Departmental Seminar

Seminar Title	: Development of a high shape fidelity composite bioink for enhanced osteogenic differentiation of mesenchymal stem cells for bone tissue engineering
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Venue	: BM Department Seminar Room
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Abstract	: 3D bioprinting of bioinks with bone-mimetic properties is advancing rapidly to address the issues associated with critical bone defects. To this end, several protein-based composite bioinks have been formulated using gelatin, collagen, silk fibroin and their methacrylated derivatives [1],[2]. The crosslinking strategies of these protein-based hydrogels typically involve either chemical crosslinkers or UV irradiation. BM-MSCs are susceptible to toxicity induced by these chemical crosslinkers. On the other hand, UV crosslinking leads to DNA damage, ultimately compromising cell viability. Additionally, protein-based bioinks exhibit poor mechanical stability and degrade quickly under in vitro conditions [2]. To solve these challenges, a protein-polysaccharide based composite bioink incorporated with self-assembled nanofibrous polyelectrolyte complex (PEC) was developed. We successfully developed a synergistic gelation mechanism of thermally treated bovine serum albumin (BSA) and sodium alginate with a cell-friendly concentration of calcium chloride (50 mM) [3]. Two distinct types of PECs, gelatin-chitosan (GC) and chondroitin sulfate-chitosan (CSC), were separately incorporated into the bioink. Bioink without PEC nanofibers was taken as 'control'. BM-MSCs (2 x 106 cells/ml of bioink) were encapsulated in the bioink samples, and post-printing cell viability was evaluated by live-dead assay. Proliferation of BM-MSCs within the bioprinted scaffolds was observed after 14 days of culture. Furthermore, the osteogenic differentiation of encapsulated BM-MSCs was evident from the alkaline phosphatase (ALP) estimation, where ALP synthesis significantly increased in CSC (29.22 U/ml) and GC (24.93 U/ml) bioinks. The type-I collagen synthesis in bioprinted scaffolds cultured in both complete and osteogenic medium was observed. The OD550nm in osteogenic medium was significantly higher (> 0.5) than the scaffolds cultured in complete culture medium (OD550nm < 0.5). Additionally, the developed bioinks had excellent shear-thinning profiles, high mechanical properties, optimal printability and high shape fidelity. The printability was calculated based on the squareness of the printed grid structure. The printability values were approximately 0.990, 1.01 and 1.03 for control, GC and CSC bioink, respectively, indicating excellent printability. The integrity factor for 20-layered printed scaffolds was also very close to 1, demonstrating high shape fidelity. FESEM analysis of the dehydrated scaffolds revealed a highly porous internal morphology of the crosslinked bioink. The MTT assay resulted in a cell viability >90%, indicating excellent biocompatibility. Further work is being carried out to analyze the gene expression analysis of osteogenic markers and BM-MSC adhesion/ spreading in the bioinks. Overall, we exploited the crosslinking capability of thermally treated BSA and sodium alginate with calcium ions, forming a highly stable hydrogel, even at low concentrations of calcium chloride. This stability was confirmed by achieving an elastic modulus exceeding 120 kPa and a prolonged degradation rate in complete culture medium. The high shape-fidelity bioink could be printed into complex geometries. Notably, the addition of nanofibrous PECs plays a crucial role in enhancing the physicochemical, mechanical and biological properties of the bioink. The developed bioink demonstrates strong potential as a protein-rich bioink for bone tissue engineering applications. ALL ARE CORDIALLY INVITED