

# Chapter one

## Introduction

# Chapter one

## General introduction

### 1-1 introduction

Bone densitometry is art and science of measuring the bone mineral content and density of specific skeletal sites or the whole body there are several different modalities for BMD, such as (Dual energy-ray absorptiometry (DEXA, DXA), single energy x-ray absorptiometry (RA), Quantitative computed tomography (QCT), Dual photon absorptiometry (DPA), Single photon absorptiometry (SPA), Among these DEXA has become the preferred modality because of its accuracy and low radiation dose. (American College of Radiology-ACR).

DEXA scan (Dual-Energy X-ray Absorptiometry) also called Bone density scanning, or bone densitometry, is an enhanced form of x-ray technology that is used to measure bone loss. DXA is most often performed on the lower spine and hips, in children and some adults, the whole body is sometimes scanned. (American College of Radiology-ACR).

### 1.2 History

Established in 1969 in province of Palembang in the south of Sumatra island in Indonesia. DXA aim was to supply medicine to Palembang and its surrounding areas, in 2011 DEXA are used in royal care international hospital in Khartoum state Sudan. (<http://www.radiologyinfo.org>, and royal care hospitals).

### **1.3 Research problem**

DXA is most often used to diagnose osteoporosis, and it is also effective in tracking the effect of treatment for osteoporosis and other conditions that causes bone loss(differential diagnosis in bone disorders).

The DXA scan examination can also assess an individual's risk for developing fractures and to initiate general age categorization for bone disorders in male and female.

DXA scanner can answer the question concerning mineral and body density. Although number of diseases may happen in bones and can be diagnosed in numerical accurate values but some of them can't be detected early so the study of the bone density related to the laboratory investigations and clinical findings will shine in DXA scanner examinations must be done.(Radiological Society of North America-RSNA ).

### **1.4 Study justification**

- Osteoporosis and other bone disorders are very common among patients referred to the radiological department DXA scanner unit.
- The percentages of osteoporosis and bone disorders among the patients referred scanner have not been extensively researched.
- The modality of DXA scanner approximately is a new modality need extensive researching.(Ann Larking – Accuracy of DEXA scanning & other methods for BMD).

## **1.5 Research Objectives**

### **1.5.1 General Objectives**

- To evaluate and measure the Bone Mineral Density (BMD) by using DXA scanner.
- Assess the final diagnosis by using DXA scanner.
- Evaluation the common bone disorders causing bone density loss.

### **1.5.2 Specific Objectives**

- To correlate the value of bone mineral density with age & gender.
- To evaluate the percentages bone disorders which diagnosed by DXA in Sudan.

## **1.6 Thesis outline**

Chapter one: introduction, statement of the problem, objectives of the study ,and thesis outline).

Chapter two: the literature review (Anatomy, Physiology, Pathology of the bones, previous studies).

Chapter three: methodology and data analysis.

Chapter four: result and.

Chapter five: Conclusion, discussion, Recommendation, Appendix, and References.

# Chapter Two

## Literature Review

## Chapter two

### 2.1 Anatomy and physiology

#### 2.1.1 Anatomy

##### Bone Components

- 25 – 70 % inorganic
  - Calcium.
  - Phosphorus.
  - Magnesium
- 25 – 30 % organic
  - Collagen.
  - Cellular elements.
- 5 – 25 % water.

#### 2.1.2 Bones of the Human Body

The skeleton has 206 bones.

Two basic types of bone tissue:-

1. Compact bone
  - Homogeneous
2. Spongy bone
  - Small needle-like pieces of bone
  - Many open spaces

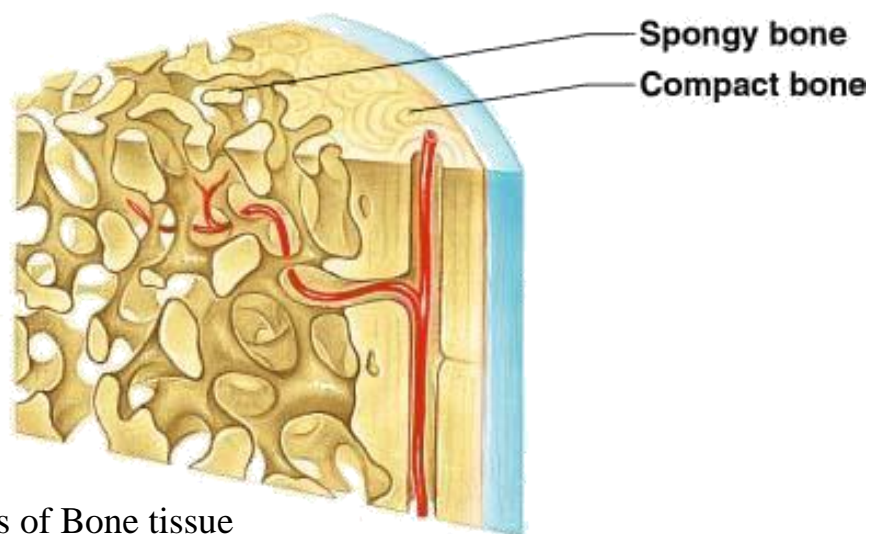


Figure (2-1) Basic types of Bone tissue

## 2.1.3 Gross Anatomy of a Long Bone

### Diaphysis

- Shaft
- Composed of compact bone

### Epiphysis

- Ends of the bone
- Composed mostly of spongy bone

### Epiphyseal line:

- bone stops growing in length

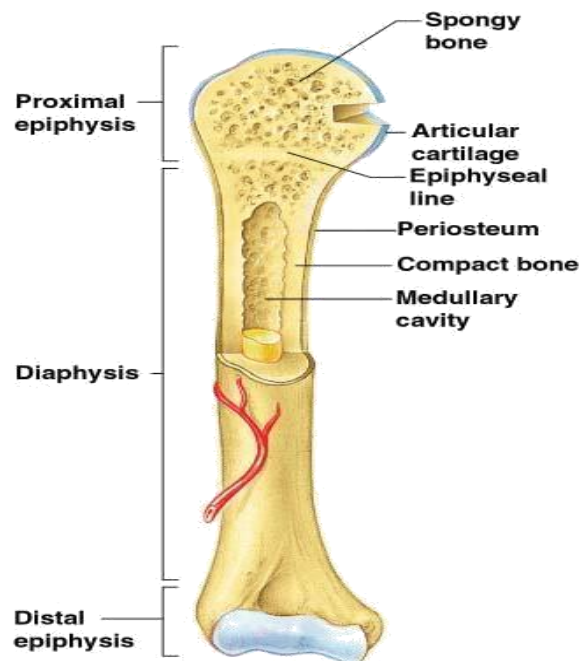


Figure (2-2) Gross anatomy of long Bone

## **2.2 Physiology**

- Supports the body
- Protects the vital organs
- Helps to produce red blood cells
- Acts as levers in locomotion
- Provides surface for muscle attachment
- Storage of salts and minerals

(Clinical Anatomy and Physiology).



## **2.3 Common disorders in bone mineral content loss:**

### **2.3.1 Osteoporosis**

Osteoporosis , which mean “porous bone ”causes bones to weak and brittle. In many cases, bones weaken when you have low levels of calcium and other minerals in the bones.so the common result of osteoporosis is fractures. Most of them occur in the spine, hip or wrist.(American college of Radiology).

### **2.3.2 Symptoms of osteoporosis**

- in early stage of bone loss, usually no pain ,los height over time.
- A stooped posture.
- Fracture of vertebra, wrist, hip or other bone.
- back pain, which can be severe, as a result of a fractured or collapsed vertebra.

### **2.3.3Cuases of osteoporosis**

- Post menopausal woman and not taking estrogen.
  - Have a personal or maternal history of hip fracture or smoking.
  - Man with clinical conditions associated with bone loss.
  - use medication that are known to cause bone loss.
  - high bone turnover, which show up in the form of excessive collagen in urine samples.
- Thyroid condition, such as hyperthyroidism.
- parathyroid condition, such as hyperparathyroidism.
  - Experienced a fracture after only mild trauma.

## 2.4 Method of Estimation of Bone Densitometry

1. RA (Subjective, Radiogrammetry, Osteogram)
2. SPA
3. DPA
4. DEXA
5. QCT
6. QUS

### 2.4.1 Radiographic Absorptiometry (RA).

Radiographic absorptiometry (RA) is a technique for bone mass measurement from radiographs of peripheral sites, most commonly the hand or heel. Its advantages include that it is less expensive and more widely available than other bone densitometry techniques, there is no need for specialized equipment, and it has been shown to be both precise and accurate, for obtaining bone-mineral content measurements of the phalanges of the hand .The major disadvantage of RA is that, because measurements are sensitive to changes in overlying soft tissues, the technique is limited to the appendicular skeleton

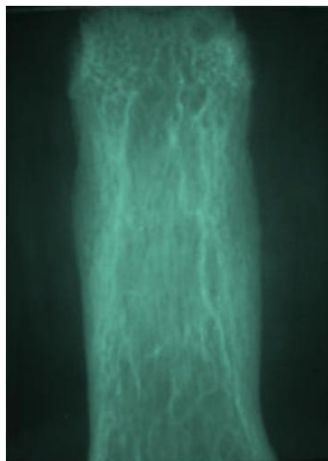


Figure (2-3) appendicular Radiographic Absorptiometry

### **2.4.2 Single Photon Absorptiometry (SPA)**

The SPA technique uses a single gamma ray source and a scintillation detector to measure photons transmitted through a particular anatomical site in the appendicular skeleton. The gamma source and detector were coupled and scanned in a rectilinear movement.

