Orthopaedics & Traumatology: Surgery & Research 100 (2014) 855–858

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Original article

DXA-based variables and osteoporotic fractures in Lebanese postmenopausal women

M.-L. Ayoub[a], G. Maalouf[b], F. Bachour[b], A. Barakat[b], B. Cortet[c,f], I. Legroux-Gérot[c,f], G. Zunquin[d], D. Theunynck[d], A. Nehme[e], R. El Hage[a,*]

[a] Department of Physical Education, Faculty of Arts and Social Sciences, University of Balamand, El-Koura, Lebanon
[b] Musculoskeletal Department, Bellevue Medical Center, Faculty of Medicine of Saint-Joseph University, Mansourieh, Lebanon
[c] Department of Rheumatology, Roger Salengro Hospital, CHU de Lille, 59037 Lille cedex, France
[d] Départment of STAPS, URePSSS-EA 4110/EA448, ULCO, 59383 Dunkerque cedex 01, France
[e] Department of Orthopedic Surgery and Traumatology, Saint-Georges University Medical Center, University of Balamand, P.O. Box 166378, Achrafieh, 1100 2807 Beirut, Lebanon
[f] EA4490, 62327 Boulogne-sur-Mer cedex, France

ARTICLE INFO

Article history:
Accepted 23 June 2014

Keywords:
Dual X-ray absorptiometry
Compressive Strength Index
Femur
Fracture risk
Menopause

ABSTRACT

Introduction: The aim of this study was to assess DXA-based variables (bone mineral density, bone mineral apparent density, compressive strength index of the femoral neck and trabecular bone score) in Lebanese postmenopausal women having presented a previous fracture.
Materials and methods: One thousand Lebanese postmenopausal women between 45 and 89 years participated in this study. The women were recruited by advertisements offering bone mineral density measurements at a reduced cost. Subjects with previous history of radiotherapy or chemotherapy were excluded. Informed written consent was obtained from all the participants.
Results: Femoral neck compressive strength index (FN CSI) was significantly ($P < 0.001$) associated with the presence of fracture using a simple logistic regression (odds ratio = 0.51 [0.385–0.653]). When a multivariate logistic regression analysis was performed with the presence of fracture as a dependent variable and each of age, FN BMD and FN CSI as independent variables, only FN BMD ($P = 0.005$) and FN CSI ($P = 0.004$) were found to be associated with the presence of fracture.
Conclusion: This study suggests that FN CSI is associated with history of osteoporotic fractures in postmenopausal women. The use of FN CSI in clinical practice may help to identify patients with high risk of fracture.
Level of evidence: Epidemiological study, level IV.

1. Introduction

Bone mineral density (BMD) is a strong predictor of fracture risk in elderly women [1–6]. BMD is influenced by several factors such as ethnicity and origin [7,8]. For instance, it has been demonstrated that BMD values for Lebanese subjects are lower compared with the American/European subjects [7,8]. The low BMD values in Lebanese subjects may be explained by several factors such as low calcium and vitamin D intakes and high prevalence of sedentary lifestyle [9–12]. These factors may affect the fracture incidence in the Lebanese population [13,14]. Nevertheless, bone size and body size also play important roles in fracture risk and contribute differentially to fracture risk in different groups [15–18]. Based on this, Karlamangla et al. [19] have examined the prediction of incident hip fracture risk by composite indices of femoral neck strength, constructed from dual X-ray absorptiometry (DXA) scans of the hip. These indices integrate femoral neck size and body size with bone density, and they reflect the structure's ability to withstand axial compressive forces and bending forces and the ability to absorb energy in an impact [19–23]. Several studies have shown that these indices have the potential to improve hip fracture risk assessment [19–21]. However, the relation between these indices and the incidence of major osteoporotic fractures needs to be clarified. The main aim of this study was to assess DXA-based variables — bone mineral apparent density (BMAD), compressive strength index (CSI) of the femoral neck and trabecular bone score (TBS) — in a population of prior osteoporotic fractures in Lebanese postmenopausal women. The secondary aim of this study was to verify

* Corresponding author.
E-mail address: rawadelhage21@hotmail.com (R. El Hage).

http://dx.doi.org/10.1016/j.otsr.2014.06.023

Table 1
Clinical characteristics and bone variables of the study population.

	Whole population ($n = 1000$)	Women without previous fracture ($n = 836$)	Women with previous fracture ($n = 164$)
Age (years)	61.1 ± 11.7	60.4 ± 11.6***	65.0 ± 11.5
Weight (kg)	67.4 ± 13.7	67.2 ± 13.8	68.5 ± 12.8
Height (cm)	155.5 ± 7.7	156.0 ± 7.8***	152.7 ± 6.5
BMI (kg/m^2)	27.9 ± 5.3	27.6 ± 5.3***	29.4 ± 5.3
L2-L4 BMD (g/cm^2)	0.960 ± 0.158	0.974 ± 0.162***	0.894 ± 0.146
TBS	1.310 ± 0.116	1.329 ± 0.118***	1.275 ± 0.098
TH BMD (g/cm^2)	0.830 ± 0.140	0.835 ± 0.144**	0.799 ± 0.126
FN BMD (g/cm^2)	0.789 ± 0.147	0.796 ± 0.158***	0.736 ± 0.120
FN BMAD (g/cm^3)	0.167 ± 0.097	0.170 ± 0.105*	0.152 ± 0.029
FN CSI (g/kg m)	3.84 ± 0.07	3.88 ± 0.81***	3.55 ± 0.74
Total radius BMD (g/cm^2)	0.533 ± 0.101	0.561 ± 0.098***	0.509 ± 0.099
1/3 radius BMD (g/cm^2)	0.715 ± 0.123	0.725 ± 0.120***	0.660 ± 0.129
UD radius BMD (g/cm^2)	0.368 ± 0.080	0.372 ± 0.080***	0.348 ± 0.077

