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SYMPOSIUM: NANOSCIENCE IN MUSCULOSKELETAL MEDICINE

Editorial Comment

Nanoscience in Musculoskeletal Medicine

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Musculoskeletal tissues and organs are constructed of natural nanostructures that can repair or regenerate themselves. Collagen is a nanoscale protein and bone is a natural nanostructure composite composed of collagen and hydroxyapatite. Skeletal muscles and tendons furthermore function as nanofibers. Damaged peripheral nerves have been recently repaired by nanotubes. As concepts of biomimetics and techniques using nanostructures have advanced, nanomaterials have been introduced to repair or regenerate musculoskeletal tissues and organs. In this minisymposium, we present recent studies on bone engineering, implant coating to prevent infection, and delivery of antibiotics plus active molecules using nanotechnology and nanomaterials (Fig. 1).

A nanometer is one-millionth of a millimeter—approximately 100,000 smaller than the diameter of a human hair. Constituent dimensions less than 100 nm in at least one direction are defined as nanomaterials. Recent studies revealed increased adhesion of cells on nanotextured surfaces resulting from larger surface areas and greater numbers of attachment sites for cells. Vitronectin and fibronectin molecules are expressed in higher amounts when cells are grown on nano- compared with nonstructured surfaces. Proliferation, differentiation, and extracellular matrix production that aid stronger and durable implant integration increase on such surfaces. Larger surface area, improved protein adsorption, and cell response allow better osseointegration, enhanced load-bearing properties, and extended implant life. Apart from implant integration, ceramic, polymer, or composite nanomaterials are currently used to regenerate bone defects. Nanoscience may inhibit inflammation and infection. Nano-silver coatings or antibiotic-loaded nano-scaffolds have been experimentally used to reduce the risk of implant-related infections. Drug-carrying magnetic nanoparticles can be directed to infection or even cancer sites in vivo. Magnetic carbon nanotubes were recently used for homing mesenchymal stem cells that can be directed to nonunions. Although currently under consideration, nanoscience may eventually help us identify and isolate viruses in vivo, carry

Fig. 1 Dr. Feza Korkusuz is shown.

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appropriate cells to diseased or injured areas, or allow us to monitor implanted prostheses through pressure and pH sensing.

Anything implanted into the human body will be accepted or rejected according to laws of homeostasis. We currently know very little about the effects of nanomaterials when implanted into tissues. Their long-term effects on the reticuloendothelial and immune systems are unknown. Toxicity, biocompatibility, and degradation studies of nanomaterials still need to be investigated. Nonetheless, the capabilities of nanotechnology may aid in diagnosing, treating, and following complex cases in the foreseeable future. We hope these articles will alert readers to some of the current areas of exploration.