This technique was applied to peripheral skeletal sites, most commonly the non-dominant forearm, wrist or heel.

### **2.4.3 Dual Photon Absorptiometry (DPA)**

Allows for simultaneous measurement of the transmission of gamma radiation of two different energies which compensates for the variation in overlying tissue and removes the need for the tissue equivalent material. (Gd153) is a common radionuclide used which provided dual energy peaks at (44 and 100 keV) photons which were counted separately by scintillation detectors.

Factors which affect the accuracy of photon Absorptiometry include:

1. Inhomogeneity of soft tissue
2. Uncertainty in values of density
3. Attenuation coefficients for both bone mineral and soft tissue components.

The limitations of (DPA & SPA):-

1. Long scanning times due to low photon flux (~40 mins)
2. Poor spatial resolution.

### **2.4.4 Single X-ray Absorptiometry (SXA)**

Collimated photon beam is directed from an x-ray source through the measurement site.

The photon attenuation of the beam by bone is then measured and

converted to bone mineral content.

The bone mineral content is computed from the increased absorption

of the beam as it passes from a constant thickness of soft tissue or water bath into the bone.

SXA is commonly used because it is relatively quick & simple to perform and results in a low radiation dose. (Kelly et al, single X-ray absorptiometry)

The limitations of SXA :-

- poorly in the axial skeleton scan

#### **2.4.5 Dual Energy X-ray Absorptiometry (DEXA) or (DXA)**

Dual energy x-ray absorptiometry (DEXA) measurements of bone mineral content (BMC) and bone mineral density (BMD) By using dual pulsed x-ray source mounted under the subject which produces low and high energy voltages of 70 kvp and 140 kvp. After that The photons having passed through the patient and the calibration wheel, are picked up by a crystal detector located in the over-table arm.

the detector which converts the photons into current. An analog to digital (A/D) converter translates the current into a digital signal directed to the computer. The system software integrates the signal information and creates a screen image. The values for area scanned in cm<sup>2</sup> bone mineral content (BMC) in gms of calcium hydroxyapatite and bone mineral areal density (BMD) in gms/cm<sup>2</sup> are computed for specific regions of interest.

DEXA provides bone mineral density measurements both axially and peripherally as well as total body scans but is most commonly applied to scanning of the lumbar spine (L1-L4) and the proximal femur.

**Factors which affect the accuracy of DEXA measurements:**

1. Variations in soft tissue composition.
2. Correct patient positioning and scan analysis.
3. Artifacts due to metal or clothing.
4. Random errors due to photon & electronic noise .
5. Drifts in scanner calibration.

#### **2.4.6 Quantitative Ultrasound (QUS)**

The use of US for the measurement of bone density has received widespread attention because:

1. Does not involve the use of radiation.
2. Inexpensive (lower cost than DEXA).
3. Relatively simple to implement and process.
4. Portable.
5. US can provide information about the density and elasticity of bone by measuring the velocity of sound through bone, and about the structure of Bone by measuring the attenuation of the signal.

### **2.5 Laboratory Investigations to Evaluate The Final Diagnose of Osteoporosis**

#### **2.5.1 Calcium and Vitamin D**

Bone is a connective tissue.it is composed of (5%) living material (lining cells, osteocytes, osteoblast, osteoclast) and of (95%)non - living materials(protein matrix encrypted with mineral which give the mechanical functions of the bones such as stiffness& rigidity and resilience).

The non-living material is formed of 50%protein and 50% minerals. Among the protein (90%)is collagen and(10%)is non-collagen such as osteocalcin.

Among the mineral around (55%) is phosphorus (40%) is calcium and (5%) is carbonate and other trace mineral (Shills et al. 1998).

A simple algebra of the numbers above suggests that 19% of the bone tissue is made of calcium, knowing that the total body calcium is around 0.9 to 1.5 kg (99%) of body calcium is in the skeleton.

During adult life bone grows in length and keeps on growing in mass until 30 to 35 years of age, dietary calcium needs to be adequate during this critical period (10-35 years of age) to attain a high PBM, the ARD of calcium is 1000-1500 mg higher range is recommended for elderly and post-menopausal women. Adequate calcium intake is considered standard care for all postmenopausal women either alone or in combination with other pharmacological treatments (Mc Garry et al. 2003).

Food sources of calcium are milk and dairy products (sardines broccoli nuts fortified beverages (orange juice) and sesame seeds). Calcium supplements are available in the form of calcium carbonate and calcium citrate, the latter is better absorbed than calcium carbonate in the body (Lin and Lane 2004).

Vitamin D maintains serum calcium and phosphorus homeostasis by stimulating their absorption from the gut; thus vitamin D taken with calcium slows bone loss in postmenopausal women.

### **2.5.2 Calcium and Exercise**

Research on calcium effects in interaction with exercise on the bone has been controversial. This conflict may arise from the fact that calcium may be essential to skeletal integrity but may not be enough to prevent osteoporosis on its own. (Heaney 1987).

In a critical review of the literature Specker (1996) concluded that exercise can only be beneficial to bone density if complemented with minimum calcium intake of 1000 mg moreover calcium supplements can only be beneficial to bone health if complemented with adequate physical activity .

In fact several researchers have argued that calcium is crucial for bone development yet its intake alone cannot suppress bone loss and replace a disintegrating matrix (kreiger et al.,1992).

Congruent with this argument Heaney (1992) mentioned that calcium should be viewed as a nutrient and not as a drug per se thus its supplementation will be useful to alleviate calcium deficiency .

## **2.6 previous studies**

Only one study had been done in Sudan in 2012 (in 64 patients) resulted as bellow:

-osteopenia are 26patients represent40%of total.88%female and12%male.

-osteoporosis are 20patients represent 31% of total 95%female 5%male.

-osteopetrosis are 7patients represent 10% of total ,71%femaleand 29%male.

# Chapter Three

## Materials and Methods



## Chapter Three Materials and methods

### 3.1 The Subjects:

50 adult patients, 21 males and 29 females with age range 20 to 80 years .no underlying diseases. Children and pregnant women were excluded from this study, Dual Energy X-ray Absorptiometry (DEXA)will be used in this study.

### 3.2 Two types of DXA equipments:

- 1 - Central device.
- 2 - Peripheral device.

#### 3.2.1 Central device (CDXA )

- Central DXA devices measure bone density in the hip and spine.
- Usually located in hospitals and medical offices.
- Central devices have a large, flat table and an "arm" suspended overhead.

