Development of a cell-laden thermosensitive chitosan bioink for 3D bioprinting

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Abstract

3D bioprinting is a technology to produce complex tissue constructs through printing living cells with hydrogel in a layer-by-layer process. To produce more stable 3D cell-laden structures, various materials have been developed such as alginate, fibrin and gelatin. However, most of these hydrogels are chemically bound using crosslinkers which can cause some problems in cytotoxicity and cell viability. On the other hand, thermosensitive hydrogels are physically cross-linked by non-covalent interaction without crosslinker, facilitating stable cytotoxicity and cell viability. The examples of currently reported thermosensitive hydrogels are poly(ethylene glycol)/poly(propylene glycol)/poly(ethylene glycol) (PEG-PPG-PEG) and poly(ethylene glycol)/poly(lactic acid-co-glycolic acid) (PEG/PLGA). Chitosan, which have been widely used in tissue engineering due to its biocompatibility and osteoconductivity, can be used as thermosensitive hydrogels. However, despite the many advantages, chitosan hydrogel has not yet been used as a bioink. The purpose of this study was to develop a bioink by chitosan hydrogel for 3D bioprinting and to evaluate the suitability and potential ability of the developed chitosan hydrogel as a bioink. To prepare the chitosan hydrogel solution, β-glycerolphosphate solution was added to the chitosan solution at the final pH ranged from 6.9 to 7.1. Gelation time decreased exponentially with increasing temperature. Scanning electron microscopy (SEM) image showed that chitosan hydrogel had irregular porous structure. From the water soluble tetrazolium salt (WST) and live and dead assay data, it was proven that there was no significant cytotoxicity and that cells were well dispersed. The chitosan hydrogel was well printed under temperature-controlled condition, and cells were well laden inside gel. The cytotoxicity of laden cells was evaluated by live and dead assay. In conclusion, chitosan bioink can be a candidate for 3D bioprinting.

Keywords

3D printing, Bioprinting, Bioink, Hydrogel, Chtiosan

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