, pons and medulla oblongata. Antriorly the fossa bounded by the superior border of the petrous part of the temporal bone, and posteriorly it is bounded by the internal surface of the squamous part of the occipital bone. The floor of the posterior fossa is formed by basilar. Condylar and squamous part of the occipital bone and the mastoid part of the temporal bone. The foramen magnam occupies the central area of the floor and transmits the medulla oblongata and it is surrounding meninges, the ascending spinal parts of accessory nerve and two vertebral arteries, and jugular foramen.

2-9 Physiology:

The skull has various functions including: cranium protects houses. The brain has respiratory passages, skull contain a nasal chambers where sense of smell is perceived, it contains and supports the eyes, and mandible and maxilla for lower and upper jaw, hyoid apparatus supported throat and tongue.

2-10 Pathology:

Head injures dangerous they lead to permenant disability, mental impairment, and even death. To most people, head injuries are considered an acceptable risk when engaging in sport and other types of recreational activities injuries to the scalp, skull or brain caused by trauma.

2-11 Abnormal of skull:

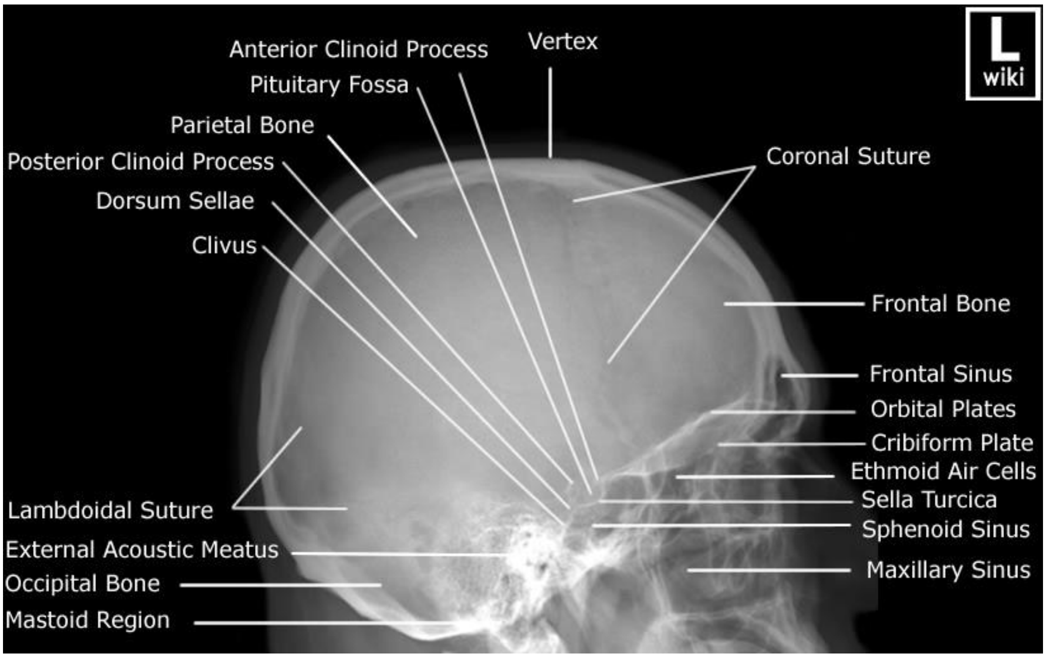
2-11-1 Congenital lesions:

