Evaluation and Detection of Osteoporosis among Rheumatoid Arthritis Patients by Dual -enegy x-ray Absorpotiometry (Dexa)

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Abstract -The Dual-energy X-ray Absorptiometry (DXA) is a pivotal diagnostic tool for detecting osteoporosis and monitoring treatment response, due to its speed and wide availability, measurement accuracy, and low radiation exposure. Early detection of osteoporosis in patients can reduce the incidence of fractures, worsening of the disease, and high economic burdens on individuals and health systems. This research aims to highlight the vital role of DXA in the detection of osteoporosis in rheumatoid patients, and to explore the main causes that have a significant role in the progression of the osteoporosis stage.

This study included a group of rheumatic patients with osteoporosis, of both sexes, approximately between the ages of 30 and 80 years. The total number of samples reached 40 patients, where part of the images were obtained from patients who were photographed during their visit to the clinics (Al-Diqqa Clinic, Clinic Al-Masarra, The Advance center for medical imaging), while the rest of the data were collected from the patients who had pictures and results of tests ready.

Through the research, we found that females are more likely to develop osteoporosis than males, because the percentage of mineral density in women is lower than in males in all locations, in addition to the increase in the incidence rate with age. We also noted an association between low vitamin D levels and an increased risk of osteoporosis ($P<0.01$), as the level of vitamin D in patients with osteoporosis decreases with age. Conclusions: DEXA plays an important role in evaluating osteoarthritis, especially in patients with rheumatoid arthritis. It is the gold standard for diagnosing osteoarthritis and improving the chances of predicting fracture risks and evaluating treatment by providing information about bone density, quality and strength.

Keywords—Osteoporosis, DEXA, rheumatoid arthritis,Vitamin

L INTRODUCTION

Osteoporosis is a chronic structural disease characterized by low bone mineral density (BMD) and deterioration of the fine structure of bone tissue, leading to increased osteoporosis and a higher risk of coagulation [1] .

This disease represents a global health challenge, and is especially important in at-risk groups, most notably patients with rheumatoid arthritis, as this disease contributes to an increased risk of fragility in these patients through the release of soluble agents from the joint and the use of therapeutic corticosteroids for long periods. A group study indicated the presence of osteoarthritis in about 30% of patients with rheumatoid arthritis. The prevalence of osteoarthritis in patients with rheumatoid arthritis is about twice higher than in the general population[4], especially with the aging of the population, as the percentage of patients over 65 years of age continues to rise [2]. In this context, the Dual-energy X-ray Absorptiometry (DXA) stands out as a pivotal diagnostic tool for detecting osteoporosis and monitoring treatment response, due to its speed, wide availability, measurement accuracy, and low radiation exposure, according to the World Health Organization (WHO). Early detection of osteoporosis in patients is critical, as it can reduce the incidence of fractures, worsening of the disease, and high economic burdens on individuals and health systems. This research aims to shed light on the vital role of the DXA device in detecting osteoporosis in rheumatism patients, and to explore the challenges and opportunities associated with its application in clinical life. This research was divided into five chapters: the general framework,

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osteoporosis, rheumatism, dual-energy X-ray measurement, the results of the examination using the DEXA device, and statistics. [3]

1. DXA Inspection System

Dual-energy X-ray absorption measurement (DEXA) is an X-ray imaging technique used mainly to measure the mass of one material in the presence of another, by knowing how much each material absorbs X-rays at different energies**.**

2. Data collection tools and methods

- Dexa Examination: We relied on Dexa images of patients. The examination is performed with the patient lying on the table, then three basic pictures are taken:

1. Lumbar vertebrae L1 to L4.

2. Neck of thigh.

3. Radial bone.

- Laboratory tests: The patients' tests were used, most of which included:

Vitamin D, Calcium, Enzymes for Liver Function Checking, and Kidney Function Checking Index (Creatinine).

3.Statistical analysis of data

The data was collected and analyzed statistically using SPSS software (version 27). Descriptive statistics were used to summarize demographic data (frequency, percentage, mean, standard deviation). Inferential statistics, including chi-square fit testing, were used to examine statistically significant differences between classes of variables in the sample distribution. The chi-square of independence and the t-test of two independent samples were used to examine the correlation between the variables. The t-test of one sample was used to determine the statistically significant differences between the sample and the assumed mean, while the one-way variance test (ANOVA) was used to determine the statistically significant differences between the variables. A P value less than 0.050 was considered statistically significant.

4.Results of statistical analysis

An analytical descriptive study was conducted on 40 patients with rheumatism who were diagnosed with fragility, with the aim of discovering the causes that led to the fragility and identifying the affected places by examining biochemical indicators in the blood, and the results of DXA tests.

