Chapter one

Introduction

1-1- Introduction:

Radiography using film has been the primary tool in radiology for overall century. The radiation dose to the patient was given only minor consideration during the early days. As the number of examinations performed has increased and data on the long term risks of cancer arising from ionizing radiation exposure has emerged, more attention has been focused on keeping the doses received to a minimum National programmers were set up to assess doses from radiological examinations in developed countries. A survey carried out in the UK in the early 1980s showed that mean doses from similar radiographic examinations varied by a factor of seven between different hospitals and a factor of a hundred was present between doses for individual patients. The National Evaluation of X-ray Trends (NEXT) program has painted a similar picture in the United States .It was apparent that in many hospitals the dose levels were much higher than required to provide a sufficiently high-quality image for the radiologist to make a diagnosis. Since that time more emphasis has been placed on the need to optimize imaging conditions to minimize the risk to patients from radiation exposure. The quality of an image and the anatomical detail seen within it depend on the properties of the imaging system and the radiation used. In general, use of more radiation will improve the quality of the image within certain limits, but will give the patient a higher radiation dose, although other factors also need to be considered. The important aspects of optimization are to first recognize the level of radiographic image quality that is required to make a diagnosis. Next to determine the technique that provides that level of image quality with the minimum dose to the patient. The image quality should be sufficient to ensure that any clinical diagnostic information that could be obtained is imaged. However, the radiation dose to the patient should not be significantly higher than necessary. Finally the procedures should be reviewed from time to time to ensure that any dose reduction that has been achieved does not jeopardize the clinical diagnosis.

1-2- IMAGE QUALITY:

The quality of a medical image is determined by the imaging method, the characteristics of the equipment, and the imaging variables selected by the operator. Image quality is not a single factor but is a composite of at least five factors: contrast, blur, noise, artifacts, and distortion.

1-2-1 Image Contrast:

Contrast means difference. In an image, contrast can be in the form of different shades of gray, light intensities, or colors. Contrast is the most fundamental characteristic of an image. An object within the body will be visible in an image only if it has sufficient physical contrast relative to surrounding tissue.

1-2-2- BLUR AND VISIBILITY OF DETAIL

Structures and objects in the body vary not only in physical contrast but also in size. Objects range from large organs and bones to small structural features such as trabecula patterns and small calcifications. It is the small anatomical features that add detail to a medical image. Each imaging method has a limit as to the smallest object that can be imaged and thus on visibility of detail. Visibility of detail is limited because all imaging methods introduce blurring into the process. The primary effect of image blur is to reduce the contrast and visibility of small objects or detail.

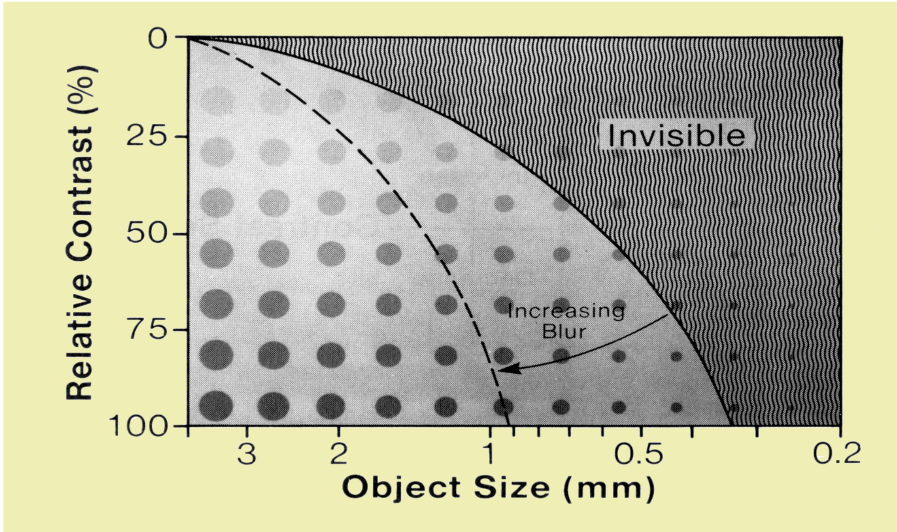

Fig.1 - Effect of Blur on Visibility of Image Detail

1-2-3- NOISE:

Another characteristic of all images is image noise. Image noise, sometimes referred to as image mottle, gives an image a textured or grainy appearance. The source and amount of image noise depend on the imaging method.