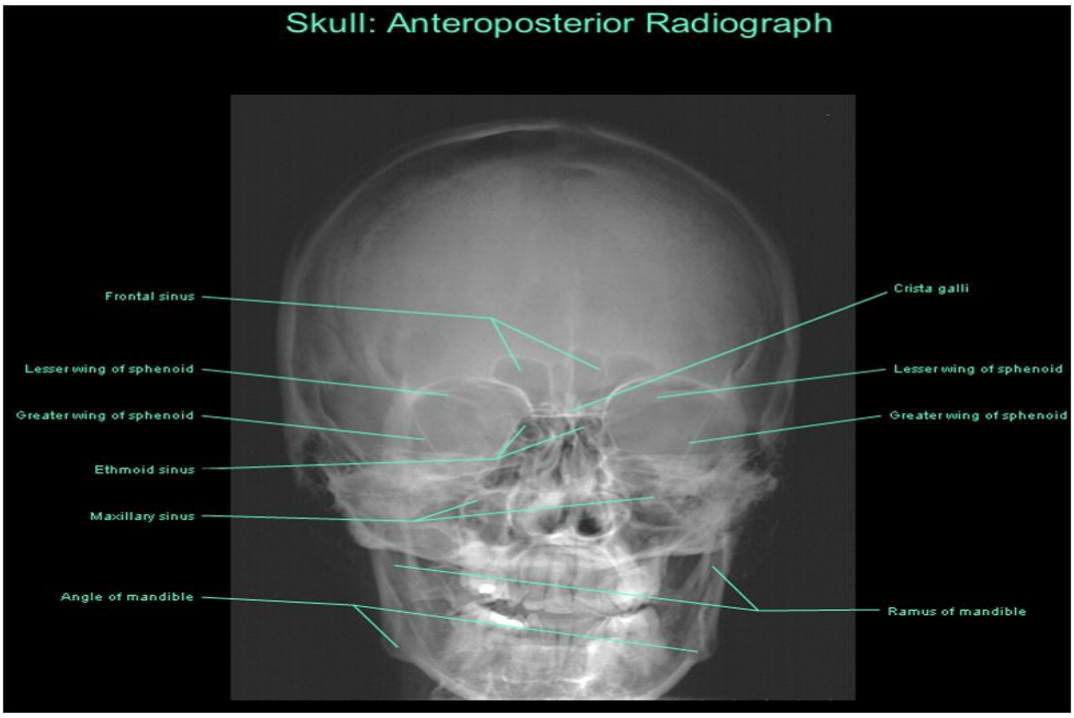
Skulls which appear abnormal in shape are convertionally described using Greaktermonology. Thus a skull which appears abnormally long in relation to their transver Diameter is refers to as dolichocephlic. While those which are broad in relation to their length are termed brathrocephaly. In some patient step like deformity is seen at back of the skull where the occipital bone overlaps the parietals at the lambdoid suture. This is termed bathrocephaly and should not be mistaken for traumatic lesion.

- Craniosynostosis: most abnormality of skull shape are due to premature fusion of skull suture involved, these are more clearly and elegantly demonstrated by CT with 3D reconstruction.
- Scaphocephaly (boat – shaped skull).
- Trigonocephaly (triangular shape of skull).
- Plagiocephaly (obligue or slanting skull) due to unilateral premature fusion of the lambdoid and coronal suture.
- Microcephaly due to premature fusion and small brain and the subject is mentally defective.
- Lacunar skull: this condition is characterized by groups of round, oval, or finger shaped pits on in inner surface of the infant skull vault.
- Cranial meningocle and encephalocelethses are commonest in the occipital and frontal regions.
- Platyblasia: this is term used to flatting of base of skull.
- Basilar impression: this indicates an elevation of the floor of the posterior fossa which occurs as a congenital anomaly.
- Congenital partial foramina and sinus pericranil and hypertelorism.

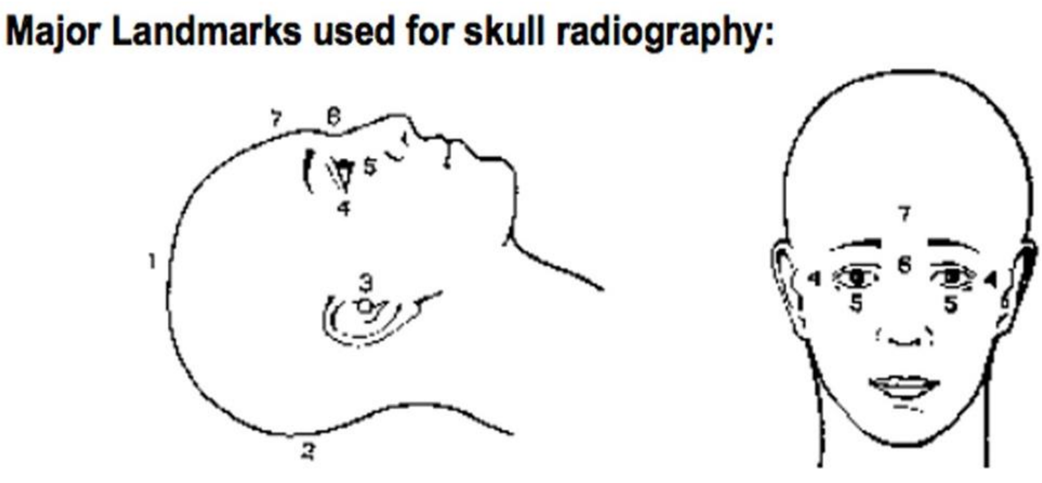
- Erosion of dorsmsellae is the cranial sign of raised intra cranial pressure in Adult and suture diatasis is not seen.
- Intra cranial calcification, skull Erosion Hyperostosis, Abnormal vascular markings pineal displacement. Vascular lesions, chronic subdural hematoma.
- Tumours: calcification occurs in many cerebral tumours and calcification is visible on skull film.
- Truma of skull: cephalhematoma this due to birth injury, and the infant present in soft tissue.
- Fractures: fractures of the skull vault have been classified as linear and depressed.

