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MODELLING THE EFFECTS OF BONE FRAGMENT CONTACT IN FRACTURE HEALING

Gongfa Chen, Cameron J. Wilson, Martin E. Wullschleger, D.L. Sean McElwain, Sanjay K. Mishra, Mark J. Pearcy, Stephan M. Perren, Graeme J. Pettet, Roland Steck, Michael A. Schütz

Institute of Health and Biomedical Innovation, Queensland University of Technology

The fracture healing process is modulated by the mechanical environment created by imposed loads and motion between the bone fragments. Contact between the fragments obviously results in a significantly different stress and strain environment to a uniform fracture gap containing only soft tissue (e.g. haematoma). The assumption of the latter in existing computational models of the healing process will hence exaggerate the inter-fragmentary strain in many clinically-relevant cases. To address this issue, we introduce the concept of a contact zone that represents a variable degree of contact between cortices by the relative proportions of bone and soft tissue present. This is introduced as an initial condition in a two-dimensional iterative finite element model of a healing tibial fracture, in which material properties are defined by the volume fractions of each tissue present. The algorithm governing the formation of cartilage and bone in the fracture callus uses fuzzy logic rules based on strain energy density resulting from axial compression. The model predicts that increasing the degree of initial bone contact reduces the amount of callus formed (periosteal callus thickness 3.1mm without contact, down to 0.5mm with 10% bone in contact zone). This is consistent with the greater effective stiffness in the contact zone and hence, a smaller inter-fragmentary strain. These results demonstrate that the contact zone strategy reasonably simulates the differences in the healing sequence resulting from the closeness of reduction.

(Oral presentation preferred)