Section 1: Demographic information about the participants

This section provides basic demographic data on the research sample of participants.

Table 1: Illustrated The distribution of the sample according to gender

Gender	Number	%	Statistical significance p-value
Female	35	87.5	* *0.000
Male	5	12.5	

* Statistical significance at a level less than 0.05

* * Thestatistical significance at the level of 0.01

As illustrated in Table (1), it was found that the highest percentage of patients with fragility were females, accounting for 87.5% of the total sample, while only 12.5% of those infected were males. There is a statistically significant difference in the incidence of fragility between males and females, with a probabilistic value (p=0.000). (1p<0.0). This indicates that the prevalence of fragility among females with rheumatoid arthritis is higher than that of males with the same disease.

Table 2: Illustrated The distribution of the sample according to age

Age group	Number	%	Statistical significance p-value
Less than 30 years old	2	5	0.000* *

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30–45 years	6.	15%
60–46 years	9	22.5%
Above 60 years	23	57.5

* Statistical significance at a level below 0.05

* * Statistical significance at the level of 0.01

Through Table (2), it was found that the highest percentage of patients with fragility was over 60 years of age by 57.5%, followed by the age group (46-60 years) by 2.5%, followed by the age group (30-45 years) by 15.0%, while only 0.5% of patients with fragility were under 30 years of age respectively. There is a statistically significant difference in the incidence of fragility among patients according to age, with a probability value (p=0.000). (1p<0.0). This indicates that the prevalence of osteoarthritis among patients increases with age, meaning that older patients with rheumatoid arthritis are more likely to develop osteoarthritis.

Table 3: The distribution of the sample according to the place of osteoporosis

Location of fragility	Number	%	Statistical significance p–value
Lumbar vertebrae (L1–L4)	19	47.5	0.161
Radius	11	27.5	
Femur	10	25.0%	

tatistical significance at a level below 0.05

Through Table (3), it was found that the highest percentage of arthritis patients had lumbar osteoarthritis (L1-L2) by 47.5%, followed by patients with radial osteoarthritis by 27.5%, while only 25.0% of arthritis patients had femoral osteoarthritis. There is no statistically significant variation in the incidence of fragility among patients according to the place of fragility, with a probability value (p=0.161). (5p>0.0). The incidence rate of radial osteoporosis and femoral osteoporosis among patients is equal, as is the difference between the incidence rate of lumbar vertebral osteoporosis (L1-L2) and radial osteoporosis, and between it and femoral osteoporosis is also equal among the sample members.

As illustrated in appendix Table (4) shows that females have more radial osteoarthritis (100.0%), femur (90.0%), and lumbar vertebrae (78.9%) than males (0.0%, 10.0%, 21.1%, respectively). There are no significant differences between males and females regarding the location of fragility (p>0.05). The

incidence of fragility in women was higher than in males in all locations and there was no specific place that was more likely to be infected in one gender than the other.

Patients over 60 years of age are more likely to develop lumbar osteoarthritis (68.4%), femur (50.0%), and radius (45.5%) than other age groups, as patients under 30 years of age represent only 20% of all femoral osteoarthritis patients. Ages 30-60 share the same incidence of lumbar and radial osteoarthritis (15.8% and 27.3%), respectively. There are no statistically significant differences between the age groups of patients regarding the location of fragility (p>0.05). That is, there is no specific place that is more likely to be infected at a certain age than the other

Section II: DEXA Examination Results for Fragile Patients

This section shows the standard score values (T-score & Z-score) in addition to the bone mineral density values in fragile patients.

As illustrated in appendix Table (5) the average standard score (T) for bone density of rheumatoid arthritis patients (-3.20 ±0.827), which is less than the average standard score (T) for bone density of healthy people without osteoporosis (T > -2.5), where there are statistically significant differences between the average standard score (T) for bone density of rheumatoid arthritis patients and the average standard score (T) for bone density of healthy people without osteoporosis. (p<0.01) .(p=0.000) That is, there is a sharp decrease in bone density and the incidence of osteoporosis in arthritis patients and an increased risk of fractures.

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The mean standard score (Z) for bone density of rheumatoid arthritis patients (-1.970 ±1.086), which is lower than the mean standard score (Z) for bone density of healthy people without osteoporosis (Z > -1.5), where there
are statistically significant differences between the mean standard score (Z) for bone density of rheumatoid arthritis patients and the mean standard score (Z) for bone density of healthy people without osteoporosis.($p<0.01$) .($p=0.009$). That is, there is a sharp decrease in bone density, brittleness in arthritis patients, and an increased risk of fractures.