2-11-2 Skull radiography





Major Land Marks used for Skull radio graph:



1. verte

2. External occipital protuberance (E.o.p)

3. external Auditory Meatus

4. Outer canthus of eye

5. infra – orbital point

6. Nation

Major body planes used in skull radiography

1. Median sagittal plane

Vertical plane diving The skull into 2

Symmetrical right and left hives when

Viewed Form The antrioraspect.

2. Anthropological plane

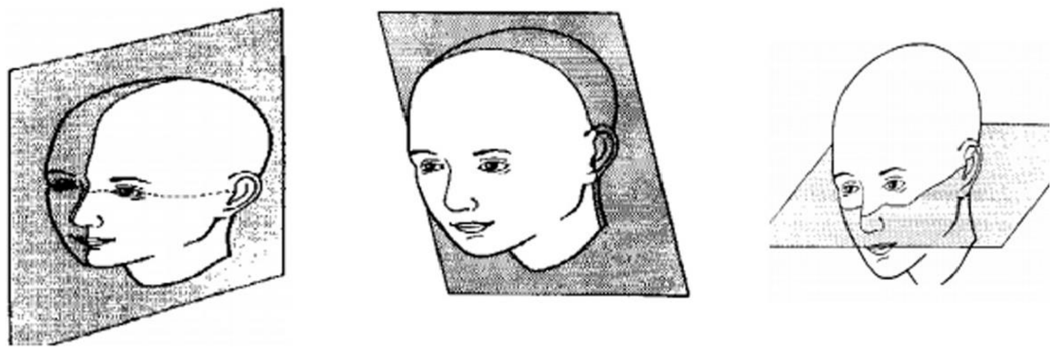
This plane splits The anthropological base Line.

2. Auricular Line

This plane divides The skull into anterior.

And posterior Compartments along the Auricular lines.

Major body planes used in Skull radiography



Median Sagittal *Auricular* *Anthropological*

Major Base Lines used in Radiography

1. Anthropological Line

   The Isometric (Base Line) which run form The inferior orbital margin to The upper border of external auditory meatus (E.A.M) .

   2. orbital .Meatal Line

   The original base Line " which run Form The nasion Though The outer canthus of The eyes to The center of the external auditory Meatus.

   3. Inter Pupillary Line .

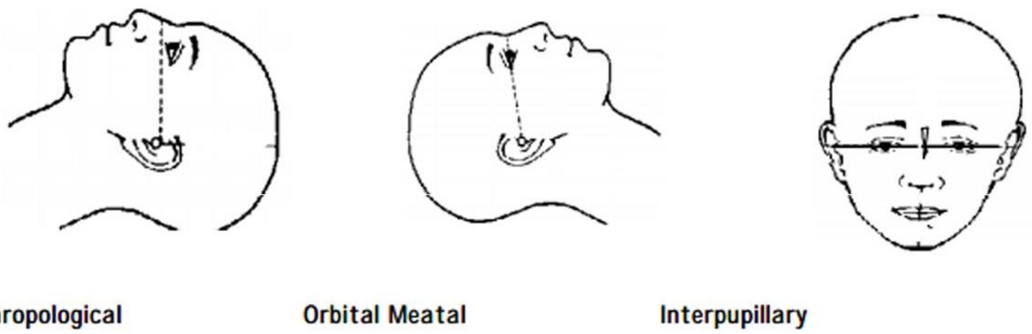
   The Line connects The canter of The orbits and is at 90 degree to The median sagittal Plane.

3. Auricular line.

   This Line passes at 90 degree to anthropological auditory meatus.

   Note:- There is difference of (10 to 15) degrees between The orbital . Meatal Line and the anthropological Line.

Major Baselines used in Skull Radiography



Accurate Location of These Line , Planes and Points is essential to ensure accurate and reproducible positioning necessary for high quality imaging of the skull and facial bone

Radio graphic technique :-

1. patient position of lateral : seated upright or semi prone , side of interest closest to IR , MSP Parallel to IR, 10 ML Perpendicular to front edge of IR and parallel to Long axis of IR , 1pL Perpendicular to IR.

2. PA Position:-

Place The patient in either a prone or Seated position. Center The mid sagittal plane of the patient's
Body to The midline of the grid .rest The patient's fore head and nose on table or organist The Upright Bucky . flex The patient elbows , place The arms in comfortable position , and adjust the shoulders to Line in The same horizontal plane. The part position Adjust the flexion the patient's neck to that the (O.M.L) is perpendicular to the plane of – Cassette – center ray is perpendicular to exit the nasion

Exposure factors :

Potential difference (KV) Kilo – voltage is the potential difference between filament and anode the energy of the X – ray beam were controlled , by voltage adjustment the higher the voltage setting , the more energetic will be the bean of x- ray .more penetrating beam will result in a lower contrast radiograph than one made with an x –ray beam having less penetrating power . it is probably obvious that the more energetic the beam , the less effect at different Level of tissue density will occur in attenuating the x- ray beam by min = 1.24/KVp.