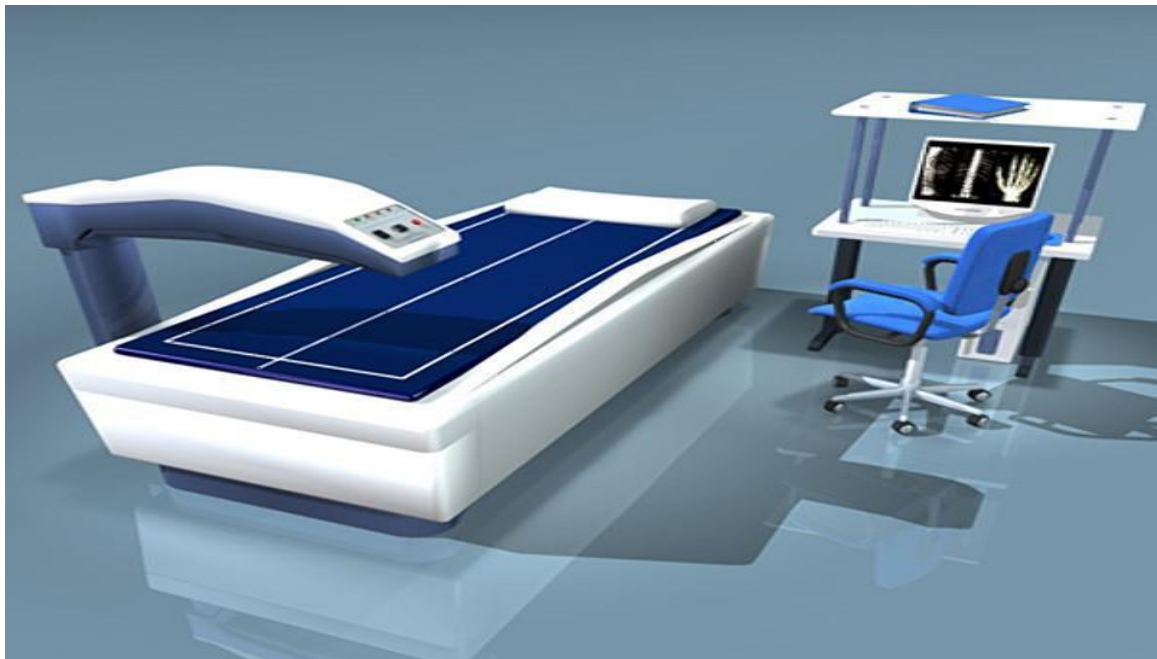
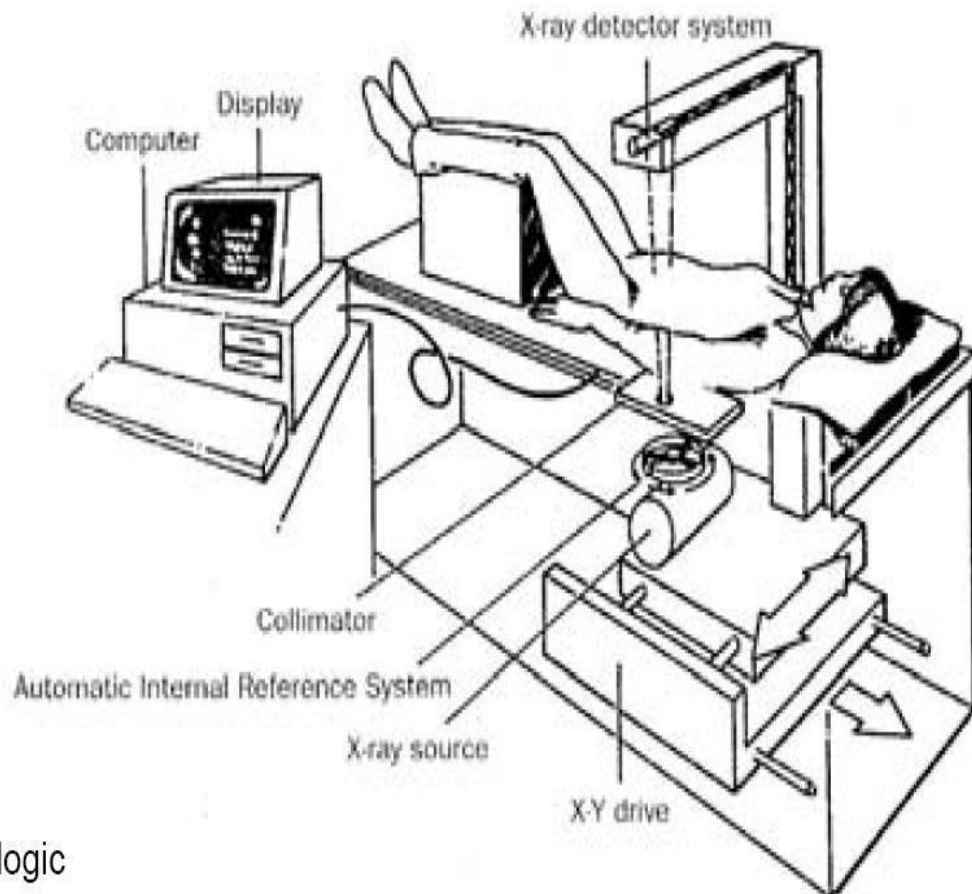


Figure No (3-1) central DXA device(C DXA)

### 3.2.1.1 Components of Central DEX ( CDXA )

- 1-X-ray tube. Cross arm.
- 2- X-ray generator. X-ray drive.
- 3- Flat table.
- 4-X-ray detector system.
- 5-Collimator.
- 6-Automatic internal reference system.
- 7-Computer system .
- 8-Display system .



Hologic

Figure No (3-2) structures of central device.

### 3.2.1.1.1 X-ray Detectors

- Solid materials in which the energy of x-ray is converted to light photons.
- Then the emitted light is converted into electrical current by using photomultiplier tube.

### 3.2.1.1.2 Types of beam x-ray:

The beam use in DEXA Fan beam and Pencil beam or Cone beam

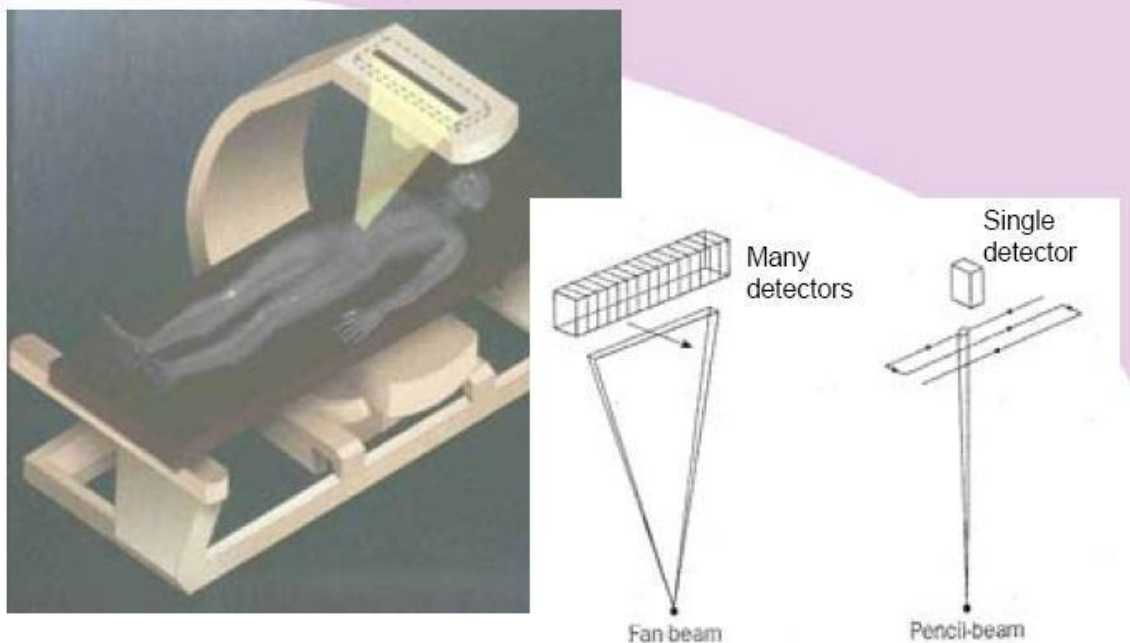


Figure No (3-3) demonstrate Beam detectors

### **PNECIL beam versus FAN beam**

#### — **PENCIL**

First generation bone densitometers. one detector

Scan time 5-10 min (slow scan speed) Good image quality

Low patient dose

#### — **FAN**

The second generation Scan time 30-60 sec

Better image quality small patient dose

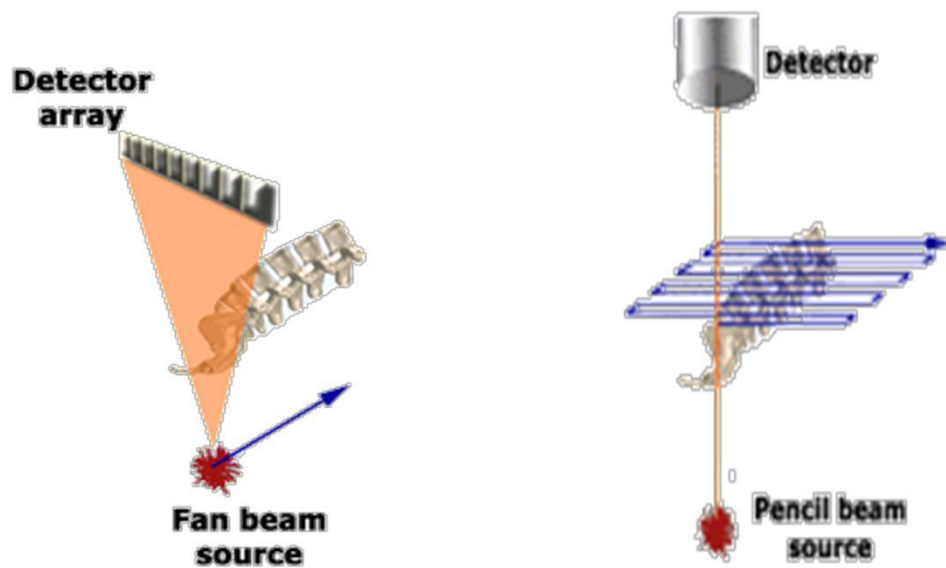


Figure No (3-4) types of beam shape

### 3.2.1.2 Peripheral device ( PDXA )

- Peripheral devices measure bone density in the wrist, heel or finger.
- PDXA often available in drugstores and on mobile health vans in the community.
- PDXA device is much smaller than the Central DXA device, weighing only about 60 pounds.
- PDXA is a portable box-like structure with a space for the foot or forearm to be placed for imaging.

#### 3.2.1.2.1 Components of peripheral DXA ( PDXA )

- Head x-ray tube.
- Collimator.
- Space.
- Detector.
- Computer system.
- Display system.



Figure No (3-5) peripheral DXA device (P DXA)

The summary of difference between CDXA & PDXA

CDXA	PDXA
Used for scanning spine and femur	Used for scanning forearm and heel
x-ray tube voltage 80 – 140 Kv	x-ray tube voltage 40 – 60 Kv
Low patient dose 10 $\mu$ Sv	Very low patient dose 0.1 $\mu$ Sv

Table No (3-1) DEXA models characteristic

### 3.2.1.3 Accessory

#### **-Padded box.**

Support the patient's legs to flatten pelvis and lower lumbar spine.

#### **-Brace.**

Rotates the (hip) inward.

## • Padded box



## • Brace



Figure No (3-6) accessory Padded box Brace for DEXA scan.

