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Original Article

Application of the World Health Organization Fracture Risk Assessment Tool to predict need for dual-energy X-ray absorptiometry scanning in postmenopausal women

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ABSTRACT

Objective: To evaluate the efficacy of the World Health Organization Fracture Risk Assessment Tool, excluding bone mineral density (pre-BMD FRAX), in identifying Taiwanese postmenopausal women needing dual-energy X-ray absorptiometry (DXA) examination for further treatment.
Materials and methods: The pre-BMD FRAX score was calculated for 231 postmenopausal women who participated in public health education workshops in the local Keelung community, Taiwan. DXA scanning and vertebral fracture assessment (VFA) were arranged for women classified as intermediate or high risk for fracture using the pre-BMD FRAX fracture probability.
Results: Pre-BMD FRAX classified 26 women as intermediate risk and 37 as having high risk for fracture. Subsequent DXA scans for these 63 women showed that 36 were osteoporotic, 19 were osteopenic, and eight had normal bone density. Concurrent VFA revealed 25 spine factures in which 14 were osteoporotic, seven were osteopenic, and four had normal bone density. The efficacy of the pre-BMD FRAX score to identify those patients with low bone mass by DXA was 87.3% (55/63). When VFA was combined with BMD to identify those patients with high risk (osteopenia, osteoporosis, or spinal fracture), the efficacy of the pre-BMD score increased to 93.7% (59/63). According to the National Osteoporosis Foundation, the overall concordance between pre-BMD FRAX and BMD, expressed through the kappa index, was 0.967. Compared with the evaluation when BMD was used alone, there was a significant increase in efficacy in identifying women who need treatment using BMD plus VFA or FRAX plus BMD. Furthermore, the highest efficacy was achieved when FRAX with BMD and VFA was used.
Conclusion: The pre-BMD FRAX score not only efficiently predicts postmenopausal patients who are potentially at risk and might require treatment but also reduces unnecessary DXA use. Concurrent VFA during DXA use increases spine fracture detection. This improvement in diagnostic efficacy allows clinicians to provide the most appropriate therapeutic recommendation.

Introduction

Osteoporosis is defined as a skeletal disorder characterized by compromised bone strength, predisposing a person to an increased risk of fracture [1]. Most cases of osteoporosis occur in postmenopausal women due to estrogen deficiency. Because osteoporotic fractures in the spine and hip are associated with substantially high morbidity and mortality, osteoporosis has become a serious health threat for elderly women. Thus, it is important to identify postmenopausal women who have low bone mass and high fracture risk to provide preventive and pharmacologic therapy.

Bone mineral density (BMD) is the most common measurement used to evaluate bone strength. Dual-energy X-ray absorptiometry

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(DXA) has been established by the World Health Organization (WHO) as a technique of reference for assessing BMD in postmenopausal women [2]. The most pivotal treatment guidelines, for example, the National Osteoporosis Foundation (NOF) treatment guideline [3], or studies also utilized the DXA T-score classification and a clinical history of vertebral or hip fractures to define the entry criteria. The North American Menopause Society recommends that BMD should be used in women aged 65 years or older and postmenopausal women with medical causes of bone loss, additional risk factors, or a fragility fracture [4]. However, it has been reported that a larger population burden of fracture occurred in people with osteopenia compared to those with osteoporosis [5]. From a healthcare perspective, fracture prevention should not depend only on DXA testing.

Besides estrogen deficiency, there are many risk factors associated with osteoporotic fractures in postmenopausal women [4,6]. The WHO has developed a registered web-based clinical scale assessing Fracture Risk Assessment Tool (FRAX) that integrates an individual's risk factors and reports the 10-year probability of hip or other major osteoporotic fracture [7,8]. FRAX can be calculated with or without hip BMD and has provided both intervention thresholds for treating osteoporosis and assessment thresholds for the use of DXA.

It has been reported that up to half of all vertebral fractures are not diagnosed [9]. It is well established that the existence of a previous vertebral fracture increases the risk of subsequent fractures, regardless of BMD. Greenspan et al [10] reported that in long-term care residents, FRAX, based on femoral neck bone density alone, identified 81% of participants for treatment but missed almost 10% of women with silent vertebral fractures that might benefit from treatment. Thus, the identification of a vertebral fracture significantly alters treatment decisions and considerations.

The aim of this study was to assess the efficacy of pre-BMD FRAX scores in identifying postmenopausal women who need DXA measurement for further treatment. In addition, this study also evaluated the use of concurrent vertebral fracture assessment (VFA) during DXA to improve osteoporosis risk detection.

