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Magnitudes of local stress and strain along bony surfaces predict the course and type of fracture healing

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Abstract

A new quantitative tissue differentiation theory which relates the local tissue formation in a fracture gap to the local stress and strain is presented. Our hypothesis proposes that the amounts of strain and hydrostatic pressure along existing calcified surfaces in the fracture callus determine the differentiation of the callus tissue. The study compares the local strains and stresses in the callus as calculated from a finite element model with histological findings from an animal fracture model. The hypothesis predicts intramembranous bone formation for strains smaller approximately Â±5% and hydrostatic pressures smaller than Â±0.15Â MPa. Endochondral ossification is associated with compressive pressures larger than about â^'0.15Â MPa and strains smaller than Â±15%. All other conditions seemed to lead to connective tissue or fibrous cartilage. The hypothesis enables a better understanding of the complex tissue differentiation

seen in histological images and the mechanical conditions for healing delayed healing or nonunions.

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Keywords

Bone healing; Mechanical stimuli; Tissue differentiation

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