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Advances in 3D printed Bone Tissue Engineering -Success and Future perspective

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Abstract

Cells require a home to proliferate and differentiate. 3D printing provides the technology to enable the manufacture of 3D scaffolds with interconnected porosity layer by layer. 3D printed medical grade polycaprolactone (mPCL) scaffolds were introduced more than 10 years ago as a scaffold for bone tissue engineering and implanted in more than 20,000 patients. The clinical successes from burr hole covers, dental ridge preservation, customized cranioplasty to orbital floor repairs were attributed to the microstructure that mimics the trabecular bone microstructure that encourages vascularization, cell-cell communications and slow degradation. Future perspective on translational bone tissue engineering will rely not only on the biomimetic microarchitecture of the scaffolds to trap and provide a home for the cells but also on the cocktail of cells (egstem cells and neutrophils) that addresses angiogenesis from the beginning and the biodegradable products that can enhance the bone forming cells. The latter is important as bone cells require trace elements of minerals such as magnesium to enable them to function in a sustainable manner. Bone is a piezoelectric material. It responds to both mechanical and electrical signals. We designed a biaxial rotation bioreactor for engineering bone tissues with mechanical cyclic strains and found that there is an increase in the upregulation of osteogenic gene expression. Recently we introduced pulsed electromagnetic field (PEMF)into the bioreactor and some results will be discussed.

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