Bioactive nanoparticles stimulate bone tissue formation in bioprinted three-dimensional scaffold and human mesenchymal stem cells.

Abstract:
Bioprinting based on thermal inkjet printing is a promising but unexplored approach in bone tissue engineering. Appropriate cell types and suitable biomaterial scaffolds are two critical factors to generate successful bioprinted tissue. This study was undertaken in order to evaluate bioactive ceramic nanoparticles in stimulating osteogenesis of printed bone marrow-derived human mesenchymal stem cells (hMSCs) in poly(ethylene glycol)dimethacrylate (PEGDMA) scaffold. hMSCs suspended in PEGDMA were co-printed with nanoparticles of bioactive glass (BG) and hydroxyapatite (HA) under simultaneous polymerization so the printed substrates were delivered with highly accurate placement in three-dimensional (3D) locations. hMSCs interacted with HA showed the highest cell viability (86.62 ± 6.02%) and increased compressive modulus (358.91 ± 48.05 kPa) after 21 days in culture among all groups. Biochemical analysis showed the most collagen production and highest alkaline phosphatase activity in PEG-HA group, which is consistent with gene expression determined by quantitative PCR. Masson's trichrome staining also showed the most collagen deposition in PEG-HA scaffold. Therefore, HA is more effective comparing to BG for hMSCs osteogenesis in bioprinted bone constructs. Combining with our previous experience in vasculature,
cartilage, and muscle bioprinting, this technology demonstrates the capacity for both soft and hard tissue engineering with biomimetic structures.