Osteoporosis Assessment using DEXA among Postmenopausal Libyan Women

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Abstract:

Osteoporosis is the most commonly diagnosed bone disease worldwide, resulting in high morbidity and mortality. It is considered one of the greatest health hazards and is thought to be caused by low bone mass. The Bone Mineral Density (BMD)Test, which measures bone fragility, it is a commonly recommended test for evaluating osteoporosis. A special method called dual energy X-ray absorptiometry (DEXA) of the lumbar spine and proximal femur is used to perform this test. Lack of bone mineral density is still a cause of fractures in certain parts of the body, such as the hip and spine. The study aims to assess osteoporosis detection rate in different regions (lumbar spine and proximal femur) and evaluate the relative risk of osteoporosis to identify optimal and predictable fracture sites. DEXA measurements were obtained using a Hologic QDR4500 (A/SL.DELPHI discovery A/SL/W/C) of the 70 post-menopausal women at Masarra Clinic – Tripoli Libya. The BMD of L1–L4 as measured by DEXA ranged from 0.542 to 1.372 g/cm^2 (mean:0.86). BMD of the femoral neck as measured by DEXA ranged from 0.328 to 1.083 g/cm^2 (mean: 0.74). 30 (42.9%) were found by lumbar PA - DEXA to have osteoporosis with high fracture risk, and femoral neck by DEXA 18 (25.7%) to have osteoporosis with high fracture risk. The intergroup detection rates for

DEXA were significantly different, and the lowest BMD were found in the femoral neck. It is evident that the risk of hip fracture can be predicted by reports of femur (neck and hip) region and of spine region determines patient's response to treatment. Hence, it is recommended by many authors that measuring hip is the better option to assess the fracture risk.

Keywords: *BMD, DEXA, Masarra Clinic, Hologic, neck and hip.*

تقييم هشاشة العظام باستخدام الديكسا بين النساء الليبيات كبار السن

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الملخص:

يعتبر مرض هشاشة العظام من أكثر أمراض العظام شيوعًا في مختلف أنحاء العالم، ويعد من أكبر المخاطر الصحية الناتجة عن انخفاض كتلة العظام. ويعتبر فحص كثافة العظام هو الفحص الموصى به عادة لتقييم هشاشة العظام والذي يتم باستخدام طريقة خاصة تسمى قياس امتصاص الأشعة السينية للطاقة المزدوجة (ديكسا DEXA) للعمود الفقري القطني وعظم الفخذ لإجراء هذا الاختبار، ولا يزال نقص كثافة العظام سببًا للكسور في أجزاء من الجسم، مثل الورك والعمود الفقري. لذا تهدف هذه الدراسة إلى تقييم معدل اكتشاف هشاشة العظام في مناطق مختلفة تشمل (العمود الفقري القطني وعظم الفخذ) وتقييم الخطر النسبي لهشاشة العظام لتحديد مواقع الكسور المثلى والتي يمكن التنبؤ بها، باستخدام جهاز ديكسا *Hologic QDR4500* حيث شملت عينة الدراسة 70 امرأة من كبار السن المترددات على عيادة المسرة بطرابلس ليبيا. أوضحت الدراسة إن كثافة العظام للفقرات القطنية (L1 – L4) تراوحت من 0.542 إلى 1.372 جم/سم^2 بمتوسط: 0.86، وتراوحت كثافة العظم في الورك من 0.328 إلى 1.083 جم/سم^2 بمتوسط: 0.74 ووجد أن 30 حالة بنسبة (42.9٪) من حالات فحص الفقرات القطنية يكون بها هشاشة العظام مع ارتفاع خطر الكسر، وبينما كانت منطقة الورك 18 حالة وبنسبة (25.7٪) لديهم هشاشة العظام مع ارتفاع خطر الكسر من بين الحالات المدروسة، وكانت معدلات

الكشف بين المجموعات متفاوتة، وتم العثور على أدنى كثافة عظمية بالعظام في الورك، بالتالي فإن خطر كسر الورك يمكن التنبؤ به من خلال منطقة عظم الفخذ (عنق الفخذ والحوض).

الكلمات المفتاحية: الفقرات القطنية، الورك، ديكسا، هشاشة العظام.