1-2-4- ARTIFACTS:

We have seen that several characteristics of an imaging method (contrast sensitivity, blur, and noise) cause certain body objects to be invisible. Another problem is that most imaging methods can create image features that do not represent a body structure or object. These are image artifacts. In many situations an artifact does not significantly affect object visibility and diagnostic accuracy. But artifacts can obscure a part of an image or may be interpreted as an anatomical feature. A variety of factors associated with each imaging method can cause image artifacts.

1-2-5- DISTORTION

A medical image should not only make internal body objects visible, but should give an accurate impression of their size, shape, and relative positions. An imaging procedure can, however, introduce distortion of these three factors.

1-3- PATIENT PROTECTION IN DIAGNOSTIC RADIOLOGY:

Diagnostic x-ray contributes the highest radiation dose to the pt the radiation dose received by pt is specified in term of entrance surface dose. The pt exposure is proportional to **mAs and kvp** squared, and inversely related to the square of the distance from the focal spot. The following are the important steps which will protect the pt from radiation dose.

The radiation protection of patients undergoing medical X-ray examinations is governed by the principles of justification and optimization. Radiation dosimetry is required to inform medical practitioners of the levels of exposure and hence the risks from the diagnostic procedures that they have to justify and to assist the operators of X-ray imaging equipment to determine whether their procedures are optimized.

1-4- TECHNIQUE - EXPOSURE FACTORS:

KVP represent Energy of x-rays which penetrate the tissue. The energy determines the quality of x-ray produced, increase in KVP produce high energy of electrons provide greater quality of x-rays, mA represent tube current (number of electrons) quantity of x-rays produced.

Grids are part of an X-ray machine that filters out randomly deflected radiation that can obscure or blur an image produced by the machine. Which Increases contrast and Reduces density, choice to use a grid depends on KVP used and thickness of part (more than 10cm). Air Gap Technique distance between patient and film, This is like a grid to reduce scatter on film.

1-6 -SCREEN / FILM COMBINATIONS:

The most important factor in the optimization of conventional radiography is the choice of screen / film combination. Screen has a layer of a fluorescent phosphor which converts X-ray photons into visible light photons. The spectral emission of the phosphor must be matched to the sensitivity of the film. Calcium tungstate emits blue light, the phosphor used in rare earth screens emits green light. Using a film in the wrong type of cassette would require an X-ray exposure of higher magnitude. The sensitivities of different screens depend on the absorption properties of the phosphors; rare earth atoms have greater absorption.

1-7 EXPOSURE CONTROL:

To produce an image on film with an acceptable level of contrast, the exposure must be within a relatively narrow range of doses. The exposure factors used will be optimized through the experience of the radiographers, and exposure charts employed for each X-ray unit. The charts provide a guide to the best factors for different examinations for a patient of standard build ,To achieve a consistent exposure level, an automatic exposure control (AEC) device is usually employed in fixed radiographic imaging facilities., This comprises a set of X-ray detectors behind the patient that measure the radiation incident on the cassette. The detectors are usually thin ionization chambers. Exposures are terminated when a pre-determined dose level is reached, thereby ensuring that similar exposures are given to the image receptor for imaging patients of different sizes. The important parameter involved in radiographic image formation is optical density, so film is used in setting up the AEC to give a constant optical density.

Region	**lumbosacral**	**Lumbosacral**
View	AP	Lat
Kvp	75	80
Mas	35	40
Cassette	Regular	Regular
Grid	Yes	Yes
Distance	100-115 (40) inches	100-115(40) inches

1-8-COLLIMATION:

Reducing the volume of tissue irradiated will decrease patient exposure and improve the quality of the radiographic image. Reduces the amount of scatter radiation produced , Reduces the amount of scatter radiation reaching the image receptor which increases image contrast. Shielding protecting people and the environment from the harmful effects of ionizing radiation.

Source-Image Receptor-Distance (SID) is a measurement of the distance between the radiation source and the radiation detector

Additional Tube Filtration is a device to block or filter out some or all wavelengths in the X-ray spectrum. X-ray filtration may be inherent (due to the x-ray tube and housing material itself) or added (additional sheets of filter material). The total filtration must be at least 2.5 mm Aluminum.

1-9-COMPUTED TOMOGRAPHY:

Computed tomography (CT) of lumbosacral spine is a computed topography of the lower spine and surrounding tissues. Almost every hospital is nowadays equipped with a CT-scanner and radiologists of today have considerable experience in diagnosis of lumbosacral region with this modality. CT is very valuable for evaluation of low-back pain for many reasons: the method is non-invasive, it is quick, it gives an excellent visualization of the region in the axial projection and it shows the root canals and paraspinal area. It is usually easy to make a diagnosis of disc herniation, as well as bony elements narrowing the spinal canal, recesses and/or root canals.

