Pre-Clinical Finite-Element Simulations on Implant Fixation in Total Joint Replacement

Aseptic loosening is a common failure after total joint replacement procedures, requiring revision surgery after several years of implantation. Current pre-clinical testing of implant devices to prevent such loosening is mainly focused on initial post-operative stability, but no reliable experimental methods are available to assess mid- and long-term fixation. Use of computational methods brings outcome, as they can be used to investigate initial stability as well as medium-/long-term bone response, under a controlled variety of conditions by changing e.g. physiological loading, bone quality and implant design and placement.

To simulate the circumstances of an implanted bone, finite element (FE) models of different knee and hip implants and of a femoral bone are created; the bone model and its material properties are based on a segmentation of a cadaveric CT-scan. The implant is subsequently modeled onto the bone following surgical instructions, and different conditions as the material properties and the forces acting on the implant during daily use are defined as realistic as possible. To be able to predict implant fixation, related outcome measures are computed during the simulation following specific algorithms. Such specifically developed algorithms compute i.e. micro-motions occurring between implant and bone, which is a measure for bone ingrowth in cementless implants, and the change is bone structure as a result of a different load distribution due to the implant.

Key words: finite element modeling; preclinical testing; matlab programming; data analysis

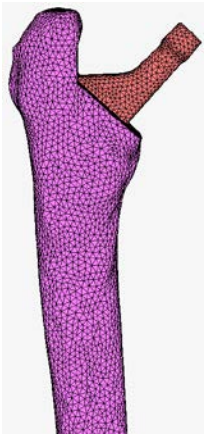

Figure 1: An FE model as used in a hip implant fixation analysis

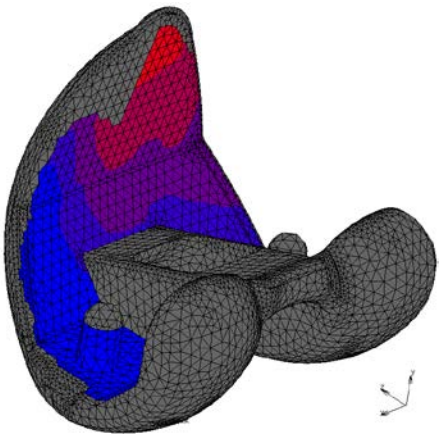

Figure 2: An output example of micro-motions between the femur and the knee implant surface

Interested? Contact us!

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