1. Introduction.

Osteoporosis is characterized by low bone mass and deterioration of the micro architecture of bone tissue, resulting in increased bone fragility and thus increased fracture risk. Fractures include: fractures of the hip, spine, forearm, and other bones. Fractures can lead to reduced quality of life and increased medical costs. Therefore, osteoporosis is often seen as a major health risk (Li et al., 2013). Osteoporosis is most common in white postmenopausal women, but it's not just a disease of older women. Osteoporosis can occur in men and women of any age and in people of all races. About 25% of all fractures occur in men. One in five men (over 50) and one in two postmenopausal women (over 50) will suffer a fracture in their lifetime. The annual risk of fracture in postmenopausal women is greater than the combined risk of cardiovascular disease and breast cancer. If not diagnosed and treated, one low trauma fracture increases the risk of a second in the near future (The Irish Osteoporosis Society, 2011). Measuring Bone Mineral Density (BMD) of the spine and hip using dual-energy X-ray absorptiometry (DEXA) scans plays an important role in assessing an individual's risk of osteoporosis and assisting physicians in recommending appropriate fracture-preventive treatments for patients (Blake and Fogelman, 2007). The World Health Organization (WHO) has identified DEXA as the optimal densitometry technique for assessing BMD in postmenopausal women and defines osteopenia and osteoporosis based on its results. Indeed, DEXA has positive attributes including measurement of BMD at multiple skeletal sites, performance safety, short examination times, and ease of use. It can be done in about 5 minutes and requires minimal radiation exposure (about one-tenth that of a regular chest x-ray for a quick hip and spine exam) (ElMaghraoui, 2012). On average, women have lower bone density than men because women have smaller bones and trabeculae. On average, women lose more bone mass than men over their lifetime because they also go through menopause, 35 – 40% for men and 50% for women. Muscle contraction increases bone strength, and immature bones respond better to the stimulus of muscle contraction than mature bones. Strength training is vital for young people because it not only reduces the risk of osteoporosis, but also obesity, high blood pressure, type 2 diabetes, heart disease, stroke, low self-esteem and depression among numerous other problems (Evans, 2014). Through the above, The aim of the study was to assess

osteoporosis at different sites among postmenopausal women attending Masarra Clinic in order to identify sites at greatest risk of fractures to avoid their negative consequences.

2. Materials and Methods.

Data collected from 70 postmenopausal women who underwent a real spinal and hip DEXA at Masarra Clinic, Tripoli – Libya at the period between February 2013 and February 2017. The recorded data were registered and reviewed the BMD to assess osteoporosis detection rate in deferent region site (lumbar spine and proximal femur) and evaluate the relative risk of osteoporosis. The reported data analyzed using Microsoft Excel. All Participants cases were approved by the clinic.

2.1 Description of Equipment.

DEXA measurements were obtained using a Hologic QDR4500 (A/SL.DELPHI discovery A/SL/W/C) as illustrated in Figure (1). The analyzed done by using the manufacturer's software. The Hologic QDR 4500A is a fan beam X-ray bone densitometer, which uses two different energy levels produced by an energy tube to estimate Bone Mineral Content (BMC) and Bone Mineral Density (BMD). The QDR uses a low level of X-rays (National Health Nutrition Examination Survey, 2007).

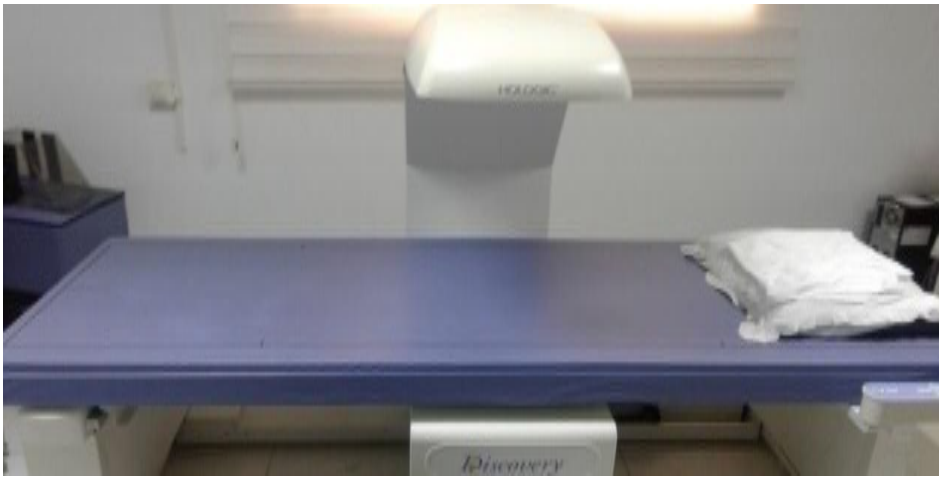

Figure (1): Hologic Densitometer QDR4500A at (Masarra Clinic)

2.2 Parameters evaluated in bone densitometry.

The system calculates various parameters as illustrated in Table (1). The values used for diagnosis (T and Z-score) are obtained by comparison with the reference database (Ramos, et al., 2012).