Other projections than the axial view can be obtained by using thin slices and reformation. However, if a large area is to be visualized, there will be a significant irradiation to the patient. The CT is performed with the patient lying face-up. In some cases, an iodine-based contrast dye may be injected into a vein to help visualize tissues. In other cases, a CT of the lumbosacral spine may be performed after injecting contrast dye into the spinal canal during a lumbar puncture, to further check for pressure on the nerves. The scan will usually last a few minutes.

1-9-MAGNETIC RESONANCE IMAGING (MRI):

Unlike conventional x-ray examinations and computed tomography (CT) scans, MRI does not depend on ionizing radiation. Instead, while in the magnet, radio waves redirect the axes of spinning protons, which are the nuclei of hydrogen atoms.

MRI has been available already for more than ten years, but early images were of poor quality. There is a dramatic technical development still going on in this field, and the quality is steadily improving. Furthermore, MRI is now rapidly becoming more available, also in general hospitals and the modality must therefore be evaluated against the other ones in the evaluation of low-back pain. The advantages of the method are that it is non-invasive, it gives a good over-view to lumbosacral region , all projections can be obtained, and the content of the dural sac, root canals and paraspinal area is visualized. It also provides good information about the bone marrow. Cortical bone is not as well visualized as with CT, but with improving quality this difference has been diminished.

1-10- PROBLEM OF THE STUDY:

Delivery of radiation to patient to acquire image depend on many factors , most of them concern the patient, generally, there is an exposure factors chart can be use to select the exposure factors global, but mostly this chart is not available or it does not work satisfactory. The attribution of exposure factors to body characteristic will solve most of this problem, especially in lumbosacral region. It has been noted there is high repetition rate due to Miss Guidance or absence of reference that can be use to select exposure factors.

1-11-OBJECTIVE:

The general objective is to optimize exposure factors to lumbosacral x-ray in order to decrease the repetition rate.

1-11-1-Specific Objectives:

- To obtain the age, gender, weight, body mass index, height, kvp and mAs.
- To correlate between exposure factors parameter and body characteristic of patient " age, gender, weight, body mass index, height"
- To find a linear equation for estimate exposure factors.

1-12- JUSTIFICATION OF THE STUDY:

This study had been preformed because Lumbar spine radiography is a common procedure that delivers a large radiation dose to the patient. It is thus of most importance that the settings be optimized as far as possible to provide a low radiation dose with an acceptable image quality and to avoid repetition rate.

1-13-OVER VIEW OF THE STUDY:

This study will consist of five chapters, while chapter one is introduction including objective and problem of the study. Chapter two is literature review .chapter three is material and method. Chapter four is the result of the study .chapter five is Discussion, Conclusion and Recommendation for further studies.

Chapter two

Theoretical background and Literature review

2-1-ANATOMY REVIEW OF SPINE:

The spine is made of 33 individual bones stacked one on top of the other. Ligaments and muscles connect the bones together and keep them aligned. The spinal column provides the main support for your body, allowing you to stand upright, bend, and twist. Protected deep inside the bones, the spinal cord connects your body to the brain, allowing movement of your arms and legs. Strong muscles and bones, flexible tendons and ligaments, and sensitive nerves contribute to a healthy spine. Keeping your spine healthy is vital if you want to live an active life without back pain. Spinal curves when viewed from the side, an adult spine has a natural S-shaped curve. The neck (cervical) and low back (lumbar) regions have a slight concave curve, and the thoracic and sacral regions have a gentle convex curve. The curves work like a coiled spring to absorb shock, maintain balance, and allow range of motion throughout the spinal column.

2-2 ANATOMY OF LUMBOSACRAL JUNCTION:

Articulations between the fifth lumbar and first sacral vertebrae resemble those between other vertebrae. The bodies united by a symphysis which includes a large intervertebral disc. The latter is deeper anteriorly at the lumbosacral angle. The synovial facet joints are separated by a wider interval than those above. Articulating surfaces The reciprocally curved surfaces of the facet joints show considerable individual variation in alignment and shape .Asymmetry (facet tropism) is not unusual Ligaments The major ligament associated with the lumbosacral junction is the iliolumbar ligament.