2. Tube current (MA):

The second control for output of x – ray tube is called the MA Mill amber control .this control determines how much current is allowed to flow through the filament which is the cathode of the tube

3. Exposure time (s):-

The third control of the X – ray tube which is used for medical imaging is the exposure time . This is usually denoted as (s) (exposure time in second) and is combined with MA control. to com bine function is usually referred to as (Mas)

(MA *s = Mas)

Currant * second

Previous Studies

The limit of dose reduction in practice is the minimum's product which guarantees an adequate image quality in clinical routine. In the case of the female head, a reduction from 7 mAs for speed class 200 screen-film to 3 mAs fior DLR can be achieved. That is, the surface entrance dose can be reduced from 0.46 tp 0.20 mGy without loss of diagnostic information. A corresponding potential dose reduction of 57%. Good agreement with the potential dose reduction of 52% obtained with the Alderson head phantom shows the utility of the Alderson head phantom for investigations of radiation exposure and its reduction in the field of diagnostic radiography.

Seifert et al . (1995) Studied a dose reduction using digital Luminescence radiography for skull radiography. For skull radiography the minimum required radiation exposure to ensure adequate image quality was determined for digital luminescence radiography (DLR) in comparison with a screen film system (speed class 200) . Radiographs were produced with a grid technique on conventional x – ray equipment . A real prepared . Areal humen head including a true fracture above the pars pertussis temporalis was imaged. . The tube current – time product (mAs) , and thus the surface entrance dose was varied systematically . Surface entrance dose was measured with TLD – 100 ends. Image quality was judged by experienced radiologists according to the criteria : visual resolution , mean optical density , contrast and perceptibility of specific bon resolution , mean optical density , contrast and perceptivity of specific bon structures. Surface entrance dos was reduced from 0.46 to 0.20 m Gy by application of DLR instead of speed class 200 screen – film systems without loss of diagnostic information in clinical routine. The corresponds to a dose reduction potential of 57% showing a good agreement with the dose reduction potential of 52% obtained in a previous study using the Alderson head phantom.

Tier et al. (1996) Radiography of dried skulls presents two major problems the lack of soft tissue which usually leads to overexposure, and difficulty in maintaining the cranium, with or without mandible, in correct position. The first problem can be alleviated by suspending a one liter drip bag containing Hartman's solution across the X-ray tube head and angled to give a fluid thickness of 10 cm. Satisfactory positioning of the skulls and relating the mandible to cranium was achieved by construction of a spinal column substitute and acrylic hooks and rubber bands. Exposure of 50 KV and 10 mA at 15 seconds for orthopantomographic views and 70 KV at1.5 seconds for lateral and 65 KV at 1.5 seconds for postero-anterior tissues exert a stong, modifying influence on the X-ray beam.

Adrian et al, (1996) compared lateral skull computerized radiographs with or without a grid in order to compare image quality of lateral skull radiographs using computerized radiography (CR) with or without the use of secondary radiation grids. 100 adult patients referred for lateral skull radiography from the accident and emergency department were randomized so 50 were examined using a secondary radiation grid and 50 without. Three consultant radiologists blinded to the randomization then individually reviewed the image quality depending on a set of pre-determined criteria. The result showed that there is no statistical difference in image quality between lateral skulls exposed with or without the use of a secondary radiation grid when applied to computerized radiography (method of test). Secondary ration grids can be removed for lateral skull radiography, using CR with no deterioration in image quality.

Mandall et al, (1999) investigation whether routine ‘during-treatment’ clinical cephalometric measurements could be obtained from a lateral skull radiograph collimated to show the maxilla and mandible. The sample consisted of 30 lateral skull radiographs, taking during treatment of patients with upper and lower fixed appliances. These conventional cephalograms (CC) were copied to give a radiograph with modified collimation (MC) showing the maxilla and mandible and the dentition only. Both types of radiographs were digitized and the readings compared to determine whether the same during treatment cephalometric values were obtained from both type of radiographs. The limits of agreement obtained, when comparing cephalometric values obtained from the CC and MC lateral skull radiographs, where only marginally larger than those for CC alone.. therefore, the use of an MC lateral skull radiograph to show the maxilla and mandible is a viable alternative for cephalometric measurements for patiens wearing two arch fixed appliances

Chapter Three
Materials and Methods

3-1 Material:

The materials used in this study were x-ray machine (KV and MAs) were directly found from the machine length admeasurements used to measure the patient height, weight as measurement used to measure weight. The study was carried out in Philips machine in East Nile Hospital, Modern hospital, Digital machine.

3-2 Design of the study

This is a cross-sectional study, of a descriptive type where data were collected to optimize the exposure factors.

3-3 Population of the study

Adult and children (6-90 years) normal who send to x-ray department for skull x-ray examination. If trauma or injury or pathological condition in routine postero-anterior projection and lateral projection.