As illustrated in append Table (6), it is clear that the value of the average standard score (T) and the mineral density of the radius is less than the femur than the lumbar vertebrae in patients with fragility, with statistically significant differences in the average standard score (T) and bone mineral density between patients with fragility according to the place of fragility ($p<0.05$). That is, the bones of the lumbar vertebrae are less prone to fracture compared to the femur and radius. While there are no statistically significant differences in the mean standard score (Z) between patients with fragility according to the place of fragility ($p>0.050$).

4 RESULTUS AND DISCUSIONS

This study was conducted on 40 patients with rheumatoid arthritis with brittleness, with the aim of detecting factors that increase the risk of brittleness and identifying the affected places by examining biochemical indicators in the blood, and the results of DXA tests.

1.Fragility rate by sex and age

Through our study, the highest percentage of patients with fragility were females, at 87.5% of the total sample, while only 12.5% of those infected were males($p<0.01$). Another study reported that out of 38 participants with osteoporosis (76.34%) were females and(23.68%) were males. A study by Hernlund E et al. found that 21% of females and 6% of males residing in Sweden have osteoporosis. This study showed that osteoporosis is more than 3-4 times more common in females than males.[4] This confirms that females are more likely to develop osteoporosis than males. This difference may be attributed to additional bone loss in females associated with estrogen deficiency during the premenopausal period and after menopause. Low estrogen associated with menopause is an important factor in osteoporosis; menopause may even be associated with between one-third and one-half of the bone loss that occurs during a woman's life. Low estrogen is associated with increased bone absorption, especially in spongy bones. Other estrogen deficiencies, such as exercise-induced amenorrhea, hypogonadism, and surgery-induced amenorrhea, are also associated with decreased bone mass.

Previous studies have shown that bone loss starts from the age of 35-40 years in both men and women[5]. These results are identical to our study, where the percentage of people with fragility in this age group reached 15.0% of the total sample, and the incidence rate increased in the older groups, where it reached 22.5% for the age group (46-60 years), and 57.5% for the age group older than 60 years, (($p<0.01$), and this was supported by a similar study conducted by Shrestha S et al., where it revealed 31.57% and 60.52% of people with osteoporosis in the age group (50-59) years and 60 years and more, respectively[6].

2.DEXA Screening Results for Fragile Patients

According to the results of the current study, the average standard scores (T) and (Z) for bone density of patients with rheumatoid arthritis were (-3.20 ±0.827) and (-1.970 ±1.086), respectively, which is less than the average standard score (T) and (Z) for bone density of people without osteoporosis (T > -2.5) and (Z > -1.5), ($P<0.01$), according to the World Health Organization (WHO), the value of (T < -2.5), (Z < -1.5), indicates that there is a sharp decrease in bone density and the incidence of osteoporosis in patients with arthritis and an increased risk of fractures

The highest percentage of arthritis patients had lumbar osteoarthritis (L1-L2) at 47.5%, followed by radial osteoarthritis patients at 27.5%, while only 25.0% of arthritis patients had femoral osteoarthritis. The incidence rate of radial osteoporosis and femoral osteoporosis among patients is equal, as well as the difference between the incidence rate of lumbar spondylosis (L1-L2) and radial osteoporosis, and between it and femoral osteoporosis is also equal ($p<0.01$). On the other hand, the mineral density of the lumbar vertebrae was higher than that of the femur and radius by an average (0.789 ±0.087, .5840 ±0.144, .4760 ±0.175, respectively), and by a standard (T) score (0.332± 2.857-, 0.791±3.360-, .(1.197± 3.654- That is, the bones of the lumbar vertebrae are less prone to fracture compared to the femur and radius, because they contain a higher level of density compared to the latter .[7]

females are more likely to have radial osteoporosis (100.0%), femur (90.0%), and lumbar vertebrae (78.9%) than males (0.0%, 10.0%, 21.1%, respectively). This is because the percentage of mineral density in women is lower than in males in all

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locations, and this is supported by a similar study conducted by Hannan et al., where it was revealed that the percentage of loss in bone mineral density in women is much greater than the loss in men in all locations .

Patients over 60 years of age have the highest incidence of lumbar osteoporosis (68.4%), femur (50.0%), and radius (45.5%) of other age groups, followed by the 30-60 age group who share the same incidence of lumbar osteoporosis and radius (15.8% and 27.3%), respectively, while patients under 30 years of age account for only 20% of total femoral osteoporosis. This is supported by a similar study by Hannan et al., which revealed that bone mineral density loss persists with age in both men and women[8].