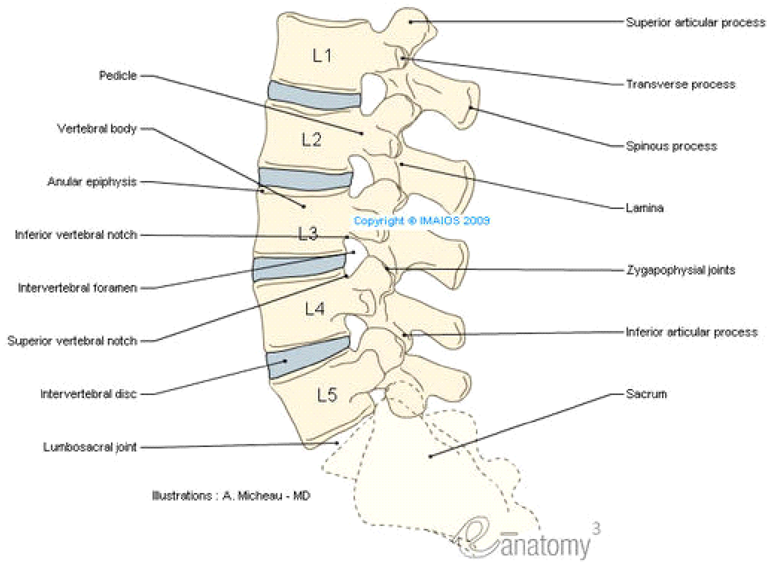

Figure 2-1 shows lumbosacral anatomy

2-2-1-Curves:

Spinal curves are either khyphotic or lordotic. In a normal spine there are four types of spinal curvatures that form an S-shape when view from the lateral side of the body (cervical and lumbar lordosis, thoracic and sacral kyphosis).

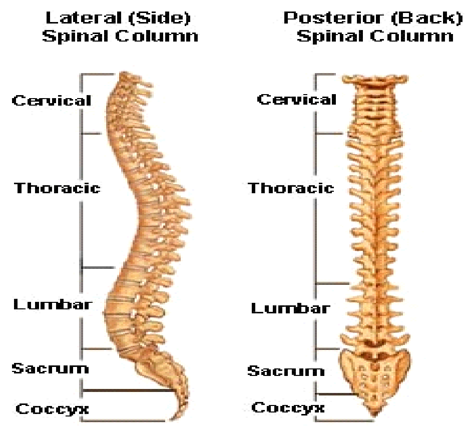

Fig: 2-2 shows curvature of spine

2-2-2 Regions:

There are five major regions of the spine (cervical, thoracic and lumbar spinal regions, sacrum and coccyx)

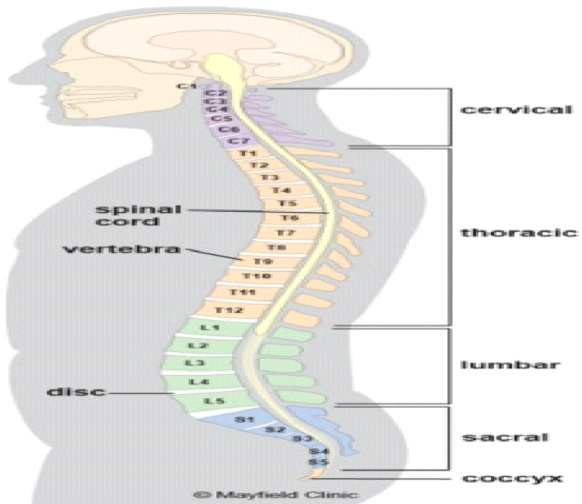

Fig: 2-3- shows five regions of the spinal column.

2-3-FUNCTION OF THE BACK:

The intricate anatomy of the back provides support for the head and trunk of the body, strength in the trunk of the body, as well as a great deal of flexibility and movement. The upper back has the most structural support, with the ribs attached firmly to each level of the thoracic spine and very limited movement. The lower back (lumbar vertebrae) allows for flexibility and movement in back bending (extension) and forward bending (flexion). It does not permit twisting

2-4- X-RAY PRODUCTION:

X-rays for medical diagnostic procedures or for research purposes are produced in a standard way: by accelerating electrons with a high voltage and allowing them to collide with a metal target. X-rays are produced when the electrons are suddenly decelerated upon collision with the metal target; these x-rays are commonly called brehmsstrahlung or "braking radiation". If the bombarding electrons have sufficient energy, they can knock an electron out of an inner shell of the target metal atoms. Then electrons from higher states drop down to fill the vacancy, emitting x-ray photons with precise energies determined by the electron energy levels. These x-rays are called characteristic x-rays.