3-4 Samples and type of the study

The data of this study collected 50 patients whom visited East Nile Hospital where the sample were chosen conveniently.

3-5 Study area and duration

This study conducted in East Nile hospitals, Sudan –Khartoum during the period from September 2014 to May 2015.

3-6 Method of Data collection:

The data were collected using a sheet for all patients in order to maintain consistency of information.

3-6-1 Imaging techniques:

In routine can do postero-anterior (PA) projection and lateral to this study for skull x-ray.

3-6-2 Patient preparation:

Replace all the material on the head and laying in the table and explain the procedure the patient before exam, in case PA patient prone .the frontal bone at table and the hand beside skull, in lateral projection must be the patient at true lateral. Distant must be 100 cm. and use the gird and cassette.

Methods and materials of perevious study

Compared with the Alderson head phantom used in study [1] the prepared female head was smaller with a thickness of 13 cm the direction of central axis versus 16 cm.

Before taking diagnostic radiographs of head as shown in finger 1a small facture above the parspetrosaossis templatliss was produced , Technique ofl skull radiograph the radiographs of the skull were obtained using a gird technique on conventional x – ray equipment with ceiling – mounted X-ray tube.

A screen – film system of speed class 200 and the technical parameters shown in Table I correspond to current German recommendations [2]. The head was fixed so that the median plane of the skull was parallel to the surface of the patient support assembly. The central axis of the radiation beam was positioned nearly 3 cm above and 1.5 cm in front of the exterior acoustic duct [3] . During all radiographs a line pair's object was exposed in the upper region of the calva.

The tube current – time product and thus the radiation dose were varied systematically. for values between 3.2 and 16 mAs radiographs were produced in each case by application of a screen – film system of speed class 200 (AGFA) CURIXMR200/AGEA CURIX RP 1000) and the (DL.R) in the region between 0.5 and 3.2 mAs only the (DL.R) was sensitive enough . the radiographs made with the screen – film system were developed in a radiographic film developer machine (AGFA CURIXCAPACITY) . the exposed storage foils (FUJI CR St – V) Were read in the laser scanner system of the DIGISAN Perceptibility of Specific bone structures was judged in the regions of basis crania and Viscerocranium as well as the calva region. For judgment of optical density , contrast and perceptibility of bone structures , a scale with 1 = " very good" , 3 = " adequate " 4 = " inadequate" , and 5 = " unsatisfactory" was applied. For judgment of diagnostic information the radiologists answered the question of repeatability. Of the fracture above the pars petrosassis temporalis and the erceptibility of metastasis the results of image quality assessment are summarized graphically.

3-6-4 Variables of data collection:-

The data of this study collected using the following variables: Age, Gender, Clinical history, Weight height, BMI front occipital mAs and KV

3-7 Analysis of data

The data was analyzed using computerized statistics for social software (spss),using excel software under windows ,using correlation to estimate the association between the exposure factors(kv and mAs) and the variables collecteted from the patients (hight ,weight,BMI).

Chapter Four
Results

The results of study presented in table and figures, the first table show the mean and standard deviation of the exposure factors and milli Amber per second, length, weight and body mass index.

Table 4-1 the mean and standard deviation of the variables used in the study

Variable	Mean
KV	67.5±1.3
Mas	0.1±0.001
Length	159.7±22.3
Weight	61.6±16.9
BMI	30.9±13.3

