Design and Fabrication of a Magnetically Responsive Dynamic Plate-Screw System for Controlled Mechanical Modulation in Fracture Non-Union Management

Dr. Mohit Dhingra
All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

R B Kalia
Professor, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

Dr. Kaushik Pal
Indian Institute of Technology Roorkee, Uttarakhand, India

Dr. Partha Roy
Indian Institute of Technology Roorkee, Uttarakhand, India

Dr. Durai
Indian Institute of Technology Jammu, Jammu and Kashmir, India

Abstract:

Introduction: Fracture healing is a complex biological process guided by interaction between cellular activity and the mechanical stability at the fracture site. The Diamond Concept emphasizes the importance of an optimal biological chamber which consist of osteogenic cells, blood flow, growth factors, and appropriate mechanical stability. Both rigid and non-rigid stability or fixation can adversely affect healing thus emphasizing the importance of controlled inter-fragmentary movement and dynamic modulation of mechanical forces. Current available internal fixation systems can just provide static compression, while external fixation methods allow controlled compression/distraction. But these external fixation methods are associated with patient discomfort and compliance issues. This creates a need for an internal fixation system which is capable of modifying the mechanical environment even after implantation.

Materials and Methods: A dynamic fixation concept was designed which incorporated a plate to be applied on the surface of bone and fixed with the help of screws which are responsive to the external magnetic field applied. This magnetic field is anticipated to generate controlled interfragmentary compression and distraction at the fracture site of the bone. The implant so designed focusses on achieving adjustable mechanical stimulation while maintaining fracture stability.

Results: The proposed dynamic plate-screw construct demonstrated the potential to provide adjustable mechanical modulation at the fracture site. The magnetically responsive screw mechanism is anticipated to allow controlled alteration of interfragmentary distance, and thus enabling both compression and distraction forces while maintaining fixation stability.

Discussion: The ability to regulate the mechanical environment after fixation may represent a significant advancement in fracture management. This is possible at present with the use of external