Table (1): Parameters evaluated in dual energy X-ray absorptiometry.

BMC	Bone Mineral Content is the quantity of calcium estimated by the energy absorbed by it in a specific region.
BMD	Bone Mineral Density much more relevant, is the mean quantity of mineral per unit area. It is calculated dividing the BMC by unit area (g/cm^2).
SD	Standard Deviation.
***T*-score**	Difference in number of SD between the mean BMD value of the patient and the mean of a young adult reference population of the same sex. The *T*-score is the value used to diagnose osteoporosis in postmenopausal women and in men aged 50 and over. *T*-score is the number of SD the patient's BMD above or below the mean for the young adult reference population of the same sex. (T-score ≥ -1.0) is ***normal*** ($-2.5 <$ *T*-score < -1) is ***osteopenia*** (*T*-score ≤ -2.5) is ***osteoporosis***
***Z*-score**	The difference in number of SD between the mean BMD value of the patient and the mean of a reference population of the same race, sex and age. The *Z*-score is used in premenopausal women, in men younger than 50 years, and in children and adolescents (up to 20 years). *Z* score is the number of SD the patient's BMD above or below the mean for the reference population of the same race, sex and age. A *Z*-score < -2 SD is defined as ''below the expected range for age.
BMI	Body Mass Index.
A/G ratio	Ratio of Android and Gynoid A/G pelvic fat.

2.3 Diagnostic Criteria.

The World Health Organization (WHO) has proposed criteria for the diagnosis of osteopenia, osteoporosis, and severe osteoporosis in women. All classifications of bone density incorporate the results of a BMD test. Results are expressed as a T-score, which is the number of Standard Deviations (SDs) above or below the peak bone mass of a young adult reference standard. Table (2) below illustrates WHO's Diagnostic Criteria for Osteoporosis (The Joint Commission, 2007).

Table (2): (WHO) Diagnostic Parameters for Low Bone Mass

Classification	BMD T-score via DEXA
Normal	BMD value within 1 (SD) of the young adult reference mean(T-score ≥ −1.0)
Osteopenia	BMD value more than 1 SD below the young adult mean but less than 2 SDs below this value (−2.5< *T*-score <−1)
Osteoporosis	BMD value 2.5 SDs or more below the young adult mean(*T*-score ≤ −2.5)
Severe Osteoporosis	BMD value 2.5 SDs or more below the young adult mean in the presence of one or more fragility fractures

2.4 Bone Density Measurements (BMD).

BMD is evaluation of patients at risk of osteoporosis and in the appropriate use of anti fracture treatment. In general the preferred method of testing is to use DEXA scans of the central skeleton to measure BMD of the lumbar spine and hip. T-scores can be calculated as following (Blake and Fogelman, 2007):

$$T - score = \frac{\text{Measured BMD} - \text{young adult mean BMD}}{Youngadultpopulation\ SD}$$

Z-scores are similar to T-scores except that instead of comparing the patient's BMD with the young adult mean, it is compared with the mean BMD expected for the patient's peers (for example, for a healthy normal subject matched for age, gender and ethnic group):

$$Z - score = \frac{\text{Measured BMD} - \text{Age matched mean BMD}}{\text{Age matched population}}$$

The DEXA T-score was calculated on the basis of the Caucasians reference database. Vertebrae from L1 to L4 and the left hip were scanned in the supine position using poster-anterior projections .The T-score for L1–L4 and for the femoral neck plus the total hip measurement by DEXA were used to diagnose osteoporosis. We used the diagnostic criteria established by the World Health Organization (WHO) in 1994. The currently recommended international standard for bone densitometry is to measure the lumbar spine (L1 – L4) and proximal femur (Blake and Fogelman, 2007).

