Numerical modelling of hip fracture patterns in human femur

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ABSTRACT

Hip fracture morphology is an important factor determining the ulterior surgical repair and treatment, because of the dependence of the treatment on fracture morphology. Although numerical modelling can be a valuable tool for fracture prediction, the simulation of femur fracture is not simple due to the complexity of bone architecture and the numerical techniques required for simulation of crack propagation. Numerical models assuming homogeneous fracture mechanical properties commonly fail in the prediction of fracture patterns, since the microstructure of the bone must be considered in order to obtain accurate results. In this work we focus on the prediction of femur fracture based on the development of a finite element model able to simulate the generation of long crack paths.

Through finite element models, we are able to predict fracture patterns under stance loading configuration, allowing the distinction between the main fracture paths: intracapsular and extracapsular fractures. It is worth noting the prediction of different fracture patterns for the same loading conditions, as observed during experimental tests.

The internal distribution of bone mineral density and femur geometry strongly influences the femur fracture morphology and fracture load. Experimental fracture paths can be analysed by means of micro-computed tomography allowing the comparison of predicted and experimental crack surfaces, confirming the accuracy of the numerical models.