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Relationship between Bone Mineral Density and Fragility Fracture

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Abstract

Background: Reduced bone density is a major risk factor for fragility fracture. Previous studies reported, that 69% to 100% of patients with fragility fractures had low bone mineral density (BMD). **Objective:** The objective of the study is to estimate the prevalence of osteoporosis and osteopenia among patients with fragility fractures. **Results:** The result of the study revealed that the mean age of patients included in the study was 65.11 ± 10.17 and the majority (77.3%) were females. The most common sites of fractures were the femur, radius and vertebra (30.7%, 17.0% and 14.8% respectively). Moreover, more than 95% of patients with fragility fracture who underwent BMD testing had low bone mineral density. In female with fragility fracture the prevalence of osteoporosis was higher in comparison to male (58.8% and 45.0% respectively). **Conclusion:** Our data showed that low BMD measurement is prevalent in patient with fragility fracture. It also highlighted the importance of implementation of Fracture liaison service, to reduce the gap between fragility fracture and osteoporosis treatment.

Keywords

Fragility Fracture, Osteoporosis, Low Bone Mineral Density, Fracture Risk

1. Introduction

Fragility fracture is defined as a fracture sustained from a fall from standing height or less. Its most common cause is osteoporosis. The fracture is both a sign and a symptom of osteoporosis. Typical fractures in patients with osteoporosis include vertebral, proximal femur, distal forearm and proximal humerus [1] [2]. These fractures are associated with an increased morbidity and mortality in elderly patients, and place a high economic burden on health care systems. Moreover, a

previous fragility fracture doubles the risk of subsequent fractures [3] [4].

Previous studies have shown that, low bone mineral density (BMD) is the main important determinant of fragility fractures [4] [5]. and this could be evaluated using the dual-energy X-ray absorptiometry (DEXA) measurements. The BMD measurements are a powerful predictor of the risk of fragility [6], this risk increases with decreasing BMD. Many studies have shown that, fragility fracture risk will increase by one-to-three times if BMD reduced by one standard deviation [7] [8].

Despite the magnitude of risk imparted by a history of fracture, the great majority of patients who present with fragility fractures are not evaluated with DEXA scan and are not considered for osteoporosis treatment. It has been reported that less than 20% of those who sustain a fragility fracture receive therapies to reduce the risk of fracture within the year following the fracture [9].

A Japanese study, included 1445 patients with a fracture of the distal end of the radius [10] reported that after the fracture, bone density was measured in only 126 patients (8.7%) and treatment for osteoporosis was performed in only 193 patients. (13.4%)

According to The Gulf Cooperation Council (GCC) countries report, women aged 65 and above with a prior fragility fracture can be considered for treatment without the need for further assessment. The BMD measurement is more appropriate in younger postmenopausal women. Nevertheless, it is recommended by many experts to have baseline BMD for all patients with fragility fracture to follow progress of therapy [11].

A fracture liaison service (FLS) is a comprehensive care, multi- and interdisciplinary intervention designed to reduce subsequent fracture risk in patients who recently sustained fragility fracture. Fracture Liaison Service is a special program designed to identify, investigate, and initiate appropriate treatment for patients presenting with fragility fracture [10]. Fracture liaison service is a secondary fracture prevention program that is led by a coordinator (liaison). A fracture liaison service follow patients sustaining fragility fractures and/or osteoporotic fractures from the time of injury presentation until care is transitioned to the primary care provider. It is an interdisciplinary team includes orthopaedic surgery, primary care, osteoporosis expert and ancillary services like physical therapy and dietician to ensure that patients are properly assessed and managed [12] [13].

A Fracture Liaison Service was implemented in Dubai health in February 2023. It aims to screen patient aged 50 and above with fragility fracture for osteoporosis and provide appropriate assessment and management to reduce the risk of subsequent fracture. Patients who were admitted in Trauma centre in Rashid hospital with fragility fracture were referred to osteoporosis clinic in primary health care. The FLS coordinator contact the patient, explain the service and then book the appointment. Patient will then do DEXA scan and BMD will be measured.

Based on the new FLS implemented in Dubai health, the purpose of this paper is to understand relationship between bone mineral density and fragility fracture,

as well as the prevalence of osteoporosis and osteopenia in among patients with fragility fracture.