2-5-PREVIOUS STUDIES:

CJ Martin, 2006, mentioned that to achieve the correct balance between optimizing patient dose and image quality it is necessary to understand the way in which the images are formed, and to know the factors that influence the image quality and the radiation dose received by the patient.

Chapeski et.al, 2007 compared the radiation dose in conventional and digital radiography. There are a number of issues to be considered when examining digital versus Stander radiographs from the perspective of the patient. This evidence based report examines the issues of caries diagnosis and radiation exposure. A methodological approach was used to locate 6 articles comparing the radiation dosages and diagnostic performance of these two imaging modalities. The null hypothesis that both modalities were equal in these areas was confirmed with respect to caries diagnosis and rejected with respect to radiation dose. The evaluated evidence suggests that digital radiographs have great potential to improve patient care by providing equal diagnostic accuracy with a significantly reduced radiation dose In light of this observed potential benefit, and a clear deficiency of research it this area, studies of higher quality and greater range of generalizability are needed to create appropriate standard of care to maximize the potential patient benefits of this new technology. Dose implications of fluoroscopy-guided positioning (FGP) for lumbar spine examinations prior to acquiring plain film radiographs.

Chapter three

Materials and Methods

3-1-Materials:

The study intended to optimize exposure factors of lumbosacral x-ray. The data which used in this study collected from Alribat University Hospital in the period from April to May 2014.

3-1-1 X-ray machine:

Lumbosacral procedure performed using over couch machine. The study was done using **smiths4SC Conventional X-ray** with nominal focus to film distance (FFD) was fix at 100 cm during the procedure, tube potential setting manually with

Automatic processor and weight & height measuring system. Fujifilm films were used.

3-2Methods:

3-2-1 Population of the study:

A total of **40 patients** had been examined

3-2-1-1: Inclusion criteria:

This study was included adult in age more than 20 years, males and females free from diseases.

3-2-1-2: Exclusion criteria:

All patients with anomalies or disease and children were excluded from this study.

3-2-2- Study area and duration:

The study was done at **Alribat University Hospital- Khartoum,** in the period from **April to May 2014**.

3-2-3-Variable of the study:

The variables were including Pt age, gender, weight, body mass index, height, kvp and mAs.

3-2-4 Imaging technique:

Routine lumbosacral x-ray examinations consist of two views: **AP& Lateral views.**

3-2-4-1 Lumbo-sacral junction:

3-2-4-1-1 Lateral :Position of patient and cassette:

The patient lies on either side on the Bucky table, with the arms raised or the hands resting on the pillow.

The knees and hips are flexed slightly for stability. The dorsal aspect of the trunk should be at right-angles to the cassette. This can be assessed by palpating the iliac crests or the posterior superior iliac spines. The coronal plane running through the centre of the spine should coincide with, and be perpendicular to, the midline of the Bucky. The cassette is centered at the level of the fifth lumbar spinous process.

Non-opaque pads may be placed under the waist and knees, as necessary, to bring the vertebral column parallel to the cassette.

3-2-4-1-2 Direction and centering of the X-ray beam

Direct the central ray at right-angles to the lumbo-sacral region and towards a point 7.5 cm anterior to the fifth lumbar spinous process. This is found at the level of the tubercle of the iliac crest or midway between the level of the upper border of the iliac crest and the anterior superior iliac spine. If the patient has particularly large hips and the spine is not parallel with the tabletop, then a five-degree caudal angulation may be required to clear the joint space.

3-2-4-1-3 Essential image characteristics:

The area of interest should include the fifth lumbar vertebra and the first sacral segment. A clear joint space should be demonstrated.

3-2-4-1-4 Radiation protection:

This projection requires a relatively large exposure so should not be undertaken as a routine projection. The lateral lumbar spine should be evaluated and a further projection for the L5/S1 junction considered if this region is not demonstrated to a diagnostic standard.

Fig 3-2-1- Shows Lateral position of lumbosacral.

Fig 3-2-1- Shows Lateral projection of lumbosacral

3-2-4-1-5 AP :Position of patient and cassette:

The lumbo-sacral articulation is not always demonstrated well on the antero-posterior lumbar spine, due to the oblique direction of the articulation resulting from the lumbar lordosis. This projection may be requested to specifically demonstrate this articulation. The patient lies supine on the Bucky table, with the median sagittal plane coincident with, and perpendicular to, the midline of the Bucky. The anterior superior iliac spines should be equidistant from the tabletop. knees can be flexed over a foam pad for comfort and to reduce the lumbar lordosis. The cassette is displaced cranially so that its centre coincides

with the central ray.