2.5 Patient preparation.

The scan is pain free and noninvasive, and the participant is not enclosed or encased by the equipment. Due to the low levels of radiation, the radiographer is able to remain in the room with the patient during the scan. The participants were instructed to be in a fasted state and were not allowed consume water within at the last 2 hours. They were also asked to void, if possible, before the

scan. All metal, including jewellery and clothing that contains metals (i.e. buttons, clips, zippers and bra's that have under-wires) was asked to be removed. The participants were informed about which scans will be taking place, and what they will involve. These include: **1. AP-Spine Scan** - A large firm cushion is placed under the knees to assist the participants in lying flat for the spine scan. 2. **Dual Femur Scan** - While scanning the hip area the participants lied flat on their back and have their legs turned slightly inward (Hackett, 2017).

Figure (2): DEXA, PA study of the lumbar spine, Patient's positioning (Masarra Clinic)

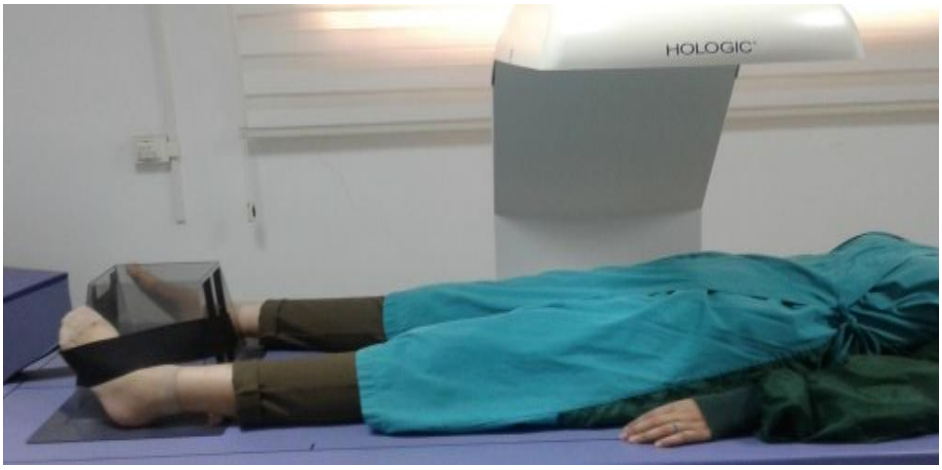

Figure (3): DEXA of the hip, Patient's positioning (Masarra Clinic)

3. Results and Discussions.

Diagnostic results of DEXA for 70 participants at Masarra Clinic are illustrated in Table (3). The study populations include; 70 post menopausal women ranged from 50 to 70 years.

Table (3): Diagnostic results of participants (n = 70).

	Normal %	**Osteopenia %**	**Osteoporosis %**
Lumbar Posterior Anterior (PA) – DEXA	6 (8.6)	34 (48.6)	30 (42.9)
Proximal femur site by DEXA	19 (27.1)	33 (47.1)	18 (25.7)

The BMD of L1–L4 as measured by DEXA ranged from 0.542 to 1.372 g/cm^2 (mean:0.86). The BMD of the femoral neck as measured by DEXA ranged from 0.328 to 1.083 g/cm^2 (mean: 0.74). The osteoporosis detection rates for lumbar PA-DEXA and femoral neck. The lowest BMD were found in the femoral neck rates. Also the intergroup detection rates for DEXA were significantly different as shown in Table (3). Of the 70 post menopausal women, 30 (42.9%) were found by lumbar PA - DEXA to have osteoporosis with high fracture risk, and any femoral site by DEXA 18 (25.7%) to have osteoporosis with high fracture risk. While the dictation rate of osteopenia were approximately equal between two different site. Appendices (A and B) show DEXA scan analysis report for spine and hips scanning problems. T-score discordance between the lumbar spine and hip testing sites is a commonly observed phenomenon in densitometery. T-score discordance is the observation that the T-score of an individual patient varies from one key measurement site to another. The software marks regions of interest in the spine and hip, but the adjustments by technologist are available if needed. The spine region of interest consists of the L1 through L4 vertebrae appendix (A). Correct placement of the top and bottom of the spine is critical. The intervertebral lines can be moved or angled, if necessary. There must be sufficient soft tissue on both sides of the spine; otherwise BMD will be under estimated. The hip regions of interest include the femoral neck, trochanter, and total hip appendix (B). The default hip analysis includes a midline that must be placed correctly for the other sites to be identified correctly. The preferred position for the rectangular femoral neck box differs for the different manufacturers. For Hologic the box is on the distal part of the femoral neck appendix (B). This induces a large difference between these 2 measurements, because of a gradient of BMD all along the femoral neck (the proximal being the highest, the distal being the lowest). Thus careful checking of the femoral neck box is mandatory (El Maghraoui, 2012). The most insightful study of osteoporotic fractures was a study conducted in the United

