Preventing osteoporotic fractures

Lars Mulder¹, Bert van Rietbergen¹, Niels Noordhoek², Keita Ito¹
¹ Biomedical Engineering, Eindhoven University of Technology, the Netherlands
² Philips Medical Systems, Best, the Netherlands

Introduction
Osteoporosis is a killer. A lot of elderly die of fracture-related complications within 12 months; all others will remain impaired. 30 to 50% of all women and 15 to 30% of all men will face an osteoporotic fracture in their lifetime. This costs Europe billions and is forecasted to double by 2050. It is therefore imperative that osteoporotic fractures are prevented rather than treated. The aim is to develop a multiscale modeling technology based on conventional imaging methods that enables the patient-specific prediction of the probability of a serious fracture and the development of possible preventive treatments.

The first step is to test and validate the resolving power of a new imaging technique, which is based on an X-ray angiography system. XperCT, as it is called, enables 3D imaging at high resolution, thereby possibly allowing the examination of the trabecular bone structure of e.g. vertebra and hip.

Materials and methods
Ten clusters of human cervical vertebrae (all women, age 80 ± 14 yr) were scanned with XperCT and with microCT. Preliminary qualitative comparison was performed.

Results
Reconstructed images from XperCT scans (Fig. 1) display the gross geometry of the vertebrae as well as the trabecular morphology quite clearly. To analyze the trabecular structure, bone and background are separated to leave only the bone structure in 3D by setting one gray values threshold (Fig. 2). However, segmentation of XperCT images is not straightforward (Fig. 3) and will need a more sophisticated regional approach.

Discussion and future plans
Qualitatively, the XperCT resolution and image quality seem sufficient to analyze trabecular bone. However, a more sophisticated method of segmentation is needed to perform a decent quantitative comparison with microCT. Eventually, XperCT scans of a patient’s hip or spine will be used to derive the bone’s constitutional mechanical behavior, which will be incorporated in a larger, multiscale, patient-specific model. From this model, which houses lifestyle, muscle, and bone properties, a general risk of fracture can be determined for a specific patient.