3-2-4-1-6 Direction and centering of the X-ray beam:

Direct the central ray 10–20 degrees cranially from the vertical and towards the midline at the level of the anterior superior iliac spines. The degree of angulations of the central ray is normally greater for females than for males and will be less for a greater degree of flexion at the hips and knees.

3-2-4-1-7 Essential image characteristics:

The image should be collimated to include the fifth lumbar and first sacral segment.

Fig: 3-2-2 Shows Ap position of lumbosacral.

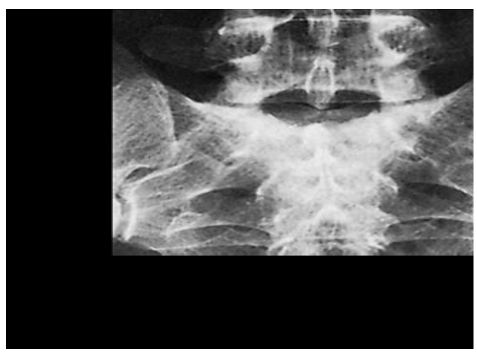

Fig: 3-2-2 Shows Ap projection of lumbosacral

3-2-4-2- Patient preparation:

There is no advance preparation necessary for routine x-ray. A hospital grown is used to replace all clothing on the upper body and all radio opaque substance must be removed from the examined organ.

3-2-4-3 Method of data collection:

Data were collecting using Master data sheet which was including the following parameters:

No	Age	Gender	Weight	Height	Kvp	mAs
1						
2						

3-2-4-4 Method of data analysis:

Data were analyzing using SPSS.21 and Microsoft Excel program.

Chapter four

The Results

The sample of this study consisted of 40 adult patients ,males and females ,their ages more than 20 years used in this study. Children and pregnancies were excluded from this study, and the data collected from sampling plain lumbosacral x-ray to optimize the dose for lumbo sacral region include (age – weight- length- gender – kvp-mAs).

Table 4-1 an independent t-test of the exposure factors in respect to gender (male and female)

Independent Samples Test		
	t-test for Equality of Means	
	T	**Sig. (2-tailed)**
Kvp Ap	-.701	.487
mAs AP	-1.250	.219
Kvp lat	-.691	.494
mAs lat	-.832	.410

Table 4-2 a demographic results of parameter data (mean ± stander deviation)

Item Used	Mean±Sd
Age	39.2±13.8
Weight	67.2±14.3
Length	166±7.9
Kvp AP	80.5±10.3
mAs AP	36.9±10.3
Kvp lateral	87.4±5.1
mAs lateral	44.1±7

Figure 4-1 scatter plot show the correlation between Weight (Kg) and Kvp in Ap lumbosacral x-ray

Figure4-2 Scatter plot show correlation between Weight (Kg) and Kvp in lateral lumbosacral x-ray

Figure 4-3 Scatter plot show the correlation between Weight (Kg) and mAs in Ap lumbosacral x-ray

Figure 4-4 scatter plot shows the correlation between Weight (Kg) and mAs in lateral lumbosacral x-ray

In summary this results indicates a direct linear relationship between the patient body weight and the exposure factors (KV and mAs for AP and lateral).

Chapter five

Discussion, Conclusion and Recommendations

5-1 Discussion

Exposure factors of lumbosacral region is high compared to other radiographic examination such as chest, knee….etc as this region is particularly thick and need high penetration.

This study consisted of 40 patients, their mean age, height, weight was **39.2±13.8. 166±7.9, 67.2±14.3** respectively. While the average exposure factors for AP concerning the Kvp and mAs was 80.5**±10.3, 36.9±10.3** respectively. and the average exposure factors for lateral projection concern KVp and mAs was **87.4±5.1 , 44.1±7.**

The result of this study showed that there is no different found between male and female in select exposure factors so they were consider as one group as shown in table 4-1.

The result also showed that factor that assume to affect the exposure factors such as age, gender and length were insignificant while the weight is the only significant parameter in selecting exposure factors.

