Artificial Injectable Bone: A Regenerative Stem Cell Treatment for Osteoporosis and Bone Fracture Healing through an Injectable Nanocomposite Orthopedic Implant and Dynamic Ultrasound Radiation

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Over two hundred million people suffer from osteoporosis, a severe bone degenerative disease which damages bone tissue, leading to high rates of non-healing fractures and bone defects. There is an urgent need for a treatment to heal osteoporotic injuries to prevent prolonged suffering in patients. Current treatments involving surgeries are invasive, expensive, and extremely ineffective, with 70% of patients unable to recover. The objective of this research is to develop a novel noninvasive injectable treatment through tissue engineering, for the complete healing of osteoporotic fractures and bone defects, which is impossible through current methods. The ideal injectable orthopedic implant was designed through a thermosensitive scaffold fusing carbon nanotubes with chitosan-ß glycerophosphate hydrogels. In this powerful treatment, Low-Intensity Pulsed Ultrasound waves interacted with carbon nanotubes, causing carbon nanotube resonance to magnify mechanical stimuli and induce accelerated bone formation through rapid stem cell differentiation. An ALP Activity assay and a fluorescent cell viability assay were conducted to determine the optimal treatment. In the treatment, the thermosensitive implant morphs from a viscous solution containing stem cells at room temperature, to a solid scaffold when injected in the body. Through optimum growth conditions within the nanocomposite implant and mechanotransduction by dynamic acoustic radiation force, stem cells will rapidly differentiate into bone tissue, healing injuries the body is unable to self-heal. This nonsurgical treatment for osteoporotic fractures and bone defects will transform the lives of millions suffering from osteoporosis, by rapidly and painlessly healing the debilitating injuries often caused by this disease.

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