Early Axial Interfragmentary Motion and its Impact on the Fracture Healing Environment: A Scoping Review

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INTRODUCTION:

The initial interfragmentary motion (IFM) at a fracture site determines the mode of fracture healing. Controlled axial IFM is postulated to promote successful fracture healing, however the effects of minimal and excessive IFM can be disadvantageous to osteogenesis. Understanding the consequences of altering the fracture environment is essential to advancing our knowledge of fracture healing and the implications of surgical interventions on patient outcomes. The purpose of this review is to analyze the pertinent orthopaedic literature to assess our understanding of the effects of early axial IFM on fracture healing outcomes.

METHODS:

PubMed, OVID, and Medline databases were queried to identify all studies from inception until June 2021 assessing axial IFM on fracture healing outcomes in animal and human subjects. We compiled information about the amount of IFM, osteotomy/fracture location, experimental methodology, and outcomes (histologic, biomechanical, and radiographic evidence of fracture healing) for each study. Two independent reviewers screened all studies, and data was extracted into a standardized spreadsheet. Data synthesis is presented as a narrative review of our findings.

RESULTS:

A total of 4,972 studies were identified. Fifteen studies met inclusion criteria, totaling 605 fractures/osteotomies in skeletally mature participants. Of the included studies, 423 animal and 182 human subjects were examined. Nine studies investigated IFM at the tibia, four at the metatarsus, and two at the femur. The median time to analysis was nine weeks. The fracture gap size did not exceed 6 mm in any study. The range of IFM in investigated tibias, metatarsi, and femurs was 0.3-2.0 mm, 0.1-2.4 mm, and 0.03-1.0 mm, respectively. No experiment that used a femur model identified a significant association between early axial IFM and healing outcomes. All studies at the level of the tibia exhibited positive effects on callus formation with small-to-moderate axial IFM (mean 0.54, SD 0.30; range 0.2-0.9 mm). Most studies (9/13, 69.2%) found that enabling early micromovement produced superior callus stiffness and biomechanical rigidity compared to absolute stability. While larger IFMs (mean 1.28, SD 0.70; range 0.25-2.4 mm) frequently led to a larger callus area, the callus quality and biomechanical strength of the callus was compromised.

DISCUSSION AND CONCLUSION:

The definitive range of initial axial IFM conducive to a favorable fracture healing environment remains elusive. The heterogeneity in results and methodology precludes meta-analysis of the included studies. However, preliminary evidence suggests an association between small-to-moderate (mean 0.41, SD 0.32; range: 0.03- 1.0 mm) initial axial IFM for stimulating successful fracture healing. There have been few novel additions to the literature despite numerous advances in our ability to safely measure the fracture healing environment in human subjects. Our findings indicate that the cumulative evidence present in the literature is insufficient to determine a definite correlation between the early axial IFM and fracture healing outcomes. Future research should be directed at high-quality studies with human participants to improve our understanding of the implications of orthopaedic interventions on fracture healing outcomes.