RHEOLOGICAL PROPERTIES OF BIODEGRADABLE HYDROGELS OF ALGINATE AND PEG FOR MYOCARDIAL TISSUE ENGINEERING APPLICATIONS

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Introduction

Tissue engineering approaches are widely considered for medical treatment after an infarction and perhaps even to regenerate the damaged tissues of myocardium [Kolettis, 2011]. Numerous highly porous scaffolds of synthetic biodegradable polymers, such as alginate hydrogels and hydrogels based on polyethylene glycol (PEG), have been proposed [Kuo, 2001].

The scaffolds attached at the outer surface of myocardium are subjected to constant dynamic forces due to the continuous pulsing of the heart. Thus, the desirable degradation of an absorbable scaffold should be a result of both chemical and mechanical degradation. This study aims to contribute to this hypothesis. Thus, the rheological properties of two biocompatible hydrogels, namely alginate and PEGSDA (where S stands for sebacoyl chloride and A for acryloyl chloride), measured with a viscometer at 37°C, are presented. These scaffolds have been successfully implanted in the myocardium of experimental animals (rats) and they have shown very good biocompatibility and *in vivo* performance [Vilaeti, 2012, 2013].

Methods

For the preparation of the alginate hydrogel, alginate acid was dissolved (2, 3 and 4 % w/w) in physiological serum. Then, a solution of glouconolactone and $CaCl_2$ was added. The preparation of the PEGSDA hydrogel is described elsewhere [Vilaeti, 2012].

Viscosity measurements were carried out at 37°C with a viscometer (Bohlin Visco 88, Malvern Instruments), where a cylinder of stainless steel rotates in the gel. The values of dynamic viscosity (η), torque (M), shear rate (γ) and shear stress (τ) were recorded.

Results

Figure 1 shows the experimental results of dynamic viscosity (η) of the alginate gels 2%, 3% and 4% over time (at the same shear rate) (Fig. 1a) and at different shear rates (Fig. 1b).

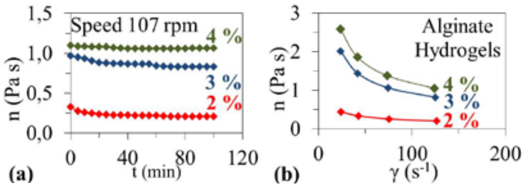

Figure 1: Dependence of dynamic viscosity (n) of alginate gels on (a) rotation time, and (b) shear rate.

The increase of alginate concentration results in more viscous gels. Viscosity slightly decreases over time (Fig. 1a). The decrease of viscosity due to increasing shear rate is more pronounced (Fig. 1b) and it is steeper in the gels with high alginate concentration than the gels with low alginate content.

The viscosity measurements with PEGSDA gel are similar to the hydrogel 2% alginate.

Discussion

It is generally assumed that the rheological parameters give an indication of the structure of the hydrogel [Mitchell, 1980]. Thus, the viscosity measurements of this study can be considered as an index of the mechanical degradation of the scaffolds when they are implanted onto the myocardium surface. In particular, the reduction of viscosity due to increasing shear rate is an evidence that structure of the interchain bridges and other structural features of the gel [Stevens, 2003] degrade when the gel is subjected to shear stress. This provides evidence of the mechanical degradation of the scaffold, along with the inevitable chemical degradation, when implanted onto the myocardium outer surface.

References

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