The weight was directly proportional to the Kvp in AP projection, where the Kvp increases by **0.18 kvp/Kg** starting from **68.6 Kvp** as threshold. Therefore to estimate the kvp factor using the weight of the patient; the following equation could be executed:

$$\underline{\textbf{Kvp (AP)} = 0.177\times \textbf{weight} + 68.59}$$

Also the weight was directly proportional to the Kvp in lateral projection, where the Kvp increases by 0.16 kvp/Kg starting from 76.77 Kvp as threshold. Therefore to estimate the kvp factor using the weight of the patient; the following equation could be executed:

$$\underline{\textbf{Kvp (lateral)} = 0.157\times \textbf{weight} + 76.77}$$

The weight was directly proportional to the mAs in AP projection, where the mAs increases by 0.310 mAs/kg starting from 16 mAs as threshold. Therefore to estimate the mAs factor using the weight of the patient; the following equation could be executed:

$$\underline{\textbf{mAs (AP)} = 0.310\times \textbf{weight} + 16.0}$$

The weight was directly proportional to the mAs in lateral projection, where the mAs increases by 0.204 mAs/kg starting from 30.39 mAs as threshold. Therefore to estimate the mAs factor using the weight of the patient; the following equation could be executed:

$$\underline{\textbf{mAs (lateral)} = 0.204 \times \textbf{weight} + 30.3}$$

5-2**conculosion**

Exposure factors of the lumbosacral x-ray measured for patients from Alribat University Hospital.

The data collected from patients free from any disease above 20 years in both male and female patients.

There is no different between male and female in selecting exposure factors . and the only significant parameter in selecting exposure factors is a weight .

From data analyses, The equations for selecting exposure factors (kvp and mAs) by know the patients weight .and this equations are more accurate in selecting exposure factors from exposure chart or select it by chance . And this equations help in optimizing factor so reduce repetition rate and patients dose.

5-3The Recommendations:

The exposure should be following the international rules of exposure and acceptable exposure factors in order to achieve ALARA principle.

Use of this equations for selecting exposure factors kvp and mAs in every radiological department so each department should contain body weight scale with meter .

The optimum factors are important to get good image quality with fewer artifacts.

The radiation protection in an effective way to save the patient with use of lead aprons and three rules of protection which are optimization, justification and limitation as can be achieve.

The accurate patient positioning and alignment of tube is crucial aspect to avoid misdiagnosis and repetition and achieve high quality images especially for this region of body which affected by many factors whatever concerning the exposure or patient setup or machine daily QA test.

Further studies are required based on the clinical outcome and final diagnosis in order to evaluate the justification of the examination.

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Appendices

Data collecting sheet:

Age	gander	Weight	Length	Kvp (Ap)	Mas (ap)	Kvp (lateral)	Mas (lateral)
75.0	1.0	106.0	165.0	90.0	50.0	97.0	56.0
43.0	1.0	67.0	168.0	83.0	36.0	90.0	40.0
19.0	2.0	56.0	163.0	79.0	32.0	81.0	36.0
25.0	1.0	63.0	175.0	75.0	32.0	79.0	40.0
41.0	1.0	62.0	171.0	75.0	32.0	79.0	32.0
27.0	1.0	75.0	178.0	75.0	32.0	79.0	36.0
30.0	2.0	55.0	152.0	79.0	32.0	83.0	36.0
59.0	2.0	83.0	150.0	90.0	45.0	96.0	45.0
30.0	1.0	75.0	159.0	79.0	40.0	83.0	45.0
71.0	1.0	60.0	160.0	79.0	40.0	83.0	45.0
42.0	1.0	100.0	180.0	85.0	40.0	90.0	45.0
45.0	2.0	86.0	161.0	83.0	40.0	87.0	50.0
52.0	2.0	80.0	167.0	87.0	50.0	95.0	50.0
39.0	1.0	85.0	178.5	80.0	50.0	90.0	56.0
26.0	1.0	46.0	164.0	75.0	40.0	85.0	50.0
25.0	2.0	77.0	160.0	87.5	45.0	94.0	50.0
42.0	1.0	60.0	171.0	77.0	28.0	87.0	45.0
57.0	2.0	74.0	170.5	85.0	36.0	93.0	56.0
28.0	1.0	70.0	181.5	83.0	32.0	90.0	50.0
34.0	2.0	62.0	164.0	81.0	32.0	90.0	45.0
29.0	1.0	55.0	167.5	77.0	28.0	83.0	23.0
27.0	1.0	59.0	160.0	80.0	28.0	88.0	32.0
63.0	2.0	65.0	157.5	81.0	32.0	85.0	45.0
41.0	1.0	65.0	167.5	81.0	32.0	85.0	45.0
28.0	2.0	42.0	157.5	70.0	22.0	81.0	45.0
46.0	1.0	72.0	174.5	81.0	40.0	83.0	45.0