BMI: Body Mass Index; TBS: Trabecular Bone Score; BMD: bone mineral density; TH: total hip; FN: femoral neck; BMAD: bone mineral apparent density; CSI: Compressive Strength Index; UD: ultra-dsital.
*Significant differences between women without incident fracture and women with incident fracture, $P < 0.05$; **Significant differences between women without incident fracture and women with incident fracture, $P < 0.01$; ***Significant differences between women without incident fracture and women with incident fracture, $P < 0.001$.

whether these DXA-based variables remain associated with history of osteoporotic fractures after controlling for BMD and age.

2. Material and methods

2.1. Subjects and study design

One thousand Lebanese postmenopausal women (mean age 61.1 ± 11.7, extr 45–89 years) participated in this study. The women were recruited by advertisements offering bone mineral density measurements at a reduced cost. Subjects with previous history of radiotherapy or chemotherapy were excluded. Informed written consent was obtained from all the participants. Health service records were assessed for osteoporotic fractures (not associated with trauma codes). Hip fractures and major osteoporotic fractures (i.e., hip, clinical spine, forearm, and humerus fractures) were recorded because these are the basis for the 10-year absolute fracture risk estimates published by Kanis et al. [4].

2.2. Anthropometric and bone measurements

Weight and height were measured, and Body Mass Index (BMI, kg/m^2) was calculated. Lumbar spine (L2-L4), bone mineral density (BMD), total hip (TH) BMD, femoral neck (FN) BMD and radius BMD were measured by DXA (GE Healthcare Lunar Prodigy). Femoral Neck Compressive Index (FN CSI) was calculated as previously described [19–23]. FN CSI (FN BMD * FN width/weight) expresses the forces that the femoral neck has to withstand in weight bearing. Bone mineral apparent density (BMAD), an estimate of volumetric bone mineral density (g/cm^3), of the femoral neck was calculated as previously described [24,25]. For FN, the formula BMAD = BMC/BMA^2 (BMC = Bone mineral content) was used [24,25]. Lumbar spine trabecular bone score (TBS) was derived from DXA lumbar spine examinations [26]. In our laboratory, the coefficients of variation were less than 1% for BMC and BMD measurements [26]. The same certified technician performed all analyses using the same technique for all measurements.

2.3. Statistical analysis

The means and standard deviations were calculated for all the clinical data and for the bone measurements. Clinical characteristics and bone variables were compared between the two groups using a one-way analysis of variance (ANOVA). Odds ratios for age, FN BMD, FN CSI, TBS and FN BMAD were estimated using multiple logistic regressions having at least one major osteoporotic fracture as the dependent variable. Data were analyzed with SPSS (version 16.0). A level of significance of $P < 0.05$ was used.

3. Results

3.1. Clinical characteristics and bone variables of the study population

In our study group, mean age was 61.1 ± 11.7 years, and mean BMI was 27.9 ± 5.3 kg/m^2. At the time of baseline DXA scan, women with previous fracture ($n = 164$) were shorter ($P < 0.001$), older ($P < 0.001$), with a higher BMI ($P < 0.001$), a lower FN BMD ($P < 0.001$) and a lower FN CSI ($P < 0.001$) than women without fracture ($n = 836$). Body weight was not significantly different between women with previous fracture and women without fracture (Table 1).

3.2. Clinical characteristics and fracture incidence

Age, height and BMI were significantly associated with the presence of previous fracture using simple logistic regressions ($P < 0.001$). FN BMD was significantly ($P < 0.001$) associated with the presence of previous fracture using a simple logistic regression (odds ratio [95% confidence interval] = 0.041 [0.011–0.152]).

3.3. Femoral Neck Compressive Strength Index and fracture incidence

FN CSI was significantly ($P < 0.001$) associated with the presence of previous fracture using a simple logistic regression (odds ratio [95% confidence interval] = 0.51 [0.385–0.653]). When a multivariate logistic regression analysis was performed with the presence of a previous fracture as a dependent variable and each of age, FN BMD and FN CSI as independent variables, only FN BMD ($P = 0.005$) and FN CSI ($P = 0.004$) were found to be associated with the presence of previous fracture (Table 2).

3.4. Bone mineral apparent density and fracture incidence

Using a multiple logistic regression analysis, BMAD of femoral neck was significantly associated with a previous osteoporotic fracture even after controlling for age ($P < 0.05$). The significant relation between BMAD and fracture incidence disappeared after controlling for FN BMD and age using a multiple logistic regression (Table 3).