Mussel-inspired adhesive, self-healing and injectable poly (L-glutamic cid)/ alginate based hydrogels

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Introduction

Injectable hydrogels have aroused much attention for the advantages such as minimally invasive surgery, avoidance of surgical trauma, and filling and repairing irregularly shaped tissue defects. Mussel-inspired injectable hydrogels can be immobilized on the surface of tissues, resulting in stable biomaterial–tissue integration. However, the commonly used biomimetic mussel-inspired hydrogels are prepared by the oxidation of catechol groups, which involves the introduction or production of cytotoxic substances. Moreover, mussel-inspired hydrogels generally display weak mechanical strength and poor adhesiveness because of the consumption of catechol groups during oxidation. Herein, we described a strategy to prepare mussel-inspired injectable hydrogels via the Schiff base reaction. A series of injectable mussel-inspired adhesive, self-healing hydrogels were fabricated by in situ crosslinking of hydrazide-modified poly(L-glutamic acid) (PLGA–ADH) and dual-functionalized alginate (catechol- and aldehyde-modified alginate, ALG–CHO–Catechol).

Experimental

^{1}H NMR spectra and UV-vis spectra were characterized to confirm the conjugation of catechol groups onto ALG–CHO. Rheological test and adhesion measurements were operated to evaluate the mechanical and adhesive properties of the obtained hydrogels. The in vivo hemostatic ability of the hydrogels was investigated using a rat hemorrhaging liver model (male SD rats, 150–200 g).

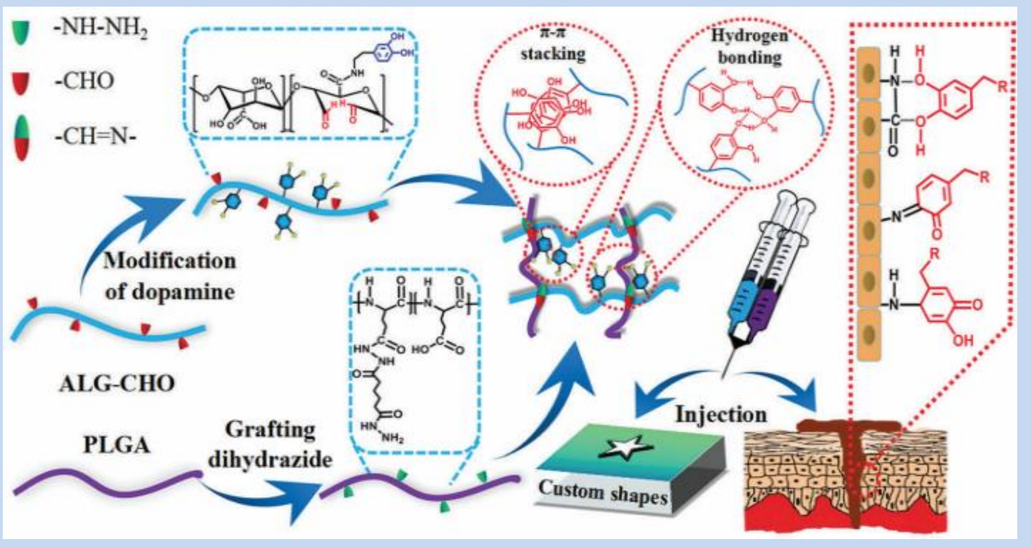

Fig.1 Schematic illustration of the hydrogels..

Results

ALG–CHO–Catechol conjugates with controllable catechol grafting ratios and hydrophilicity were synthesized. The mussel-inspired adhesive, self-healing and injectable PLGA/ALG–CHO–Catechol hydrogels were prepared via self-crosslinking of PLGA–ADH and ALG–CHO–Catechol by Schiff base reaction, which avoided the introduction of small molecular oxidants and preserved the catechol functional groups (Fig. 1). The gelation occurred in a reasonable time. Compared with the oxidized ALG–CHO–Catechol hydrogels, the PLGA/ALG-CHO–Catechol hydrogels showed greatly improved mechanical properties and adhesive properties. The PLGA/ALG–CHO–Catechol hydrogels also exhibited strong self-healing ability and good biocompatibility with adipose stem cells. In vivo antibleeding displayed superior hemostatic capacity of the PLGA/ALG–CHO–Catechol hydrogels. The injectable PLGA/ALG–CHO–Catechol hydrogel system demonstrates attractive properties and has shown promise as a suitable hemostatic agent with high performance (Fig.2**)**.

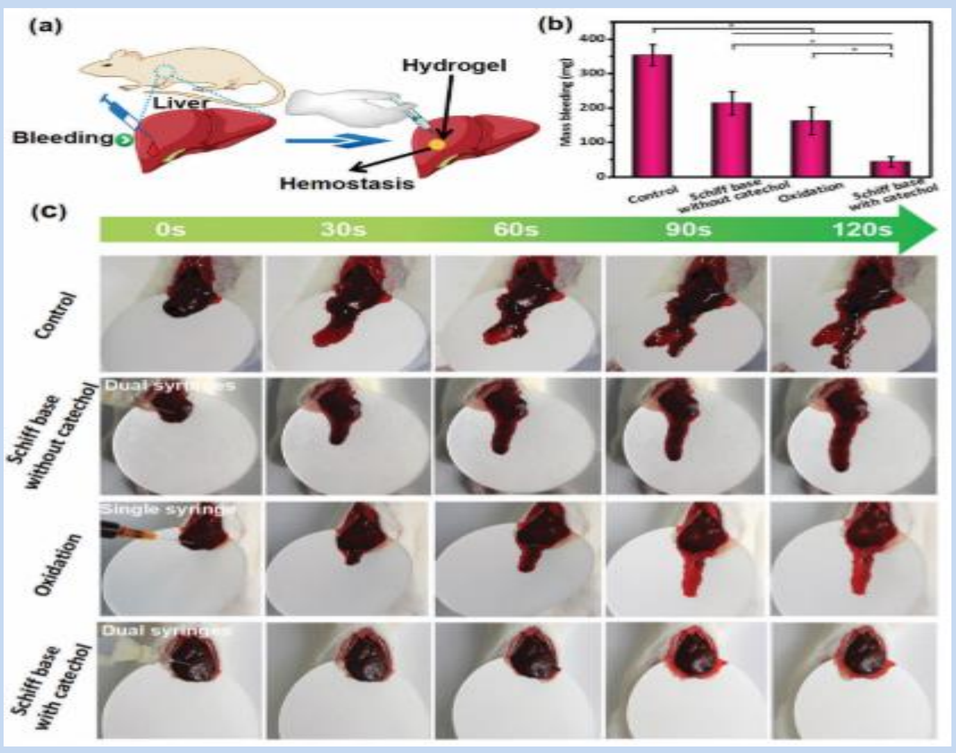

Fig.2 Hemostatic capability of the hydrogels.

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