Automated segmentation of cortical and trabecular bone to generate finite element models for femoral bone mechanics - DTU Orbit (03/09/2019)

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Finite element (FE) models based on quantitative computed tomography (CT) images are better predictors of bone strength than conventional areal bone mineral density measurements. However, FE models require manual segmentation of the femur, which is not clinically applicable. This study developed a method for automated FE analyses from clinical CT images. Clinical in-vivo CT images of 13 elderly female subjects were collected to evaluate the method. Secondly, proximal cadaver femurs were harvested and imaged with clinical CT (N=17). Of these femurs, 14 were imaged with µCT and three had earlier been tested experimentally in stance-loading, while collecting surface deformations with digital image correlation. Femurs were segmented from clinical CT images using an automated method, based on the segmentation tool Stradwin. The method automatically distinguishes trabecular and cortical bone, corrects partial volume effect and generates input for FE analysis. The manual and automatic segmentations agreed within about one voxel for in-vivo subjects (0.99±0.23mm) and cadaver femurs (0.21±0.07mm). The strains from the FE predictions closely matched with the experimentally measured strains (R2=0.89). The method can automatically generate meshes suitable for FE analysis. The method may bring us one step closer to enable clinical usage of patient-specific FE analyses.

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