3.Results of laboratory tests for patients with fragility and its relationship to increased risk of fragility

In our current study, mean vitamin D levels in osteoporosis patients (21.573 ± 10.491) are lower than normal (above 30 ng/mL) with an association between lower vitamin D levels and an increased risk of osteoporosis ($P<0.01$). The level of vitamin D in frailty patients decreases with age.($p<0.01$) This is often due to the low consumption of this vitamin by older people, as well as their insufficient absorption of the vitamin, in addition to their lack of exposure to sunlight. Previous studies have shown that vitamin D deficiency is one of the most prevalent risk factors for[6] rheumatoid arthritis. Deficiency of this vitamin may lead to a disorder of the vitamin D/parathyroid hormone (PTH) system, a known factor for bone health. Moreover, RA patients appear to be relatively resistant to the suppression of PTH caused by vitamin D. Therefore, the association between rheumatoid arthritis and osteoarthritis may be partly due to changes in the vitamin D/parathyroid hormone system[7]. With regard to calcium and potassium levels (9.123± 0.525,4.206 ±0.582, respectively) in fragile patients, they are in the normal range and there is no significant dysfunction in kidney and liver function according to the analysis of creatinine levels, the enzyme Alt and the enzyme AST (.8810 ± 0.245,28.110 ± 10.579,29.940 ± 9.095, respectively) in fragile patients; noting that there is a gradual decrease in creatinine level in fragile patients with increasing age, ($P<0.05$),which is normal as a result of decreased muscle mass in the elderly and thus decreased creatinine production among patients who have a smaller muscle mass.

4.Obstacles and Difficulties**:**

The study is limited by the small size of the sample and the difficulty of accessing cases and analyzes, which makes it difficult to generalize its results, so it is recommended to conduct more studies at a higher level of evidence using the random sampling method and in wider environments, which provides national data on the prevalence of osteoporosis in Libya and facilitates the identification of the most common causes of this disease**.**

5. Conclusions and Recommendations**:**

1. Dexa and other imaging methods greatly facilitate the assessment of osteoporosis. While DEXA remains the gold standard for diagnosing osteoporosis, other imaging techniques may shed light on bone health in more detail.
2. DEXA imaging methods improve the chances of predicting fracture risk and evaluating treatment by providing information about bone density, quality, and strength.
3. If not treated properly and in a timely manner, osteoporosis can lead to fracture, the need for long-term nursing care, a decline in quality of life, social isolation, depression, and loss of self-confidence.
4. Osteoporosis is a treatable condition, where the incidence and mortality rate among the elderly can be reduced with adequate intake of calcium, and vitamin D (adequate exposure to sunlight).
5. Thirty-minute weight-bearing exercises, such as walking and back-strengthening exercises, should be encouraged throughout life. Measures should also be taken to prevent fall injuries in people diagnosed with osteoporosis.

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Appendix.

Table 3: Illustrated the location of fragility according to the sex and age of patients

Demographic data		Location of fragility						Statistical significance
		Lumbar vertebrae (L1-L4)		Radius		Femur		
		Number	%	Number	%	Number	%	
Gender	Female	15%	78.9	11	100%	9	90	0.235
	Male	4	21.1	0	0.0%	1	10	
Age group	Less than 30 years old	0	0.0%	0	0.0%	2	20	0.120
	30-45 years	3	15.8%	3	27.3	0	30	
	60-46 years	3	15.8%	3	27.3	3	30	
	Above 60 years	13	68.4	5	45.5	5	50	

Table: 4 Illustrated Comparison of patients' bone density standard score and healthy people's bone density

Fragility Scale	Number	Lowest value	Highest value	Standard Deviation	Test Value t	Statistical significance (P-value)
T-score	40	6.00-	2.50-	-3.202±0.827	5.367-	* *0.000
Z-score	40	6.00-	0.10-	-1.970±1.086	2.737-	* *0.009

* Statistical significance at a level less than 0.05

* * Thestatistical significance at the level of 0.01

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Table 5. illustrated the standard degree of bone density and bone mineral density according to the location of fragility

* Statistical significance at a level less than 0.05

Scale	Location of fragility	Lowest value	Highest value	Standard Deviation	Test Value t	Statistical significance (P-value)
T-score	Lumbar vertebrae (L1-L4)	3.60-	2.50-	0.332+2.857-	4	*0.027
	Radius	6.00-	2.50-	1.197+3.654-		
	Femur	4.80-	2.60-	0.791+3.360-		
Z-score	Lumbar vertebrae (L1-L4)	2.70-	0.10-	0.746+1.668-	3.069	0.058
	Radius	6.00-	1.10-	1.521+2.618-		
	Femur	3.00-	0.10-	0.834+1.830-		
Bone mineral density (BMD)	Lumbar vertebrae (L1-L4)	.590	.910	+0.7890.087	21.785	* *0.000
	Radius	.190	.790	0.476+0.175		
	Femur	.340	.800	0.144+0.584		

* * The statistical significance at the level of 0.01

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