**Introduction**

Increasing knowledge suggests that both osteoporosis and sarcopenia originate from several common denominators. Both fat and muscle tissue provide systemic and local stimuli, including mechanical strain that modulate bone mass and strength. Low bone mass, sarcopenia and obesity have common pathobiologic factors, such as chronic low-grade inflammation, inadequate nutrition, endocrine disorders, low level of physical activity, and neuro muscular disorganization. Estrogens have a protective role for muscle and bone, and estrogens depletion after menopause may explain the natural increase in adipogenesis, weight gain, and accelerated loss of muscle and bone mass. Adipose tissue, and particularly visceral fat, generates many adipokines, such as leptin, whose receptors are expressed by osteoblasts and myocytes, that could maintain a low-grade inflammatory milieu, contributing to worsening of several clinical conditions, including obesity, osteoporosis and sarcopenia.1-3 For years, it has been hypothesized that obesity exerted protection against bone loss after menopause,4 but recently Nielen et al.5 reported that osteoporotic fractures occur at higher levels of BMD in obese subjects.

Sarcopenic obesity can be observed clinically as the result of various factors including menopause.6-7 Probably, obesity increases the percentage of intramuscular fat mass infiltration, lowering muscle quality and physical performance, with increased risk of falls and fractures.8-10 Moreover, the redistribution of adipose tissue might play a role in determining bone strength, particularly at femoral neck.

The aim of our study is to investigate the influence of sarcopenic obesity on hip bone strength indices: Femoral Strength Index (FSI), Cross-Sectional Moment of Inertia (CSMI), Cross-Sectional Area (CSA), Section Modulus (Z) and Buckling Ratio (BR).11-13

**Methods**

We evaluated 127 women, mean aged 63.50 ± 8.69 years (SD). All the included patients were classified into 2 groups: 45 sarcopenic obeses (35.43%), mean aged 62.69 years ± 8.50 SD, with a mean BMI ± SD of 35.36 ± 4.94 kg/m², and 82 non sarcopenic obeses (54.57%), mean aged 63.96 years ± 8.11 SD, with a mean BMI ± SD of 33.68 ± 2.89 kg/m².

In this retrospective case-control study, participants were recruited among patients that referred to a Physical Medicine and Rehabilitation outpatient’s department for management of osteoporosis, from January 2011 to December 2013. Inclusion criteria were: post-menopausal women aged 50 or older; BMI ≥ 30 kg/m². Women who had current or previous MRT (Magnetic Resonance Therapy), secondary osteoporosis or pathological fractures were excluded from the assessment. The patients’ total and regional body composition classifications (ASM, appendicular skeletal muscle mass, FM, - total fat mass), bone mineral density (BMD) at total body (total body less head; TB1H), at the lumbar spine (LS) (anteroposterior projection at L1-L4) and at femoral neck (FN), were measured with the Dual-Energy X-Ray Absorptiometry method (iDXA GE Healthcare densitometer). The World Health Organization classification system was applied to define osteoporosis (T-score <-2.5), osteopenia (-2.5<T-score<-1), and obesity (BMI - body mass index >30 kg/m²). For each patient we reported anthropometric characteristics, BMI, ASM (residuals), total-body BMD and T-score, femoral neck BMD and T-score, lumbar spine BMD and T-score, and Hip Structural Analysis parameters.

**Results**

In our cohort of post-menopausal women, sarcopenic obeses had lower bone quality and strength than non-sarcopenic obeses. This finding is supported by an increase of buckling ratio, which is the ratio of the outer radius to the cortical thickness, that represents a mean for estimating stability of the cortex in thin-walled regions subjected to bending. The buckling ratio uniquely reflects the transition from strength homoeostasis to skeletal fragility. In our population, sarcopenic obeses women with higher buckling ratio showed an higher frequency of vertebral fragility fractures, probably linked to a worse-adapted impaired bone strength.

Our data furtherly supported the hypothesis that excess adiposity (over-weight/obesity) should be an integral component of the diagnosis of both sarcopenia and osteoporosis.11,12 HSA should be included in sarcopenic obesity assessment, representing an important evaluation tool to define the close relationship among fat, muscle, and bone that influence each other on a biomechanical as well as on tissue level.

**Conclusions**

Sarcopenic obesity worsens bone strength: hip strength analysis in post-menopausal women

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