GENDER DIFFERENCES IN THE IN-VIVO PREDICTIVITY OF BONE FRACTURES THROUGH FE-BASED BONE STRENGTH

Enrico Schileo1, Cristina Falcinelli1,2, Sigurdur Sigurjonsson3, Vilmundur Gudnason3,4, Fulvia Taddei5

1 Computational Bioengineering Laboratory, Rizzoli Orthopaedic Institute, Italy; 2 Department of Civil Engineering, University of Rome Tor Vergata, Italy; 3 Icelandic Heart Association Research Institute, Kopavogur, Iceland; 4 University of Iceland, Reykjavik, Iceland; 5 Medical Technology Laboratory, Rizzoli Orthopaedic Institute, Italy

Introduction

Evidence based studies show that osteoporotic fractures significantly affect also men and not only women [Szulc, 2012]. In both genders, the predictivity of the quantitative tools (bone mineral density (BMD) and/or derived indices e.g. FRAX) routinely used to assess the risk of fracture of an individual, is far from ideal [Tremolliers, 2010].

Bone strength derived from CT-based finite element models (FEBS) has been recently tested as a bone fracture risk predictor on clinical cohorts [Amin, 2011; Keyak, 2011; Orwoll, 2009], showing a similar performance to BMD and no differences between genders. A similar FEBS approach, but based on a different, validated FE modelling procedure [Schileo, 2008] has recently showed a possible improvement over BMD in a retrospective study on women [Falcinelli, 2012].

The aim of this work is to evaluate the clinical predictivity of FEBS (as per [Falcinelli, 2012]) on men and women in a nested case-control study taken from a longitudinal prospective study (AGES-Reykjavik Study).

Methods

A total of 105 subjects were included: i) 13 men and 21 women were randomly selected from those that suffered hip fracture (F) during the follow-up period; ii) 26 men and 45 women as control subjects (NF-age and gender matched with F and not statistically significant differences in weight and height between 2 groups). Baseline proximal femur CT scans and simulated DXA aBMD values from QCT were available for all.

FE models were generated from CT [Schileo, 2008]. FEBS, evaluated in a number of quasi-axial configurations to mimic the in-vivo variability of hip reactions, was defined as the minimum load inducing on the femoral neck surface an ε>εlim [Bayraktar, 2004].

We tested the ability of FEBS and aBMD to: 1) discriminate between F and NF; 2) individually classify cases at risk.

Results and Discussion

Significant gender differences were observed in the FEBS (but not BMD) predictivity. Women cohort: both FEBS and aBMD indices clustered F and NF cases, with a better performance for FEBS (mean in F 19% lower than in NF, p=0.0003) vs. neck, total, trochanteric aBMD indices (F 8%, 14% and 15% lower than NF, p 0.12, 0.01 and 0.004). Logistic regression models applied to test the ability to individually classify cases confirmed the result, with an AUC of the ROC curve of 0.78 for FEBS vs 0.72 for aBMD. AUC was 0.80 when combining FEBS and aBMD, but only FEBS was retained significant.

Male cohort: only a subset of the aBMD indices significantly clustered F and NF cases (F 13-17% lower than NF, p-value ranging from 0.056 to 0.0073), while FEBS was only 5% lower in F, with p-value not significant. In logistic regressions the max AUC was 0.76 for aBMD, while FEBS was not significant.

In summary, in women we confirmed, in a prospective study, an improvement of FEBS over BMD. The mean FEBS differences for F and NF were also higher than [Keyak, 2011], and FEBS estimate may be further improved by incorporating a bone remodelling model. Conversely, for men we can conclude (with a caveat related to the low sample numerosity) that BMD retained a similar predictive ability with respect to women, confirming what previously found in similar studies, while the proposed FEBS calculation was not able to discriminate cases from controls.

References

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