### **3.2.3 Technique of DXA**

- The DXA machine sends a thin, invisible beam of low - dose x-ray with two energy.
- One energy is absorbed mainly by soft tissue and the other by bone.
- The soft tissue amount can be subtracted from the total and what remains is a patient's bone mineral density.
- DXA machines feature special software that computer and display the bone density measurements on a computer monitor.

(DXA procedures Manual 2007).

### **3.2.3.1 Patient preparation**

- Patient eat normally.
- Patient should not take calcium supplements for at least 24 hours before exam.
- Explain the examination for Patient.
- Remove some or all of clothes and wear a gown during the exam.
- Objects such as keys or wallets that would be in the area being scanned should be removed.
  
- Remove jewelry and any metal objects or clothing that might interfere with the x-ray images.

### **3.2.3.2 Procedure Projections**

- 1-PosteriorAnterior (spine – hip).
- 2-Lateral (spine).
- 3-Whole body

#### **3.2.3.2.1 PA Lumbar Spine Positioning (SP) of patient**

The SP should be positioned with his or her head to your right as you face the table. Make sure that the SP is straight and centered on the table and that his or her shoulders are at the upper scan limit hash marks on the long edges of the table, to ensure the spine will be within the scan area.

Stand at the head end of the DXA table, reach under the SP's underarms, and gently pull toward you to straighten the spine.

Place radiolucent pillow under SP's head and under the paper

On the control panel, press the center table switch to move the table and C-arm to the center position. Place the large square cushion under the SP's lower legs and under the paper with the thighs as close to a 90° angle to the body as possible. Have the SP rest his or her arms. (DXA procedures Manual 2007).

#### **3.2.3.2.1.1 Positioning the C-Arm**

Locate the SP's iliac crest. Using the arm motion controls on the control panel, bring the laser indicator vertical line to approximately 2 inches below the iliac crest. The laser indicator horizontal line should coincide with the midline of the SP (see Exhibit 3-9). The laser indicator is projected when the motion control is activated.

#### **3.2.3.2.1.2 Scanning**

Prior to beginning the scan, confirm that the SP's body is straight with respect to the laser, the table, and the lines on the table pad

Press "Start Scan" to begin the scan.

The Scan window displays with the image appearing on the left side.

Flashing X-rays On indicator at the top of the window continues until the scan stops.

Make sure that the spine is centered and straight, there are even amounts of soft tissue on each side of the entire spine, and that a small amount of the iliac crest is visible in the lower corners of the screen (Exhibit 3-11).

If not, click "Reposition Scan" to stop the scan.

The image acquired so far displays with scroll bars on the right and bottom.

Position the cursor over the spine image. The arrow cursor changes to a hand. Click and drag the image (or use the scroll bars) so that the iliac crest is at or below the blue horizontal positioning line and within the lower portion of the scan field. The center of the lumbar spine should be aligned with the blue vertical positioning line.



If the spine is not straight, move the patient's upper torso either left or right to straighten the spine. When the spine is repositioned correctly, click the "Restart Scan" button. The Scan Parameters window displays. Click the "Start Scan" button to start a new scan at the new position. The Scan window displays with a flashing X-rays on message. The image displays.

When you see the ribs attaching at T-12 click the "Stop Scan" button. When the scan completes, the Exit Exam/New Scan window displays

### **3.2.3.2.2 Lateral lumbar spine Patient position**

True lateral.

#### **3.2.3.2.2.1 Part position**

- 1 – The mid axillary line at the center of the table.
- 2 – The hand over the head.
- 3 – Flexible the knee to avoid lordatic curvature.

#### **3.2.3.2.2.2 Center point**

at the axillary line at the level of the lower costal margin ( L3 ).

**Tube direction:** vertical.



Figure No (3-7) lateral lumbar spine position

### 3.2.3.5 Common problems with spine scans

1. Spine isn't straight.
2. Scan starts in sacrum.
3. Scan stops too soon.
4. Wrong scan mode.
5. Scan doesn't include L5.

### 3.2.3.6 AP Hip joint Positioning

The SP should be positioned with his or her head to your right as you face the table.

Make sure that the SP is straight and centered on the table. The hip region should be within the two sets of hash marks on either side of the long edge of the table.

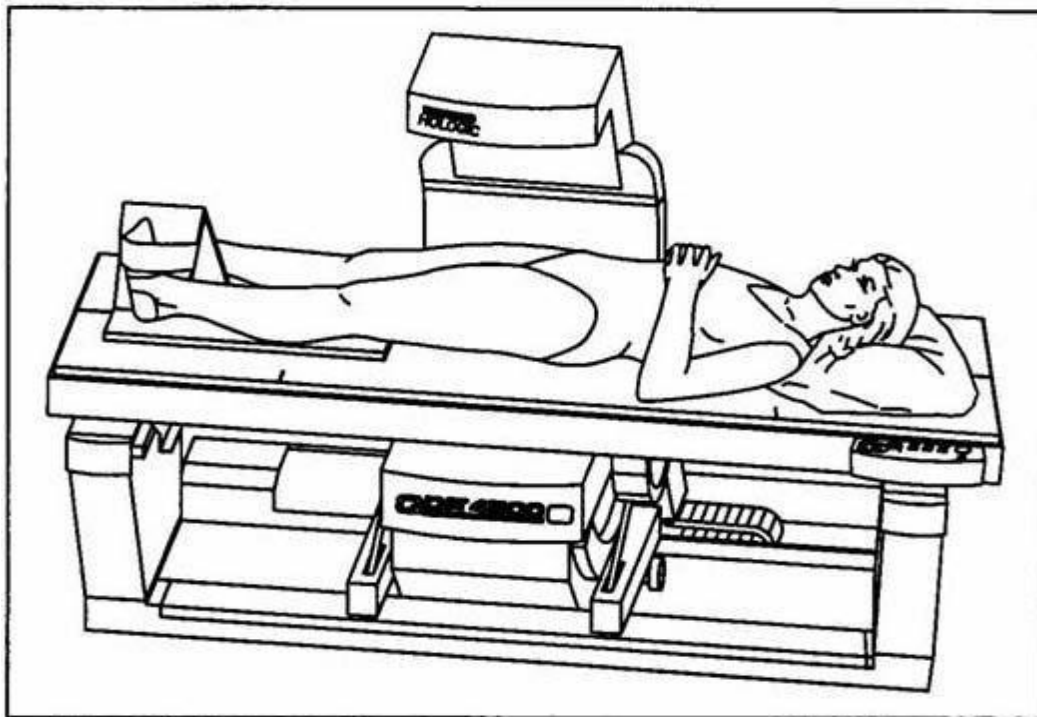


Figure (3-8) AP hip joint position.

On the control panel, press the Center Table switch to move the table and C-arm to the center position.

Place the hip scan positioning device on the far left end of the table near the SP's feet. align the center of the device with the patient's midline.

The leg to be examined should be rotated inward so that the foot can be placed against the positioning device and secured with the strap .Adjust the abduction of the leg so that the shaft of the femur is parallel with the center of the table.

In rotating the leg inward, place one hand above the knee and one hand below the knee and gently rotate the leg to ensure the whole leg is rotated, as opposed to just the lower portion of the leg.

Make sure that the SP's arms are placed across his or her chest outside of the scanning area.

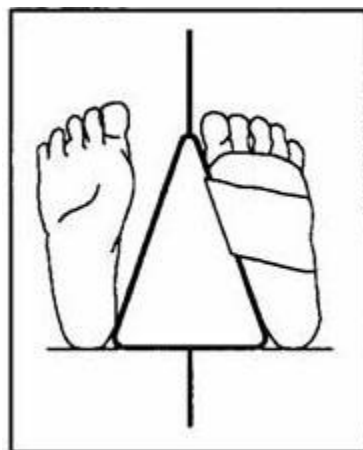


Figure (3-9) feet rotating.

### **3.2.3.6.1 Positioning the C-Arm**

Locate the SP's greater trochanter. This can be done as described below:

Grasp the leg to be scanned near the ankle and gently rotate the leg inward and outward several times. Press firmly on the outside of the

thigh while rotating the leg.

You should feel the greater trochanter roll under your fingertips.

If you are not able to feel the trochanter have the SP bend the leg at the knee and lift (may be necessary to assist the SP).

Locate the crease formed at the top of the leg and use this as an approximate location of the greater trochanter.

In both cases these are approximate location (s) to begin the scan.

Move the C-arm until the laser cross-hair is 2 inches below the level of the greater trochanter and is on the center shaft of the femur (Starting Point Left) and (Starting Point Right).

Align the femoral shaft so it is parallel to the horizontal line of the laser.