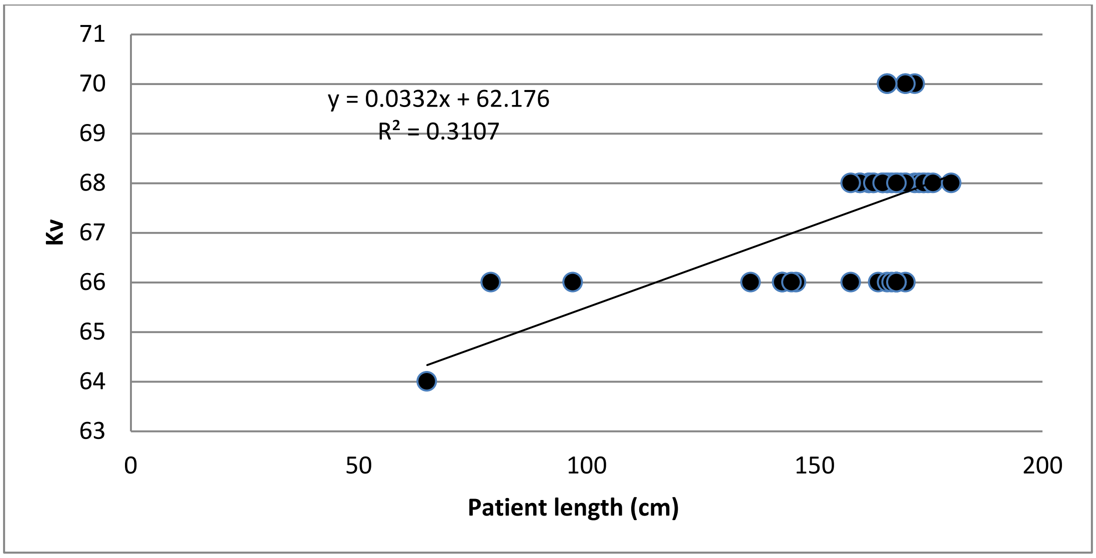


Figure 4-1 scatter plot show a direct linear relationship between kv and patient length, the Kv increases by 0.033 unit/cm of patient length

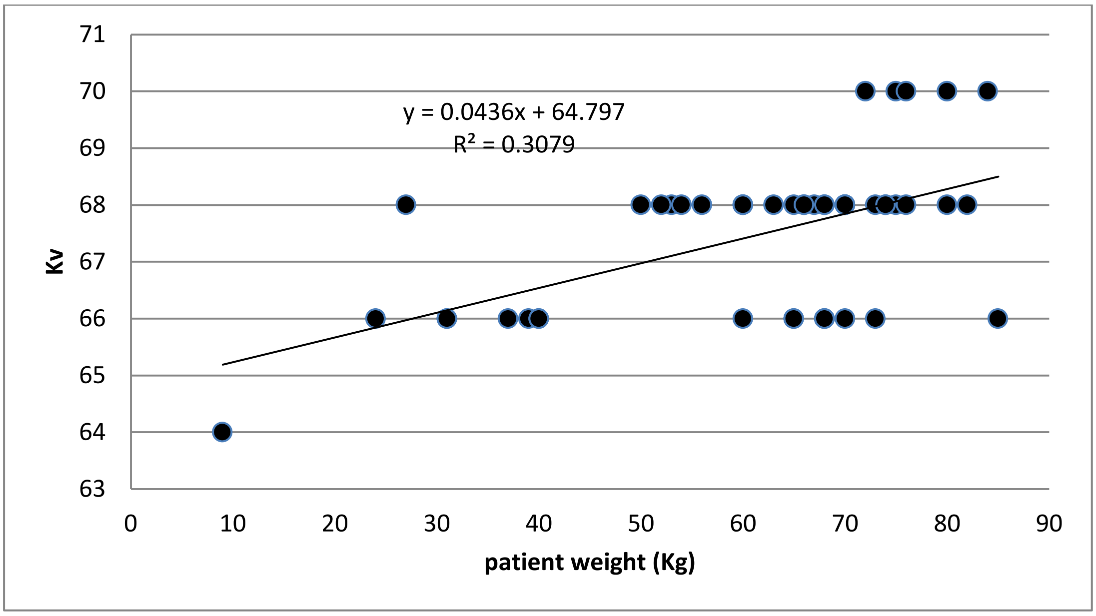


Figure 4-2 scatter plot show a direct linear relationship between kv and patient weight, the Kv increases by 0.044 unit/Kv of patient weight

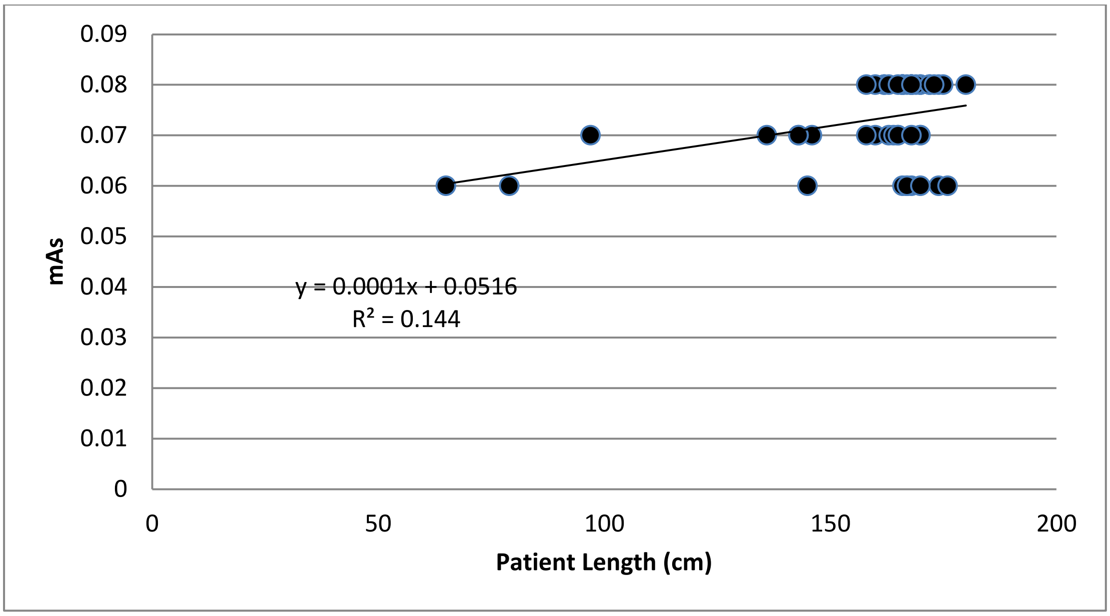


Figure 4-3 scatter plot show a direct linear relationship between mAs and patient length, the mAs increases by 0.0001 unit/cm of patient length

