Automated segmentation of cortical and trabecular bone to generate finite element models for femoral bone mechanics - DTU Orbit (07/08/2019)

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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.

General information
Publication status: Published
Organisations: Neutrons and X-rays for Materials Physics, Department of Physics, University of Eastern Finland, Kuopio University Hospital, Lund University
Corresponding author: Väänänen, S. P.
Number of pages: 10
Pages: 19-28
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Medical Engineering & Physics
Volume: 70
ISSN (Print): 1350-4533
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
Original language: English
Keywords: Automated segmentation, Bone, Femur, Finite element modeling, Isotopology, Surface strains
DOIs: 10.1016/j.medengphy.2019.06.015
Source: FindIt
Source-ID: 2450595477
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review