CASE SPECIFIC FINITE ELEMENT MODELS PREDICT FEMORAL FAILURE RISK BETTER THAN EXPERIENCED PHYSICIANS

J.B. van Aken (1); N. Verdonschot (1,2); H. Huizenga (1); J.G. Kooloos (1); E. Tanck (1)
1. Radboud University Nijmegen Medical Center, The Netherlands; 2. University of Twente, The Netherlands.
E.Tanck@orthop.umcn.nl

Introduction
Bone metastases occur in about 15% of all cancer cases. Pathological fractures that result from these tumours most frequently occur in the femur. Unfortunately, it is extremely difficult to determine the fracture risk with the current X-ray methods, even for experienced physicians. As a result, many patients are surgically over-treated, whereas some patients, who are defined to be at low risk, may fracture their bones [1]. The purpose of this study was to develop a femur (patient) specific finite element model to improve the prediction of failure risk under stance loading. In addition, we tested if our model was better in predicting failure risk under stance loading than experienced physicians.

Methods
Eight human cadaver femora, with and without simulated metastases, were CT-scanned (Philips, ACQsim, 120kV, 220mAs, 3mm slices). A solid calibration phantom (Image Analysis, 0, 50, 100 and 200 mg/ml calcium hydroxyapatite) was included in each scan. From the scans, eight finite element (FE) models were generated using brick elements with sizes of about 1x1x3 mm. The ash density of each element was computed from the calibrated CT scan data. Using ash densities, non-linear isotropic mechanical properties were implemented [2].

Discussion
In daily practice, the prediction of fracture risk has been mainly based on X-rays. We showed that femur specific FE models better predicted femoral failure risk under axial loading than experienced physicians. When the model is further improved by adding, for example, other loading conditions, it can be clinically implemented to predict in vivo fracture risk for patients suffering, for example, bone metastases or osteoporosis.

References