2. Methodology

This study was conducted in the osteoporosis clinics in the primary healthcare from February December 2023. The study included 88 patients who met the following inclusion criteria: patients aged 50 years or more with a recent fragility fracture referred through fracture liaison service. Patients who refused osteoporosis clinic appointment and DEXA scan were not included in the study (Figure 1).

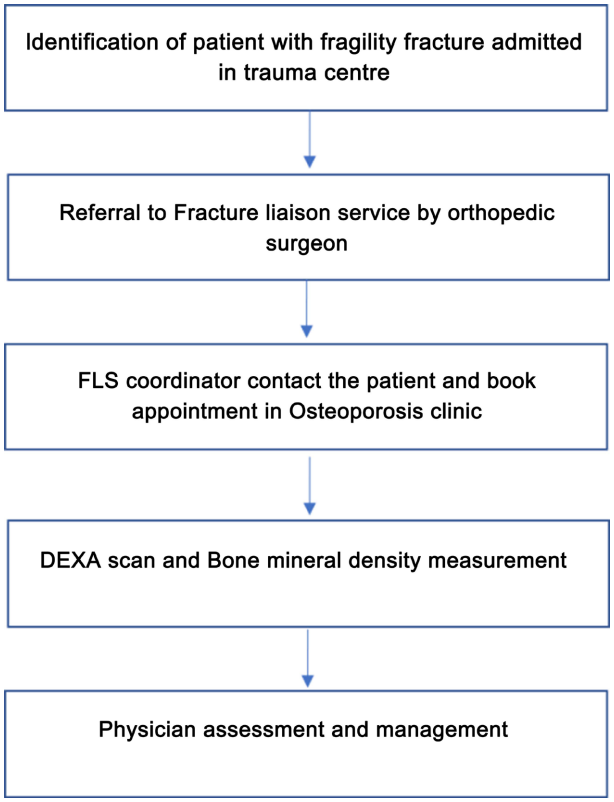

Figure 1. Patient journey in FLS.

2.1. Data Collection

Data were collected from patients' electronic health records and fracture liaison service registry. The following variables were studied: epidemiological variables (age, sex, nationality), clinical variables (vitamin D, calcium, creatinine, site of fracture), radiological variables (Lumbar T score and femur T score).

2.2. BMD Measurement

The BMD of the hip and the lumbar spine was measured using dual energy X-ray absorptiometry (Lunar, GE Health Care) and the result was expressed as BMD, T-score and Z score and. The reference standard of a T-score is the peak bone

density, as reached in men or women between 20 - 30 years of age. The T-score is then defined as the number of standard deviations from this score. According to the WHO definition, "osteoporosis" is defined as a T-score equal to or lower than −2.5, "osteopenia" is defined as a T-score between −2.5 and −1.0, and when the T-score is equal to greater than −1.0 BMD is "normal" [14].

2.3. Ethical Consideration

The procedures used were approved by the Research Ethics Committee (Medical Research Committee, Dubai Health Authority, Dubai, UAE-MBRU IRB-2023-324).

2.4. Data Analysis

Data collected were analyzed using the SPSS version 20 for the descriptive statistics of the demographic characteristics of the patient. Chi-square test was used to compare the patients with regard to the qualitative variables. Fisher exact test was used when cell counts less than 5. P value < 0.05 was considered statistically significant with 95% confidence interval.

3. Results

Table 1 summarizes the characteristics of the patients referred in FLS. The total number of patients included in the study was 88. The mean age was 65.11 ± 10.17 and more than one third (34.8%) aged 70 - 79. The majority (77.3%) were female and 56.8% of patients were UAE national.

Table 1. Characteristics of the patients referred in FLS.

Age	50 - 59	18 (20.2%)
	60 - 69	24 (27.0%)
	70 - 79	31 (34.8%)
	≥80	16 (18.0%
mean age	65.11 ± 10.17	
Sex	Male	20 (22.7%)
	Female	68 (77.3%)
Nationality	UAE	50 (56.8%)
	GCC	5 (5.7%)
	Expat	33 (37.5%)

Table 2 summarizes the lab investigation results of patients referred in FLS. Overall out of 88 patients, 60.2% (n = 53) of patients had vitamin D deficiency and 21.6% (n = 19) of patients had hypocalcemia. Moreover, 30.7% (n = 27) had renal impairment.

Table 2. Distribution of patients according to Lab investigation result.