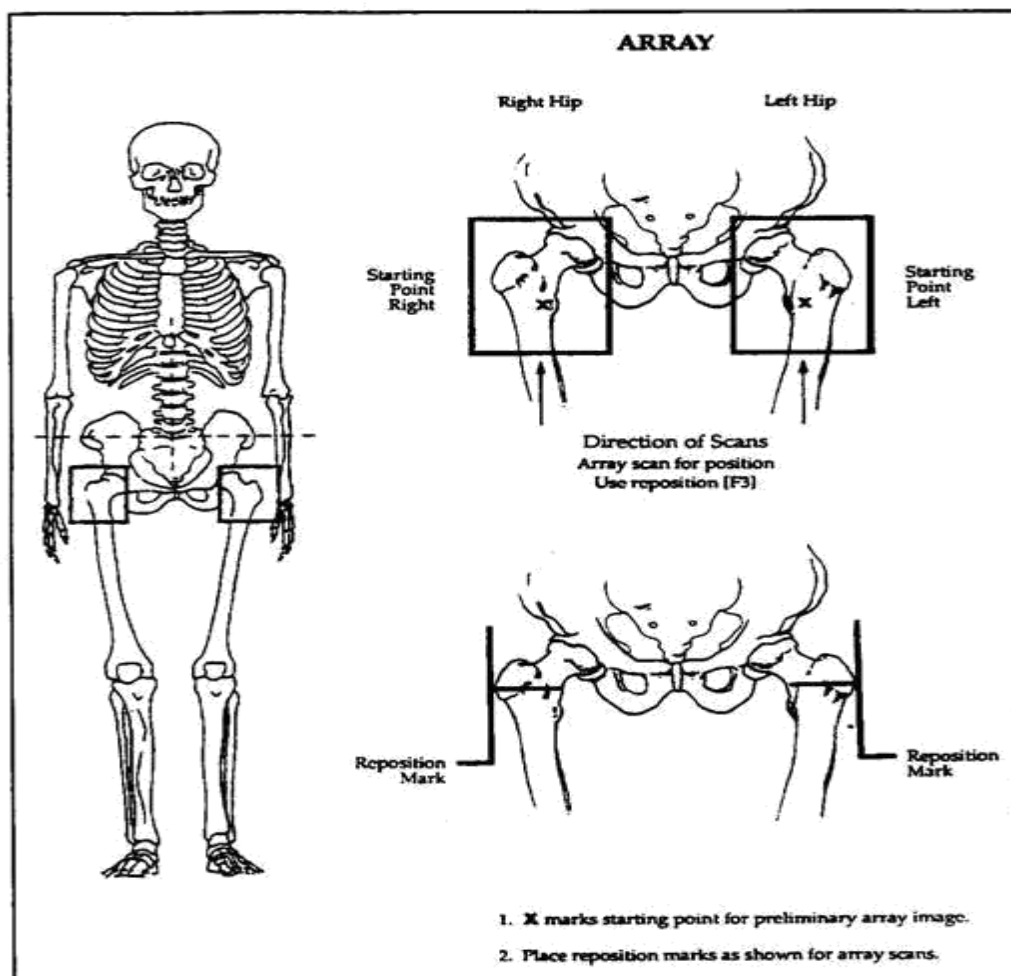


Figure (3-10) centering of hip scan

### 3.2.3.6.2 Scanning

Reconfirm that the SP is properly positioned and press (Start Scan) to begin the scan.

The Scan window displays with the image appearing on the left side. The flashing X-rays On indicator at the top of the window continues until the scan stops. The image will appear on the screen, one line at a time from the bottom up.

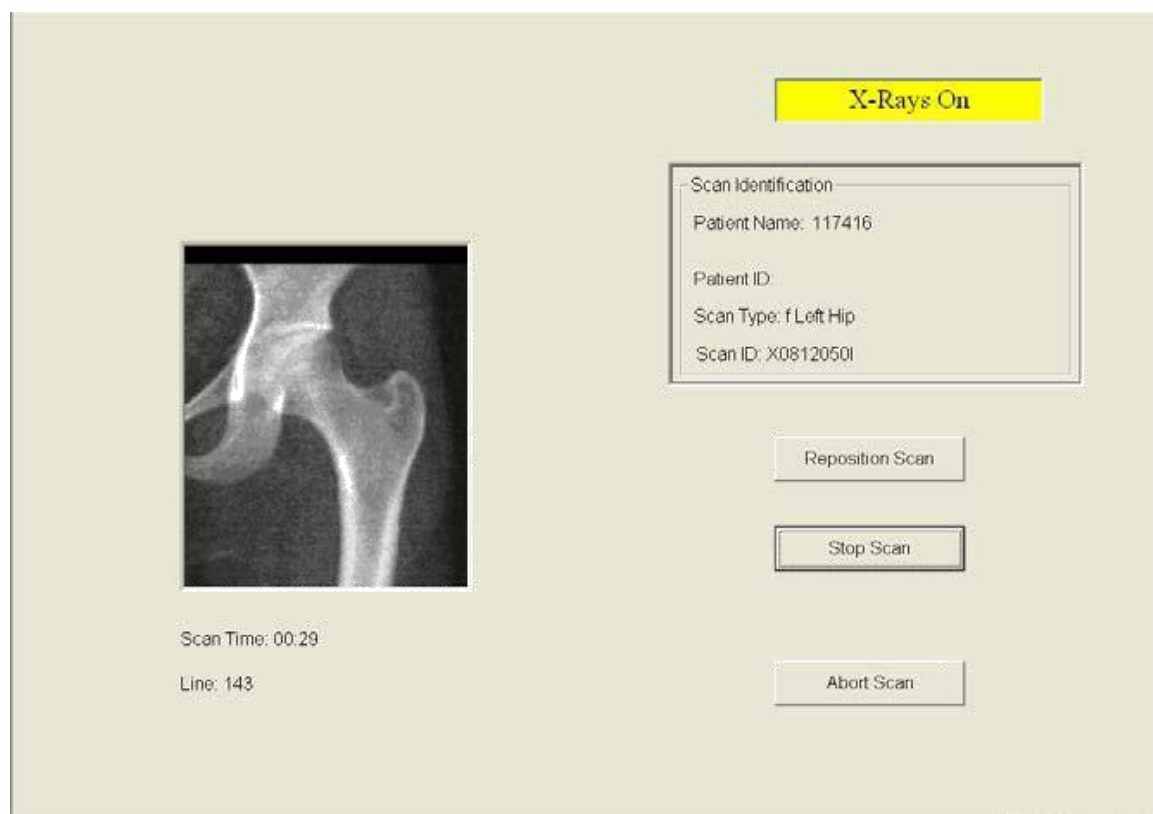


Figure (3-11) the scan window displays.

Inspect the image as it is generated. If the hip is positioned correctly, allow the scan to complete. If the hip is not positioned correctly, click

the “Reposition Scan” button to stop the scan.

When the outer edge of the greater trochanter can be identified ,press “Reposition Scan” to re-scan.

If the scout scan reveals that the SP has a hip replacement or pin previously not reported, stop the scan and proceed with scan on the other hip, if possible. If this is not possible, discontinue the scan and complete the Femur Scan data entry scan to document the reason for the incomplete scan.

Reposition the image up & down & left or right using the scroll bars or cursor hand to include the entire femoral head, neck, and approximately 3 inches of the shaft.

(Reposition Mark).

The new starting point is automatically adjusted to have the correct amount of soft tissue lateral to the greater trochanter.

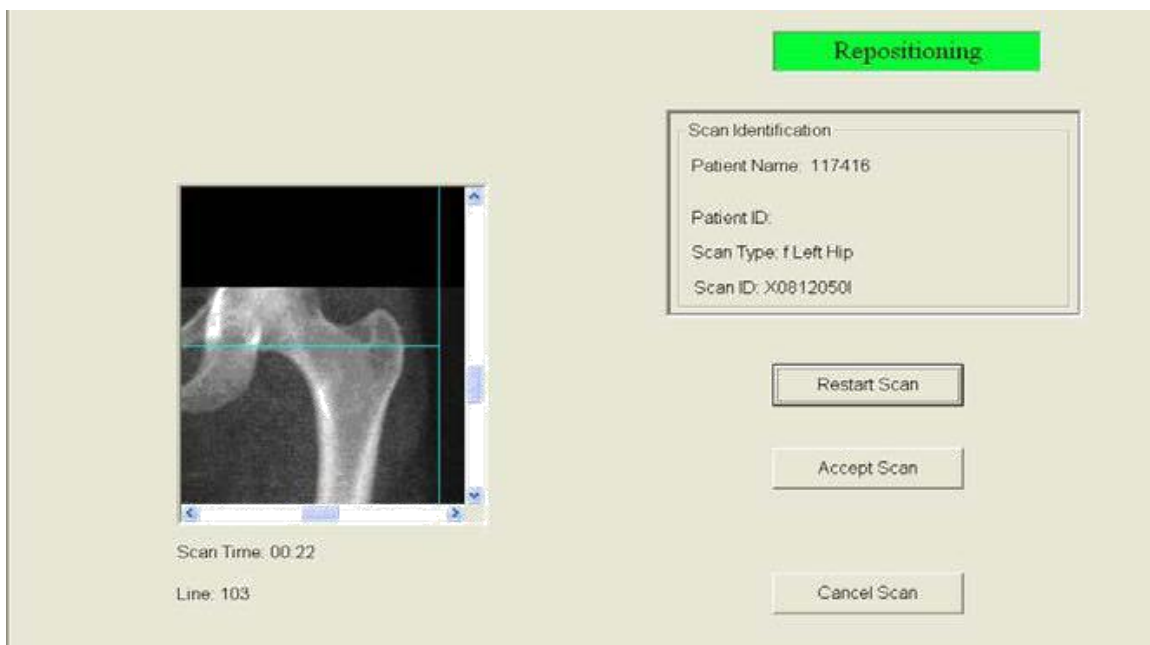


Figure No (3-12) Repositioning the femur

Press “Restart Scan” to return to the scan parameter screen. When the Scan Parameter screen re-appears, press “Start Scan” to repeat the scanning process. The scanning will start from the corrected starting point. Repeat the re-scan process until acceptable anatomy is shown, then allow the scan to finish. (See Figure 2-14) for an example of a properly aligned and rotated femur scan.

