Numerical simulation of bioabsorbable implant-aided bone healing processes with the Cartesian grid Finite Element Method

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ABSTRACT

Metal implants are commonly used in certain repair surgeries of fractured long bones (femur, tibia, ...) but, according to implants manufacturers, they must be removed after the treatment to avoid possible negative effects on the human body [1]. The use of bioabsorbable polymers (BPs) might have great relevance to eliminate a required second surgery.

In this work, we present a first implementation of a numerical analysis methodology based on the Cartesian grid FEM (cgFEM), developed by members of I2MB, which allows testing different BPs and implant geometries for different bone fractures. The advantages of cgFEM are that it allows to create a bone numerical avatar able to simulate the bone healing process including the bone remodelling process and the callus evolution, thus giving information from the very beginning of the implantation to the complete bone healing.

Specifically, a mechanical assessment of a poly-lactic acid (PLA) intramedullary implant has been carried out on a fractured tibia model. Making use of implant maximum stress values along the healing period with a stress safety factor, it is possible to evaluate the implant viability. In this simulation, bone callus healing process [2] and internal loads during gait [3] have been considered.

Finally, preliminary results for a 100 kg patient show that he could walk properly 300 days after placing surgery. Thus, this is a numerical proof of the viability of using BP implants.

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