Materials and methods

Study design

From January 2012 to June 2013, public health education workshops and clinical services were held in the local community of Keelung. A total of 231 postmenopausal women were enrolled in the WHO pre-BMD FRAX evaluation. The enrollment criteria for DXA and VFA examination were patients with intermediate FRAX fracture risk (10–20% probability for major osteoporotic fracture or 1.5–3% for hip fracture) and high risk (≧20% probability for major osteoporotic fracture or ≧3% for hip fracture). The study was approved by the Chang Gung Memorial Hospital Ethical Medicine Committee.

FRAX score

FRAX scores were calculated with an online tool using the Taiwan algorithm [7]. In brief, completion of 12 fields were required, which included age (years); sex (male or female); height (cm); weight (kg); history of previous fracture (defined as a fracture in adult life occurring spontaneously, or arising from trauma which, in a healthy individual, would not have resulted in a fracture); history of parental hip fracture; current smoking; glucocorticoids exposure (defined as current exposure or previous oral glucocorticoid exposure for >3 months, with a dose of 5 mg prednisolone daily or more); diagnosis of rheumatoid arthritis; secondary osteoporosis [including type I (insulin-dependent) diabetes, osteogenesis imperfecta in adults, untreated long-standing hyperthyroidism, hypogonadism or premature menopause (<45 years), chronic malnutrition or malabsorption, and chronic liver disease]; daily alcohol intake of more than three units; and femoral neck DXA score (in g/cm^2 or T score based on the National Health and Nutrition Examination Survey III female reference data).

The FRAX scores were calculated first using clinical factors alone and were then reassessed with the inclusion of BMD (g/cm^2) of femoral neck.

BMD measurement and VFA

BMD of the hip (total hip, femoral neck) and posterior–anterior spine (L1–L4) were measured by DXA scanning (GE-Lunar, iDAX, Madison, WI, USA) installed at Keelung Chang Gung Memorial Hospital. WHO guidelines were used to define BMD: a T score of ≧−1 denotes normal bone; a T score between −1 and −2.5 denotes osteopenia, and a T score of ≦−2.5 denotes osteoporosis. After BMD measurement, the presence of vertebral fractures in the thoracic or lumbar spine was determined by VFA with DXA scanning simultaneously. VFA assesses T3–L4 vertebral fractures and classifies them according to Genant's criteria of mild, moderate, and severe vertebral fractures [11].

Statistical analysis

The levels of agreements between BMD and FRAX + BMD, BMD and BMD + VFA, and BMD and FRAX + BMD + VFA were assessed using kappa statistic and Fisher exact test. Positive predictive value (PPV) and negative predictive value (NPV) of NOF treatment guideline [3] for pre-BMD FRAX, BMD, FRAX, BMD with VFA, and FRAX with VFA were also calculated.

Results

A total of 63 patients (aged 48–81, mean age 66.2 years), who were identified from pre-BMD FRAX, were enrolled. According to the pre-BMD FRAX scores, 26 patients were classified as intermediate risk and 37 were classified as high risk for fracture. Clinical risk factors evaluated by FRAX are shown in Table 1.

BMD and VFA of DXA scans were performed and evaluated by a radiology specialist (Dr YC Lin). Results of DXA examination ($n = 63$) showed that 36 (57%) were osteoporotic, 19 (30.2%) were osteopenic, and eight (12.7%) were normal for bone density. VFA evaluation ($n = 63$) showed that 25 patients had spine fracture (Table 1). Of the 25 patients with spinal fractures, 14 were previously deemed to be osteoporotic, seven were osteopenic, and four were identified from the eight patients with normal bone density by DXA. From the results of the BMD alone, the efficacy of the pre-BMD FRAX score to identify the patients with low bone mass [osteoporosis ($n = 36$) or osteopenia ($n = 19$)] by DXA was 87.3% (55/63). Furthermore, when both BMD and VFA were used, the efficacy of the pre-BMD FRAX score increased to 93.7% (59/63) in identifying high-risk patients (osteopenia, osteoporosis, or spinal fracture).

According to the NOF treatment guideline [3], treatment is recommended for patients with the following conditions: hip or vertebral (clinical or asymptomatic) fractures, T scores of −2.5 or less at the femoral neck, total hip, or lumbar spine by DXA, postmenopausal women and men aged 50 and older with osteopenia (T score between −1.0 and −2.5) at the femoral neck, total hip, or lumbar spine by DXA, and a 10-year hip fracture probability of 3% or more or a 10-year major osteoporosis-related fracture probability of 20% or more based on the WHO absolute fracture risk model