3D Printed Orthopaedic Implants: Biodegradation Behavior, Infection Prevention, and Bone Regeneration

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3D printing otherwise known as additive manufacturing has enabled fabrication of volume-porous implants which may or may not be personalized in terms of their overall shape. The fully-interconnected, highly porous, and topologically ordered micro-architecture of such biomaterials has important implications for infection prevention and improved bone regeneration. First, the surface area of volume-porous implants is much larger than the corresponding solid implants. The much larger surface area amplifies the effects of coatings and surface treatments aimed at reducing the risk of infections and stimulating the growth of bone tissue. Second, there is a very large pore space that could be used to accommodate drug delivery vehicles for local delivery of growth factors and/or antibacterial agents (e.g. antibiotics, inorganic antibacterial agents, or antimicrobial peptides). Finally, the biodegradation behavior of bone substitutes could be controlled using the topological design of volume-porous implants at the micro-scale to make sure bone regeneration continues unhindered to the maximum possible extent. Combined together, these three features of 3D printed volume-porous implants offer a host of opportunities to simultaneously reduce the risk of implant-associated infections and enhance bone regeneration performance. In this talk, the recent progress in this regard will be reviewed with a particular emphasis on metallic materials, their coatings and surface treatments, and new generations of 3D printed biodegradable metallic biomaterials.

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