Automatically generated 3D shape, density, cortical thickness and finite element mesh of proximal femur from a DXA image

By: Väänänen, Grassi, Flivik, Jurvelin, Isaksson

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Over 200 million people worldwide suffer from osteoporosis. Osteoporosis is currently diagnosed based on the bone mineral density (BMD) of the femur or lumbar spine measured with dual-energy X-ray absorptiometry (DXA). However, the BMD measured with two-dimensional DXA is only a moderate predictor of fracture risk. In this study, novel image analysis and mechanical simulation methods are presented which enable automatic estimation of the three dimensional shape and morphology of the femur, as well as the femoral fracture strength from single DXA image.

The developed method is based on a statistical shape and density template and intensity-based registration. Feature-based reconstruction techniques are faster whereas intensity-based reconstruction results in an automatic procedure that produced the input for the mechanical simulation. The feature and intensity-based methods displayed rather similar accuracies. The femoral surface was reconstructed with mean accuracy of one millimeter.

The developed methodology may improve the fracture risk prediction of the femur and the diagnostics of osteoporosis in the future.