Prediction of Hip Fracture: Combination of WHO Absolute Fracture Risk Model (FRAX®) and Proximal Femoral Geometry

INTRODUCTION:
Hip fracture is the most serious osteoporotic fracture because it incurs significant costs and cause substantial disability, morbidity and mortality. Although low bone mineral density (BMD) is a strong predictor of hip fracture, it is not the sole predictor. Geometric components of bone strength, evaluated by hip strength analysis (HSA) on dual-energy X-ray absorptiometry (DXA) images, are related to hip fracture [1]. In addition, clinical factors contribute to the risk of hip fractures, independent of BMD. They are included in the computer-based fracture risk assessment tool (FRAX®) to estimate the 10-year fracture risk in the individual patient. The purpose of this study was to compare femoral bone density, structure and strength parameters obtained from DXA measurements, and fracture probability calculated with FRAX tool in a group of patients with and without hip fracture and to find out combination of these variables can better predict hip fracture.

METHODS:
DXA measurements of the proximal femur were obtained from 88 patients with proximal femoral fracture older than 40 and lesser than 90, of whom are 34 with hip fractures and 54 controls. In addition to the conventional densitometry measurements, structural variables were determined using analysis program. Hip axis length (HAL), cross-sectional moment of inertia (CSMI), cross sectional area (CSA) and the femur strength index (FSI) which is calculated as the ratio of estimated compressive yield strength of the femoral neck to the expected compressive stress of a fall on the greater trochanter, were obtained. We calculated 10-year probability for the hip fracture using FRAX model.

We compared demographic data, femoral neck BMD, HAL, CSMI, CSA, FSI, and FRAX score between two groups using two sample (unpaired) t test. Logistic regression models were used to calculate odds ratios for hip fracture using SPSS Ver. 14.0 (SPSS Inc., Chicago, USA). Receiver operator characteristics (ROC) analysis was performed to compare the capability of femoral neck T score with the logistic model incorporating HAL, FSI and FRAX score to predict the presence of fracture using MedCalc for Windows, version 11.6 (MedCalc Software, Mariakerke, Belgium).

RESULTS:
Patients with hip fracture were significantly older than control. They were lighter and taller so that mean BMI values were smaller in fracture group. When these results were adjusted for age, they were significantly taller and slender. Femoral neck BMD was significantly lower and HAL higher in the fracture group compared with controls. When adjusted for age, HAL was significantly higher. Mean CSMI and CSA were not significantly different between fracture patients and controls after adjustment for age. Mean FSI was significantly lower in the fracture group. Mean 10-year probability for hip fracture was significantly higher in the fracture group. Odds ratios per standard deviation were 2.9 for T score, 1.1 for HAL, 2.3 for FSI and 1.2 for FRAX probability (Table 1).

The fracture discrimination ROC curves for both T score alone, and the logistic regression probability model incorporating FRAX probability, HAL and FSI are shown in Figure 1. The area under the ROC curve was larger for the regression model (0.830 vs 0.770, p=0.001), indicating that fracture discrimination might be improved when these femur structural variables and FRAX fracture probability were combined with BMD measurements.

DISCUSSION:
To date this is the first study to find out whether combination of HSA, FRAX and T-score can better predict hip fracture than T-score alone. Although not significant, the area under the ROC curve was larger for the regression model indicating that fracture discrimination might be improved when these structural variables and FRAX fracture probability were combined with BMD measurements.

Table 1. Odds ratios for hip fracture

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRAXhip</td>
<td>1.2 (1.0 - 1.3)</td>
<td>0.008</td>
</tr>
<tr>
<td>FSI (per SD)</td>
<td>2.3 (0.5 – 10.0)</td>
<td>0.278</td>
</tr>
<tr>
<td>T score (per SD)</td>
<td>2.9 (1.6 – 5.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HAL (per SD)</td>
<td>1.1 (1.0 - 1.1)</td>
<td>0.069</td>
</tr>
</tbody>
</table>

*aOdds ratios for the additive inverse, since risk increases with decreasing value. FRAX10; 10-year probability for major fracture; FSI, femur strength index; HAL, hip axis length.

SIGNIFICANCE:
This is the first study to find out whether combination of HSA, FRAX and T-score can better predict hip fracture than T-score alone.

REFERENCES:

This study was supported by a grant of the Korea Healthcare technology R&D Project, Ministry for Health, Welfare & Family Affairs, Republic of Korea. (A084120)

Poster No. 1531 • ORS 2012 Annual Meeting