Lab investigation	Normal	Low
vitamin d	35 (39.8%)	53 (60.2%)
calcium	69(78.4%)	19 (21.6%)
	Normal	**High**
creatinine	61 (69.3%)	27 (30.7%)

Table 3 reveals the result of DEXA scan of patients referred through FLS, more than 50% of the patients were found to have osteoporosis and more than 40% were osteopenia.

Table 3. Distribution of patients according to DEXA result.

Diagnosis	Number	Percentage
Normal	1	1.1
Osteopenia	38	43.2
Osteoporosis	49	55.7

Table 4 shows the site of fracture in patients referred through FLS. The most common sites of fractures were the femur, radius and vertebra (30.7%, 17.0% and 14.8% respectively).

Table 4. Distribution of patients according to site of fracture.

Site of fracture	Number	Percentage
Vertebrae	13	14.8
Femur	27	30.7
Pelvis	5	5.6
Tibia	3	3.4
Fibula	1	1.1
Patella	4	4.5
Ankle	6	6.8
Shoulder	2	2.3
Humerus	8	9.1
Radius	15	17.0
Ulna	1	1.1
Elbow	3	3.4

Females referred in FLS had higher percentage of osteoporosis in comparison to male (58.8% vs 94.5). The difference was statistically non-significant (Table 5).

Table 5. Distribution of Bone mineral density according to sex.

	Bone mineral density			P value
	Normal	Osteopenia	Osteoporosis	
Female	1(1.5%)	27 (39.4%)	40 (58.8%)	NS
Male	0 (0%)	11(55.0%)	9(45.0%)	

4. Discussion

Reduced bone density is a major risk factor for fragility fracture. Because of increased bone loss after the menopause in women, the prevalence of osteoporosis increases markedly with age, from 2% at 50 years to more than 25% at 80 years in women. Moreover, it's reported that the longevity of the population increases, and therefore osteoporosis and fragility fracture will increase [15].

Bone mineral density decline and the incidence for most fractures increases after menopause in women and with advanced age in men. Previous studies have demonstrated that bone density is an important predictor of fracture risk [16]. It was reported that 69% to 100% of patients with fragility fractures who underwent BMD testing across 20 intervention studies had low BMD [16] [17]. This is in congruent with our study which showed that almost all of the patient with fragility fracture had low bone mineral density.

In the United Arab Emirates, it was reported that there are 2.25 osteoporosis hip fractures per 1000 population per year. The femur fractures are life-threatening due to the long period of bed immobilization and the high risk of complication [18]. Our study showed that, the most common fragility fracture was femur fracture. If such fracture is recognized and osteoporosis treated, the risk of a future fracture can be reduced, preventing the downward spiral in health and quality of life that often follows hip fracture.

Globally, women at a higher risk of osteoporotic fracture in comparison to men, one in three women and one in five men over the age of 50 will suffer an osteoporotic fracture [6]. This could be explained that women have thinner bone that men and they tend to lose bone at younger age in comparison to men. Similarly, our study showed that, female had more fragility fracture and higher percentage of female were referred through FLS in comparisons to male.

Moreover, our study showed that among female with fragility fracture, the prevalence of osteoporosis was higher than osteopenia, 58.8% and 39.4% respectively. However, among male with fragility fracture the prevalence of osteopenia was higher than osteoporosis (45% and 55% respectively). This suggests that osteoporosis is more common in female with fragility fractures than in male.

In our study, we observed that the 60% of patients referred through FLS had vitamin D deficiency. Vitamin D deficiency has been documented to increase fracture risk. Bone turnover is increased and accelerated bone loss occurs in elderly with Vitamin D deficiency. Moreover, it has been observed that these patients experience muscle weakness and therefore at increased risk for falls [19].

5. Limitation of the Study

This study didn't include other risk factors associated with fragility fracture, such as comorbidities, medications and previous family history of fracture. It didn't include bone turnover markers related to bone metabolism.

6. Conclusion

In conclusion, this study showed that more than 95% of patients with fragility fracture who underwent BMD testing had low bone mineral density. It highlights the importance of implementation of FLS, to reduce the gap between fragility fracture and osteoporosis treatment.

Author Contribution

All authors have been directly involved with the various aspects of the study. We attest to the fact that all authors have participated in the research, read the manuscript, attest to the validity and legitimacy of the data.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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