States that examined BMD measurements of the hips, spine, forearms, and heels of 9,704 white women aged 65 and older and conducted. Annual follow-up data on the relationship between BMD and fracture risk in different types of fractures; the data show that using hip BMD measurement to predict hip fracture risk has the largest relative risk value and is the most effective type of DEXA examination. Another study on the relationship between hip fracture and hip BMD, based on a meta-analysis of different fracture studies in Japan, Canada, Europe, and Australia, found that relative risk values were similar for men and women Osteoporotic Fractures study (Blake and Fogelman, 2007). The update recommends that the diagnostic use of T-scores be reserved for hip DEXA BMD measurements and that other T-scores not be used to diagnose osteoporosis. BMD measurements at sites other than the hip can be used to assess the relative risk of osteoporosis and calculate the probability of fracture using the WHO FRAX® tool, which suggests that BMD or T-score should be measured at the femoral neck in postmenopausal women (Mindways, 2012). Fracture risk increases exponentially as BMD decreases. Results are expressed as an increase in risk factors for each 1-SD decrease in BMD. Relative risk value results by fracture site and BMD measurement site. Typically, each SD decrease in BMD is associated with a 1.5- to 2.5-fold increase in fracture probability. The spine and hip are often considered the most important areas to measure because they are the sites of common fractures. Hip BMD measurement is the most reliable method of assessing hip fracture risk (Fogelman and Blake, 2000). Our work revealed significant differences in DEXA osteoporosis detection rates at respectful measurement sites. The lowest BMD were in the femoral neck rates which is more susceptible and predictable to fracture other than central sits especially in post menopausal women that cause considerable harm of quality of life and increased morbidity and mortality.

4. Conclusions.

Hip and spine DEXA exams have a number of significant clinical benefits, such as their compatibility with the WHO T-score definition of osteoporosis, their efficacy in predicting fracture risk, their efficacy in guiding anti-fracture therapy, and their efficacy in tracking patients' response to therapy. Spine BMD assessments will be done for the purpose of therapy monitoring, and hip BMD assessments will be done for treatment decision-making. According to the available data, the spine is the ideal location to assess treatment response while the femur (neck or entire hip) is the best location for predicting the risk of hip fracture.

5. Acknowledgment.

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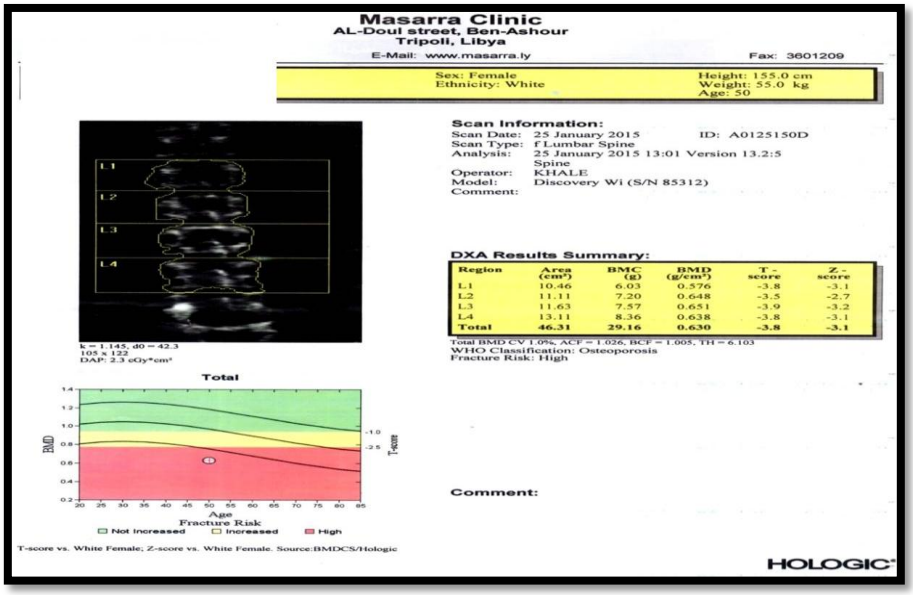
Appendices

Appendix (A): Correct positioning and analysis of the L1–L4 spine (Hologic)



Appendix (B): correct positioning and analysis of the proximal femur (Hologic)