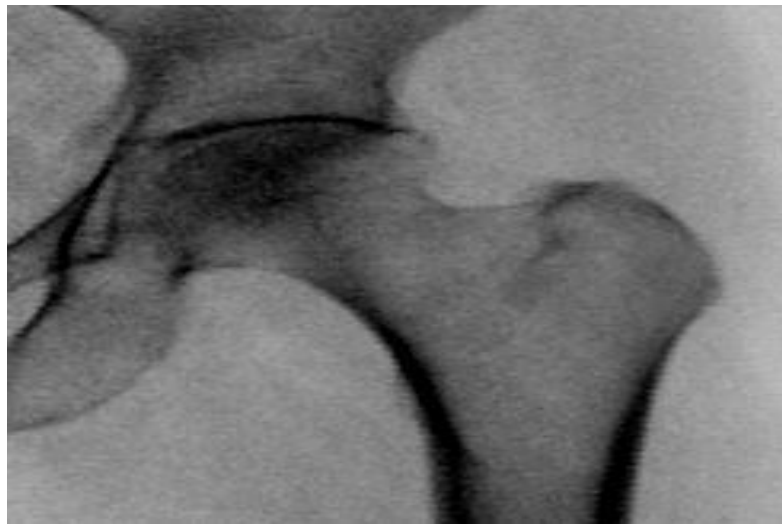


Figure (3-13) hip image

### 3.2.4 Report of DXA

Analysis of the scans will be done at the QC Reading Center. Exhibit **Table (2-3)** displays the bone mineral content (BMC) and bone mineral density (BMD) for the SP. In addition the box below the graph gives the T-score and the Z-score for the BMD for this SP.

**Results Summary:**

---

Total BMD: **0.797 g/cm<sup>2</sup>**  
Peak reference: **76%** T score: **-2.3**  
Age matched: **94%** Z score: **-0.4**

Region	Area [cm <sup>2</sup> ]	BMC [g]	BMD [g/cm <sup>2</sup> ]	T score	%PR	Z score	%AM
L1	10.47	6.18	0.591	-3.0	64%	-1.4	79%
L2	11.77	9.47	0.805	-2.0	78%	-0.2	97%
L3	12.15	10.37	0.853	-2.1	79%	-0.2	98%
L4	15.03	13.37	0.889	-2.1	80%	-0.1	99%
<b>Total</b>	<b>49.43</b>	<b>39.39</b>	<b>0.797</b>	<b>-2.3</b>	<b>76%</b>	<b>-0.4</b>	<b>94%</b>

Table (3-2) displays the bone mineral content

**T-Score**

— T-score indicates the difference between the patient’s measured

BMD and the ideal peak bone mass achieved by a young adult.

**Z-Score.**

— Z-score indicates the difference between the patient’s measured BMD and the ideal peak bone mass achieved by aged-matched peers.

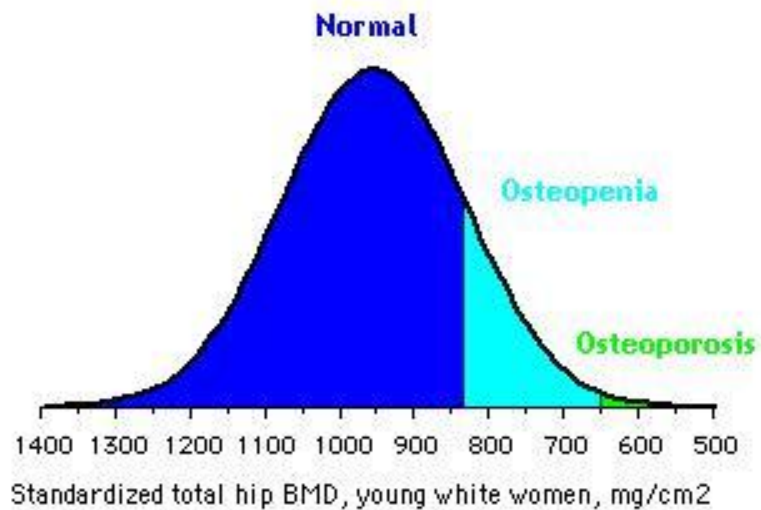
— Z-score can not be used to diagnose osteoporosis.

— indicate a need for further medical tests.(W.H.O Diagnostic Classification)



<b><u>Classification</u></b>	<b><u>T-score</u></b>
Normal	2 to -1.0
Osteopenia	-1.0 and -2.5
Osteoporosis	-2.5 to -4
Severe Osteoporosis	-4 to -5 fragility fracture

Table (3-3) W.H.O Diagnostic Classifications



W.H.O Diagnostic Classification related to BMB

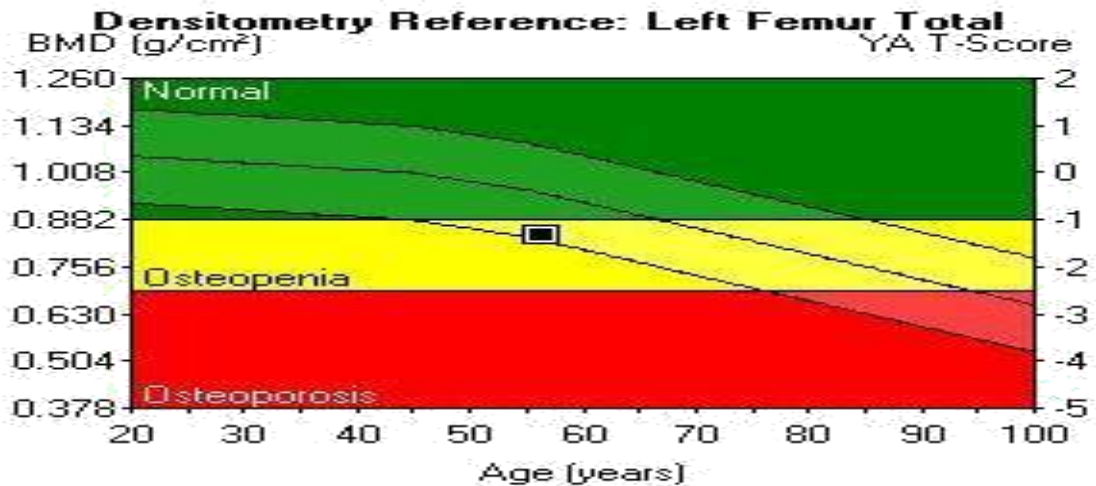


Figure (3-14) WHO Diagnostic classification related to BMD.

**Report**

- A radiologist, a physician specifically trained to supervise and interpret radiology examinations.
- analyze the images and send a signed report to your primary care or referring physician.
- DXA scans are also interpreted by other physicians such as Rheumatologists and endocrinologists.

**3.2.5 Radiation Protection in DXA**

In this section we take about radiation doses and protection:-

The radiation dose for the patient typically low doses, patient effective dose between 0.001 mSv\_0.01mSv, Doses increasing with newer technology.(Quality Control protocol for DEXA Systems)

**Table (3-5) demonstrates the Effective doses for DEXA spine and hip in adults for deferent models and scan mode:-**

DEXA MODEL	SCAN MODE	PA Spine(mSv)	Hip(mSv)
DPX	Medium	0.2	0.15
HOLOGIC – QDR1000	Fast	1.3	0.9
LEXXOS	Array	13.3	9.3

### **3.2.5.1 The radiation dose for the staff**

1-scattered radiation necessitates protection of staff and public.

2-scatter is highest closest to the source of scatter (patient).

3-staff doses from DEXA scanner are typically low.

4-annual scatter dose for typical workload has been measured at in form the scanner between 0.1mSv\_1.0mSv.

### **3.2.5.2 The radiation dose for the public**

1-there is a risk to members of the public from scattered radiation.

2-have an annual dose limit of 1mSv per year.

### **3.2.5.3 The radiation protection for the patient**

1-ALARA –As Low As Reasonably Achievable.

2-Every exposure must be justified& optimized..

3-Equipment factors: Appropriate selection of equipment, system operating satisfactorily.

4-Technique :Careful positioning to avoid repeat.

5-Training for staff: radiation protection training use proper collimation and proper selection of scan mode.

### **3.2.5.4 The radiation protection in pediatrics patient**

1-reduced attenuation from overlying tissues.

2-radiosensitive organs should be receiving low dose, ideally-low dose pediatric mode should be available.

### **3.2.5.5 The radiation protection for the staff**

1-Training of the staff should be trained in system operation

2-radiation safety procedures

3-Equipment layout position staff desk.

4-protective equipment a mobile lead screen is more suitable if additional shielding required .

5-classification of areas only staff that have a necessity to be in the "controlled" area may be there during X-ray exposure.

6-Dose monitoring staff to wear personnel dosimeters and dose to be monitored .

