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Voxel-based finite element model of a reconstructed bone: Simulating a bone tumor surgery

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Finite element (FE) modeling is used to simulate the surgery procedure of a bone tumor. Accurate geometry of bone and material properties assigned are very important in FE modeling. Material properties of bone are very complex. Hence, a sophisticated method to address bones material heterogeneity is necessary. Voxel-based finite element method using quantitative CT (QCT) and Simpleware is presented. A cavity in the distal part of a femur allograft was created and filled with cement to simulate the surgery, and QCT scanned was taken. A calibration phantom with five tubes having known densities was also used during the scan. The DICOM images were imported in Simpleware software to segment the bone from the surrounding and the 3D model of reconstructed bone was created. Homogenous material property was assigned for cement as there was no variation in its properties. Heterogeneous material mapping procedure was chosen for bone due to the great variation of its properties. In greyscale based material properties mapping, the average Hounsfield unit (HU) within each of the calibration tubes was calculated and a linear curve was fitted to the points corresponding to HU and density values. The equation of this curve was used to convert the greyscales to bone mineral density. The FE models were generated by conversion of each voxel into an 8-node brick element. Using experimental equations, the young modules of the elements were also calculated according to their densities. The model described, can be used to predict the outcome of tumor surgery, and predict the risk of postoperative fracture.

Biography

Azadeh Ghouchani has received her MSc from Amirkabir University of Technology (AUT) and is now a PhD candidate in the Department of Biomedical Engineering at AUT. She has published more than 10 papers in reputed journals and conferences on Finite Element methods.

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