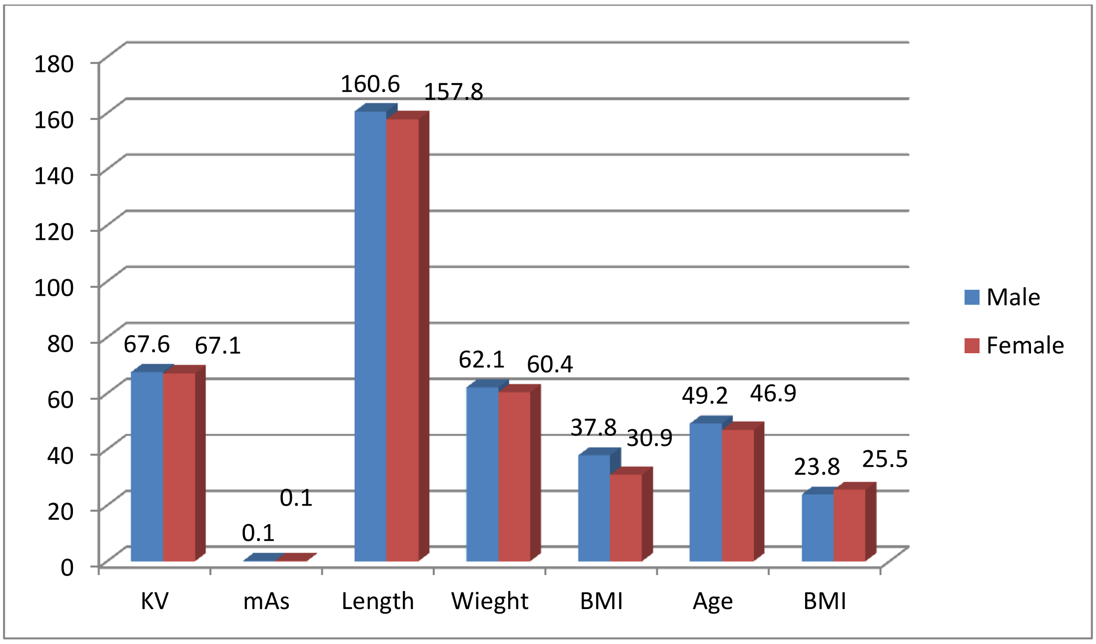


Figure 4-4 bar graph show the males and females variables

Chapter Five
Discussion, conclusion and recommendation

The main objective of this study was to determine the optimization factor of skull x-ray image and reducing the radiation which received the patients.

5-1 Discussion

The data of this study consisted of 50 patient underwent planner skull x-ray in order to optimize the exposure factors objectively. The mean value for exposure factors (Kv and mAs) and body characteristic (length, weight and body mass index) was 67.5±1.3 kv unit, 0.1±0.001 mAs unit, 159.7±22.3 m, 61.6±16.9 Kg and 30.9±13.3 kg/m^2 respectively (Table 4-1). This result indicates that the exposure factor consisted of minimal variation while the body characteristics in respect to variation measure it has a considerable variation, which means that the selection of exposure factor does not strictly depend on these factors as criteria of selection during the examination, but relationship were exist.

Concerning males and, females as shown in Figure 4-4 the difference between male and female concerning exposure factors in average were very minimal and it was inconclusive using *t*-test at $p = 0.05$; therefore both groups (male and female) will be considered as one group (one sample) , similar results were obtained for projection (AP and Lateral).

The Kv showed a significant correlation with the body weight and height using stepwise linear regression, while the other factor showed insignificant association with Kv. The Kv can be estimated using the height of the patient in cm and weight in Kg as follows: $Kv = (height \times 0.02) + (weight \times 0.026) - 62.7$. While each of these factors (height and weight) increases the Kv by 0.033 kv/cm and 0.044 kv/kg respectively. These results assured that the skull of the patient with increased weight should be increased and vice versa for the decreased weight using the mentioned coefficient. Similarly for the height also affects the Kv in a direct linear fashion (Figure 4-1 and 4-2).