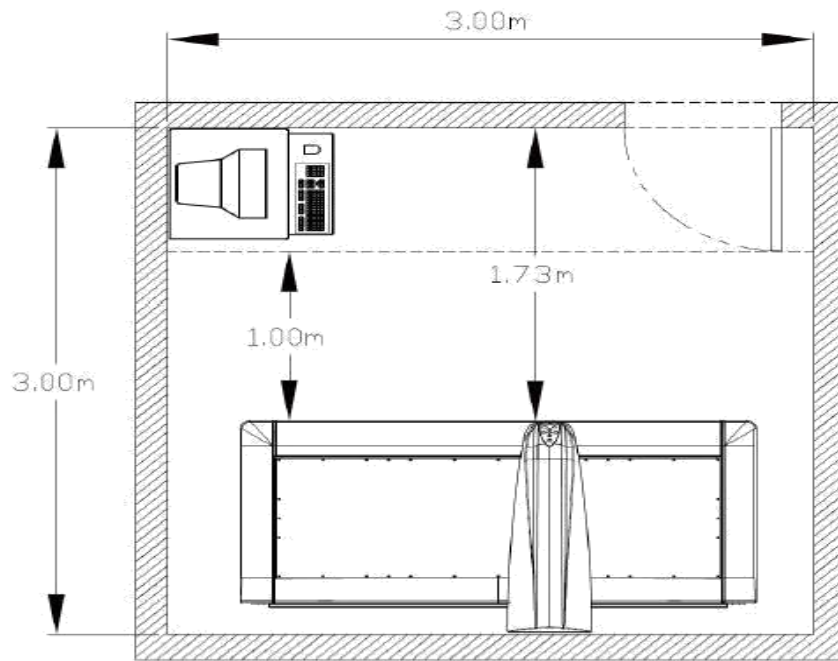


Figure (3-15) demonstrate the ideally equipment layout

### 3.2.5.6 In the Pregnant Staff

#### 1. Dose Limits

Limit of 1mSv applies for term of pregnancy after declaration.

#### 2. Declaration

Notify line manager as soon as possible.

3. Pregnant staff member to review local rules and adhere to good practice as normal.

### 3.2.5.7 The radiation protection for the public

All X-ray facilities should be designed to reduce the scattered radiation outside the X-ray room to acceptable limits.

Shielding design of rooms is optimized by using a design constraint of 0.3mSv per year. If levels exceed this, shielding will be required.

### 3.2.5.8 Summary of radiation protection

Three Principles of Protection:

1. Time
2. Distance

Radiation will fall off with distance (inverse square law).

Double the distance - reduces dose by factor of 4.

Always stay out of primary radiation beam.

### 3. Shielding

Use mobile lead screen if advised

### **3.3 Data collection and interpretation**

Data collected from patients examined by DXA scanner(Royal Care International Hospital) AP projection of lumbar spines by automatic machine self-reporting and then represented in table and graph.

### **3.4 Data Analysis**

Data represented in tables, graphs and analyzed by Microsoft Excel.

# **Chapter Four**

## **Results**

## **4.1 Introduction**

50 adults population, 29 female, 21 male with age ranged from 20-90 years no underline disease, children and pregnant women were excluded. Information obtained from examination by Dual Energy X-ray Absorptiometry (DEXA).

Data collected from sampling AP projection of lumber spines to measure and evaluate bone mineral density to make differential diagnosis in bone mineral density loss (normal, Osteopenia and osteoporosis) to evaluate the finding according to the T-score value.

## **4.2 Data Collecting Sheet**

The result of this study collected by:

- General patient information (age and gender)
- Estimation of Bone Mineral Density via DXA scanner examination.



## Chapter four

### The results

**Table (4-1) show the total correlation between age and gender**

status \ gender	Male	Female	Total
Osteopenia	11	12	33
Osteoporosis	1	8	9
Normal	9	9	18
Total	21	29	50

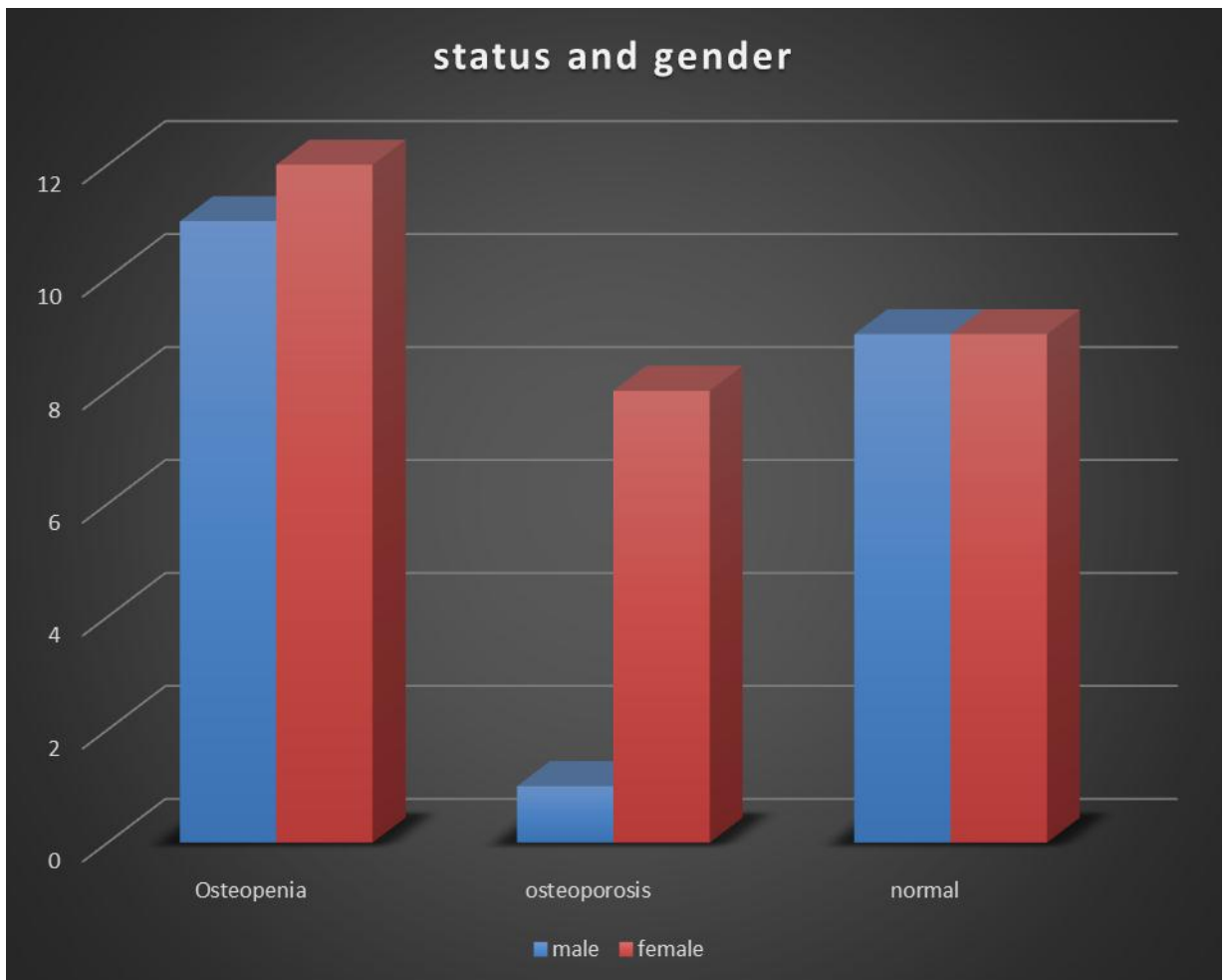
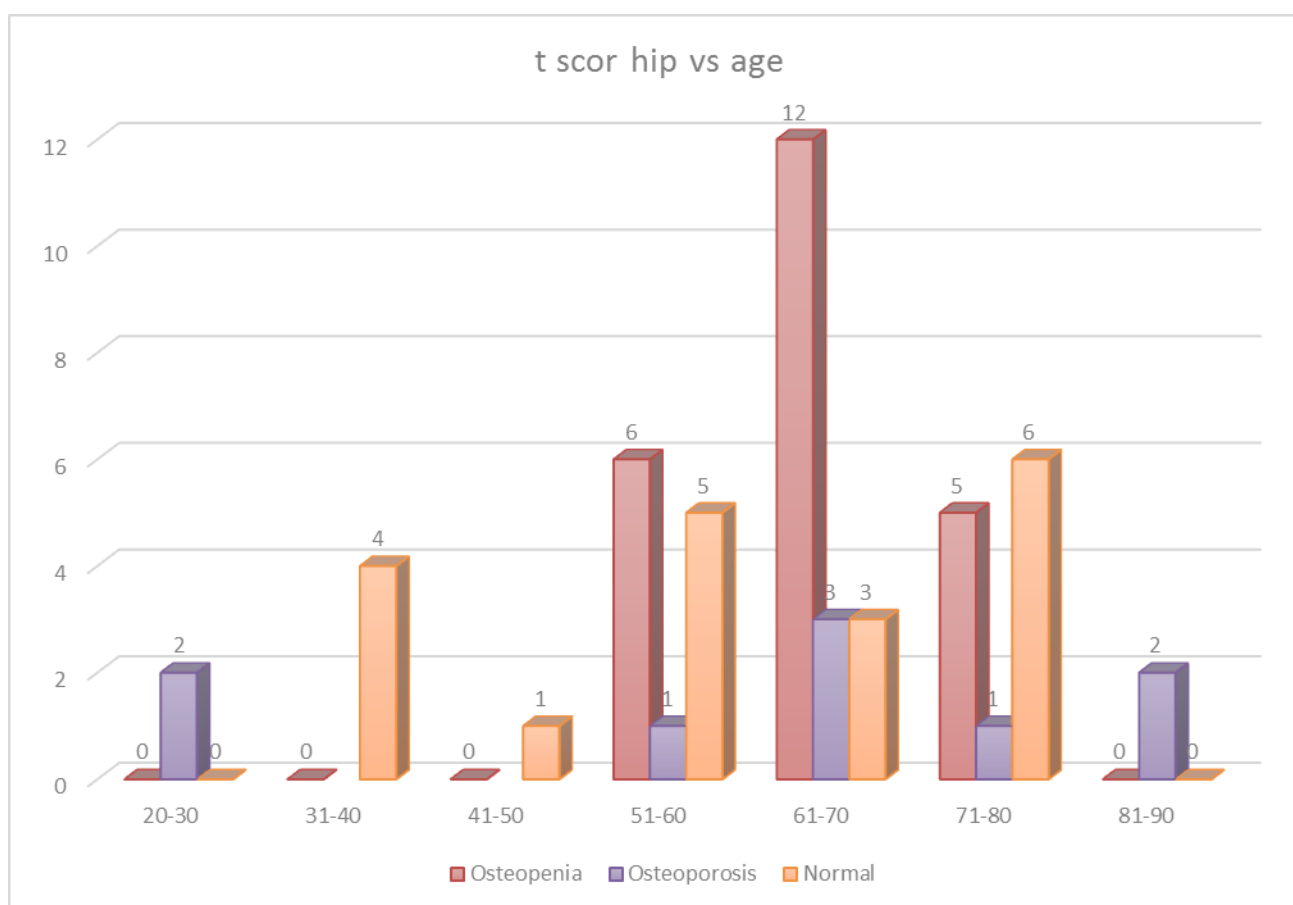


