Clin Orthop Relat Res (2009) 467:1937–1938
DOI 10.1007/s11999-009-0907-6

SYMPOSIUM: BIOMECHANICS OF BONE HEALING

Biomechanics of Bone Healing

Editorial Comment

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Published online: 22 May 2009

The ability to assess the degree to which a fracture has healed has challenged orthopaedic caregivers since the dawn of history. One can rest assured the earliest shamans struggled in a similar fashion to their modern counterparts in knowing when a fracture has healed enough to allow the resumption of unrestricted load bearing and function. The aim of all fracture care is restoration of limb function, which depends heavily on the fractured bone healing and regaining its original mechanical strength. One of the important skills that must be acquired by surgeons who treat fractures is the ability to assess the extent of healing from clinical and radiographic information. Recently, this assessment has become even more important because new devices, bone graft substitutes and pharmacological agents are being introduced which are intended to speed fracture healing and enhance the resistance to fracture of bone weakened by aging, osteoporosis and other disease. In order to assess the efficacy and benefit of these materials, exacting methods to assess healing and the strength of bone are required. This symposium reports examples of current research in methods to assess fracture healing and the mechanical properties of bone. Although few of these new technologies can be applied clinically at this time, becoming familiar with this research will benefit any clinician in this field.

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For the modern fracture surgeon serial radiographs of a healing fracture are the mainstay of the assessment of healing. However, radiographic assessments are notoriously unreliable with past studies suggesting that interpretation is highly dependent on experience with relatively poor interobserver and intraobserver reliability. Presented in this symposium are data that suggest surgeons can reliably predict the mechanical strength of a healing fracture during the early stages of healing. The task becomes more difficult after 80% of healing has occurred, suggesting that radiographs are unable to assess the late stages or completion of healing. Another helpful study suggests a refinement of classic radiographic assessment by introducing the concept of "Callus Index". Defined as the maximum diameter of the callus divided by the bone diameter, this index, when followed serially, can indicate when mechanical strength is restored.

The ultimate goal of this field is the development of nondestructive mechanical tests and imaging techniques which will enable the clinician to fully understand the mechanical properties of a patient's bone and quantify restoration of the strength of any fracture. This symposium reviews the vastly increased power of new techniques to assess bone structure and strength at the macro, micro and nano level. New understanding of the relationship between bone mass, three dimensional orientation and chemical composition of osteoporotic bone is addressed. A hierarchy of the importance of these factors is proposed, but most fascinating is the suggestion that an individual's propensity to remodel to habitual loading may be a primary distinguishing factor in fracture risk. Included is a project which has developed a model to assess adaptation of cancellous bone to loading and how the intensity and duration of cycles of loading are important.

The papers in this symposium represent the most current research dedicated to improving the methods of assessing bone strength and fracture repair. Translation of this work to useful tools for the future clinician will be the legacy of these efforts. It has been a great pleasure for us to collaborate with these investigators and to help them prepare this symposium.