The mAs showed a significant linear relationship with patient height only i.e. the others characteristics of patient showed inconclusive. The mAs increased by 0.0001 unit/cm of patient height stating at 0.05 (Figure 4-3) which is look as minimum amount since the average values was 0.1 mAs. Also this result tells us that the mAs can be increased objectively from 0.05 and further in respect to patient height using the mentioned coefficient.

In summary the results of this study indicate that Kv and mAs can be chosen objectively using the patient height and weight therefore, optimization can be prevail dynamically.

5-2 Conclusion:

This study aimed to optimize the exposure factors (Kv and mAs) for skull x-ray using the body characteristics of patients as an effecter and exposure factor as response.

The data of this study collected from 50 patient examined by AP and lateral skull x-ray in the period from September 2014 to May 2015 in East Nile Hospital and Modern Hospital in Khartoum using Digital Philips machine.

The exposure factor can be selected objectively using body characteristic length, weight, body Mass index.

The results of this study showed that the Kv factor can be selected objectively using the patient height (cm) and weight together in a linear equation as follows: $Kv = (height \times 0.02) + (weight \times 0.026) - 62.7$ with an error less than 1.07. Also the mAs can be estimated successfully using patient height as input factor: $mAs = (0.0001\times height) + 0.05$.

The result of this study also showed that the skull x-ray exposure factors for male and female were similar i.e. there is no significant difference between them as well as the factors for AP and lateral.

The obtained results validate that exposure factors for skull x-ray can be estimated in an optimized mode using patient body characteristics.

5-3 Recommendations

This study can be extend to include optimization explore factors o sinuses and Nasal Bone because to need reduce factor of this is parts.

- Study of factor that affecting the exposure factors concerning other parts.
- The X-ray machine should be calibrated routinely in order to make sure the exposure factor present real values.
- Careful analysis of reject Film well point out the problem objectively.
- Every X-ray machine of the same model vary in both quantity and quality of out put to variation of in put voltage and calibration.

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Appendix A

No	Projection	KV	MAS	Gender	Length	Weight	Age	
1	LA	70	0.08	M	170	84	40	49.1
2	LA	66	0.08	F	168	68	27	42.2
3	AP	68	0.08	M	166	70	65	47.9
4	LA	68	0.08	M	166	70	65	52.0
5	AL	70	0.08	M	172	75	55	47.0
6	AL	68	0.08	F	166	70	29	45.0
7	AP	66	0.06	M	79	24	5	42.0
8	LA	68	0.07	M	160	50	18	59.8
9	LA	68	0.08	M	162	53	13	46,0
10	LA	68	0.08	M	174	66	38	60.3
11	LA	70	0.08	M	170	76	47	44.6
12	LA	66	0.07	F	158	65	44	51.6
13	LA	68	0.08	F	162	60	25	53,8
14	LA	68	0.07	F	165	65	31	48.3
15	LA	68	0.07	F	163	70	40	45.5
16	LA	68	0.08	M	167	70	52	39.1
17	LA	68	0.08	F	160	52	15	51.4
18	LA	68	0.08	M	169	74	52	41.0
19	LA	66	0.07	M	146	39	10	53.3
20	LA	70	0.08	M	166	72	55	55.5
21	AP	68	0.07	M	170	73	39	60.1
22	LA	66	0.07	M	170	73	39	50.6
23	LA	66	0.07	F	143	31	10	40.2
24	AP	66	0.07	F	143	31	10	50.5
25	AP	68	0.08	M	168	68	35	43.3
26	LA	66	0.08	M	168	68	35	43.6
27	LA	66	0.07	M	136	37	10	48.1
28	LA	66	0.07	F	97	65	37	43.3
29	LA	68	0.08	M	175	27	6	41\.1
30	LA	66	0.07	F	164	40	20	30.4
31	LA	70	0.08	F	166	80	38	45.1
32	LA	64	0.06	M	65	9	2	48,8
33	LA	66	0.06	M	145	40	14	36.6
34	LA	68	0.06	M	167	75	66	60.6
35	LA	66	,06	M	168	70	53	42.1
36	LA	68	0.07	M	165	60	34	34.9
37	LA	68	0.08	F	172	67	55	54.1

38	LA	66	0.06	M	166	85	72	40.3
39	LA	68	0.07	M	168	76	60	50.6
40	LA	68	0.08	M	173	54	43	58.3
41	LA	66	0.06	F	167	68	50	48.3
42	LA	68	0.08	F	163	74	37	52.3
43	LA	68	0.06	M	174	82	55	54.8
44	LA	68	0.06	M	176	68	37	54.8
45	LA	68	,08	M	158	56	25	53.9
46	LA	66	0.08	F	168	60	26	48.7
47	LA	68	0.06	M	170	66	46	58.4
48	LA	68	0.08	M	165	60	43	47.8
49	LA	68	0.08	M	180	80	34	58,5
50	LA	68	0.08	M	168	63	22	46.8