Fig (4-1)correlation Between Osteopenia and Gender

**Table (4-2) show the relation between age group and T score Hip**

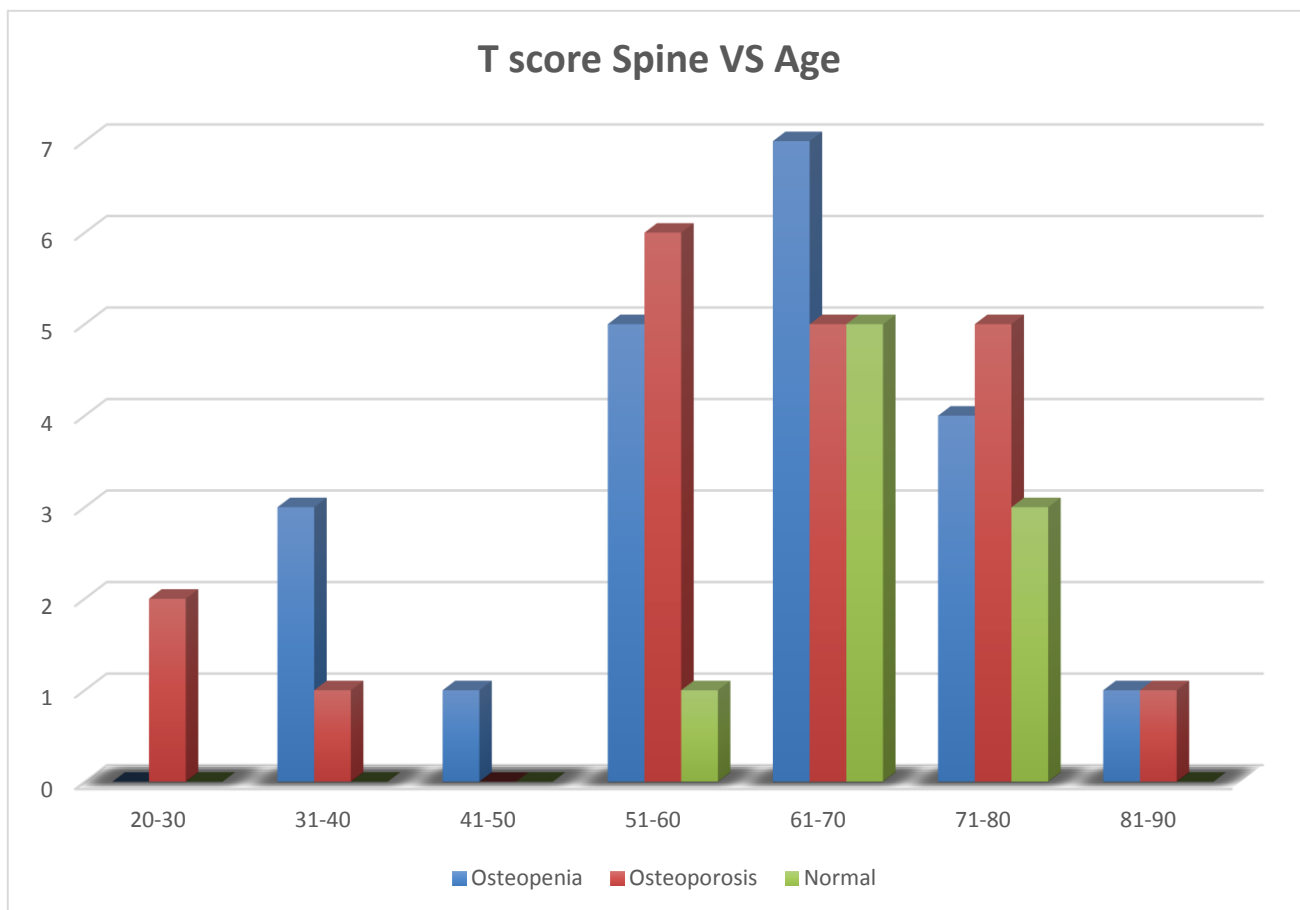
age group \ status	20-30	31-40	41-50	51-60	61-70	71-80	81-90
Osteopenia				6	12	5	
Osteoporosis	2			1	3	1	2
Normal		4	1	4	3	6	
Total	2	4	1	11	18	12	2



**Fig (4-2) correlation between osteoporosis and gender**

**Table (4-3) show relation between age group and T score spine**

Age group \ status	20-30	31-40	41-50	51-60	61-70	71-80	81-90
Osteopenia		3	1	5	7	4	1
Osteoporosis	2	1		6	5	5	1
Normal				1	5	3	
Total	2	4	1	12	17	12	2



**Fig (4-3) correlation between osteoporosis and gender.**

# **Chapter Five**

## **Discussion, Conclusion and Recommendation**

## 5.1 Discussion

**Table (4-1) represent the status(Osteopenia, Osteoporosis, or Normal)and gender .**

-Osteopenia are 23 patient representing 46%of total .52% female and 48% male.

-osteoporosis are 9 patients representing18%of total.89%female and 11% male.

-Normal Sudanese are18 representing 36%of total.50%femal,50% male.

**Table(4-2)represent T score Hip correlate with Age.**

Osteopenia begin to appear in patient up to 50 years.

51-60 show 12%of total osteopenia patients.

61-70 show 24% of total osteopenia patients.

71-80 show 10% of total osteopenia patients.

-Osteopenia is 46%of the total sample.

-Osteoporosis 18%of the total sample.

-Normal cases are 19patients represent 38% of total sample.

**Table(4-3)represent T score spine.**

Osteopenia :

31-40 show 6% of total osteopenia patients.

41-50 show 2% of total osteopenia patients.

51-60 show 10% of total osteopenia patients.

61-70 show 14% of total osteopenia patients.

71-80 show 8% of total osteopenia patients.

81-90 show 2% of total osteopenia patients.

-Osteopenia are 21 patient representing 42% of total .62% female and 38% male.

Osteoporosis:

20-30 show 4% of total osteopenia patients.

31-40 show 2% of total osteopenia patients.

51-60 show 12% of total osteopenia patients.

61-70 show 10% of total osteopenia patients.

71-80 show 10% of total osteopenia patients.

81-90 show 2% of total osteopenia patients.

Normal: 9 of total are normal represent 18%.

	The previous study	This study
Osteopenia	40%	46%
Osteoporsis	31%	18%
Osteopetrosis	11%	0%
Normal	19%	36%

Table(5-1)compression between the first Bone Measurement Densitometry(**BMD**) study in sudan 2012 and this study.

## **5.2 Conclusion**

According to the result 24% of females diagnosed with osteopenia, 22% are male. 16% of female osteoporotic, 2% osteoporotic males. 18% normal female, 18% normal males. From this diagnosis of osteodisorders there is significant correlation between disorders and gender. Bone loss and age, which is very important in track and manage osteoporosis.

### **5.3 Recommendations**

- 1- Further studies should be done with larger sample to evaluate bone mineral density to make differential diagnosis.
- 2- Study was limited by the fact that certain hospital has the bone mineral density scanner and segments of society were selected.
- 3- Quantitative CT scan, laboratory, investigation must be done to confirm the result.
- 4- Special care is taken during X-ray examinations to use the lowest radiation dose possible while producing the best images for evaluation.
- 5- State of the art X-ray systems have tightly controlled X-ray beam with significant filtration and dose control methods to minimize stray or scatter radiation.



# Appendix