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Objectives Previous studies have exhibited the protective effects of synthesised polymers alone or as scaffold for myocardial infarctions (MI) treatment. However, the exact role of synthesised polymers when used for MI treatment is still unknown. Besides that, the suitable degradation time of synthesised biomaterials is still under controversy. In our present study, we synthesise two kinds of poly N-isopropylacrylamide thermoresponsive hydrogel with theoretic different degradation time, and aim to investigate the interaction of physical characteristics and function of the synthesised polymer in MI-induced rat model.

Methods Two types of poly N-isopropylacrylamide thermoresponsive hydrogel (defined as Gel A and Gel B) were synthesised by our previous report. In vivo hydrogel formation and maintenance were observed and confirmed in male KM mice (20±5 g) to make sure the degradation days of hydrogel in vivo. MI was induced in male Wistar rats (200±20 g) by the ligation of left anterior descending coronary artery. The MI rats were grouped to receive intra-myocardial injection of 100 µl phosphate buffered saline, 3% (w/v) Gel A or 3% (w/v) Gel B solution randomly by intra-myocardium injection. The geometric structure of the hydrogel was also tested by electron scanning microscopy. Echocardiography and hemodynamic analysis were used to evaluate left ventricular systolic and diastolic function. Isolated infarcted or sham myocardium was tailored for contractility measurement in vitro. Western blotting and immunohistochemistry were used for detecting collagen metabolism.

Results In vivo degradation investigation showed the biodegradation time of Gel A is approximate 85 days and the days of Gel B is nearly 28 days. Electron scanning microscopy images exhibited the three-dimensional structure of cross-linked and skeleton-like networks contributing to form holes which could adhere to red blood cells. At the aspect of inhibiting ventricular infarction enlargement, Gel A or Gel B showed no significant difference, while, Gel B performed better than Gel A on improving left ventricular systolic and diastolic function ($p<0.05$). Collagen hyper-deposition around the infarcted and non-infarcted myocardium is a common phenomenon after infarction. However, the injection of thermoresponsive hydrogel could significantly down-regulate collagen deposition. Notably, the effectiveness of hydrogel on regulate collagen metabolism is not through TGF- β signal pathway. Additionally, contractility of isolated infarcted myocardium was significantly deteriorated, however, contraction force significantly increased due to the improvement of contractile coordination after hydrogel used.

Conclusions Synthesised poly N-isopropylacrylamide hydrogel is an excellent option for MI treatment. Proper physical features may be the potential reason for the effective cardiac protection of the thermoresponsive hydrogel post-MI. Additionally, suitable degradation time of synthesised poly N-isopropylacrylamide hydrogel is another consideration for biomaterials designing. We deem the physical properties of poly N-isopropylacrylamide hydrogel promote its effects on structural and functional replacement of damaged myocardium tissue.

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PHYSICAL FEATURES OF THERMORESPONSIVE HYDROGELS PROMOTE ITS EFFECTS ON CARDIAC PROTECTION POST MYOCARDIAL INFARCTION

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