Predicting cyclic failure of single screw-bone constructs using homogenized finite element models

**Background:** Biomechanical simulations of bone-implant constructs (e.g. fractured bone treated with a fracture fixation plate, see figure below) allow systematic comparisons of different implants as well as patient-specific solutions with reduced complication rates.

**Problem:** The biomechanical simulation of the bone-implant interface is still challenging. Especially implant loosening due to cyclic loading is a critical value to be assessed since, e.g., the fracture reduction might be lost, resulting in mal- or nonunion of the fracture. A statistical criterion to predict cyclic failure based on homogenized finite element models has been presented previously [1]. However, this criterion was established specifically for humerus fracture implants for one specific load case (see figure 1).

**Goal:** The goal of this work is to investigate whether a simplified criterion for cyclic failure of the screw-bone interface in homogenized finite element models can be established on the level of a single screw-bone construct (see figure 2). The generality of the criterion shall be tested by applying different loading directions on the screw. The work involves experimental tests of the samples and simulation using homogenized finite element models.

Field: Numerical and experimental biomechanics

Contact: Prof. Dieter H. Pahr (pahr@ilsb.tuwien.ac.at)
Dr. Alexander Synek (asynek@ilsb.tuwien.ac.at)

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![Figure 1](image1.png)  

![Figure 2](image2.png)