3D Printed Gelatin Scaffolds for Fibrocartilage Regeneration

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Abstract

The temporomandibular joint (TMJ) is bilateral synovial joint with an interpositional fibrocartilage disc connecting the mandible to the temporal bones. Unlike conventional treatment strategies, tissue engineering seems promising to regenerate lost/damaged TMJ structures. Gelatin type A were 3D printed, cross-linked with genipin, freeze-dried and sterilized. The scaffolds were characterized in terms of structure, swelling and stability. Interactions of the scaffolds with mesenchymal stem cells (MSCs) in terms of seeding efficacy, attachment and chondrogenic differentiation were conducted. The chondrogenic differentiation of the cells on scaffolds were compared to standard pellet culture and microspheres. The scaffolds demonstrated good shape fidelity. Structural characterization by SEM and µCT showed open porosity of 93%. The freeze-drying resulted in 38% shrinkage. However, the printed scaffolds had high swelling capacity (500%) after 1h and showed stability over 21 days in culture medium. With respect to the biological performance, the printed scaffolds supported cell attachment and differentiation. Compared with pellets and spheres, the 3D printed scaffolds had a similar trend of upregulation of the chondrogenic gene markers, i.e. SOX9, aggrecan, collagen I and II and a downregulation of the hypertrophy marker collagen X over 21 days. Gelatin is suitable for 3D printing fabrication and genipin successfully prevented rapid degradation of the scaffolds. Gelatin scaffolds supported cell attachment and chondrogenic differentiation *in vitro*. 3D printed gelatin scaffolds hold great potential for fibrocartilage tissue engineering applications.