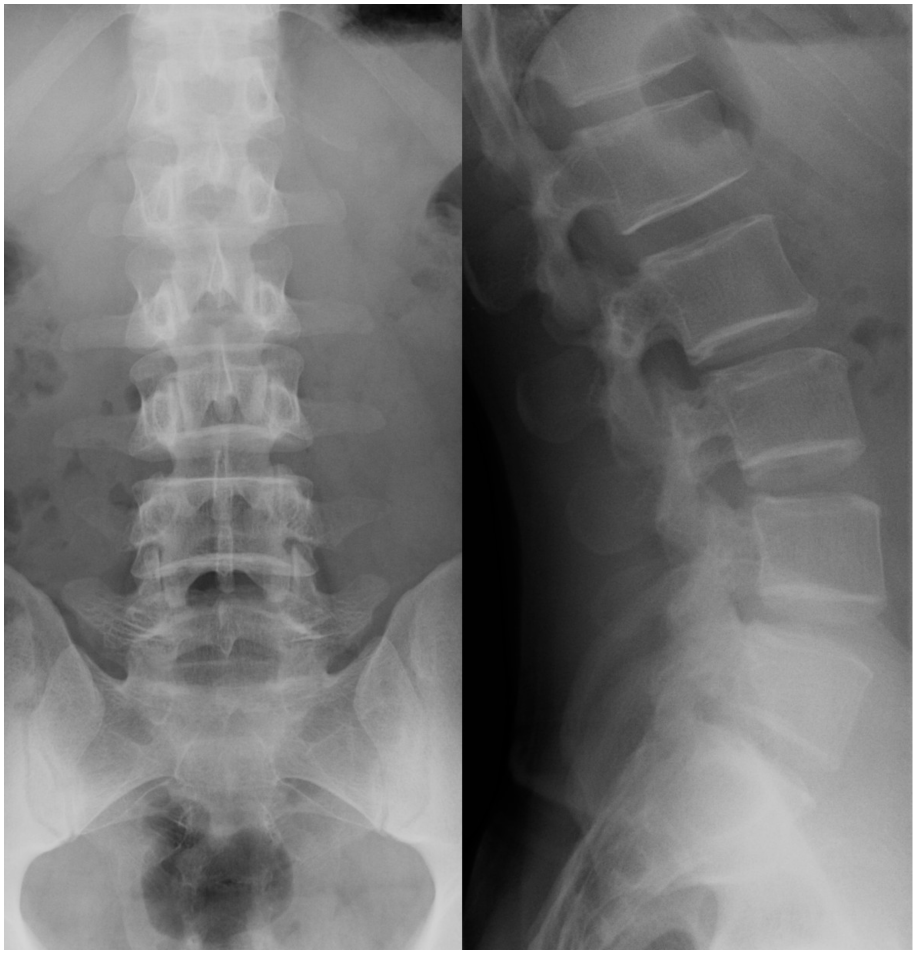
40.0	2.0	63.0	155.0	77.0	28.0	90.0	45.0
37.0	1.0	62.0	161.5	77.0	28.0	90.0	50.0
31.0	1.0	55.0	157.5	88.0	45.0	99.0	36.0
50.0	2.0	76.0	157.0	80.0	40.0	90.0	50.0
32.0	1.0	46.0	169.5	79.0	28.0	87.5	45.0
22.0	1.0	46.0	176.5	79.0	28.0	85.5	45.0
25.0	1.0	56.0	167.5	81.0	32.0	90.0	50.0
40.0	2.0	65.0	164.0	79.0	83.0	83.0	40.0
22.0	1.0	57.0	164.0	83.0	32.0	90.0	45.0
54.0	2.0	87.0	167.5	81.0	40.0	93.0	50.0
43.0	1.0	61.0	169.55	81.0	40.0	83.0	45.0
28.0	1.0	81.0	175.5	80.0	33.0	90.0	40.0
52.0	2.0	59.0	159.0	77.0	32.0	85.0	36.0
46.0	2.0	72.0	174.5	81.0	40.0	83.0	45.0

1.0= Male

2.0= Female

Lateral L/S X-ray for female, 30 years old, 55kg weight

Lateral L/S X-ray for male, 27 years old, 75kg weight



AP and Lat L/S X-ray for male, 42 years old, 60kg weight