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Research paper

Investigating a novel nanostructured fibrin–agarose biomaterial for human cornea tissue engineering: Rheological properties

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ABSTRACT

In this work, the rheological properties of the biomaterial fibrin with different agarose concentrations, used for the generation of a bioengineered human corneal stroma by tissue engineering, before and after using a nanostructuring technique, were analyzed. The transparency of these artificial human stromas was also investigated. The temporal evaluation of the properties of these biomaterials is essential for the design of functional biological human corneal replacements. The nanostructuring technique used for the generation of nanostructured corneal constructs (NCCs) had a major influence on the rheological properties of the fibrin–agarose corneal equivalents. For an oscillatory shear stress of 1 Hz, well in the order of the natural oscillations of the human cornea, the NCCs had viscoelasticity values higher than those of non-nanostructured corneal constructs (N-NCCs), but similar to those of an ex vivo native cornea. The model that most resembled the rheological behavior of the native cornea was a fibrin–0.1% agarose concentration nanostructured construct. In addition, this artificial cornea model displayed optimal levels of transparency, similar to the native tissue. All these properties indicate that the fibrin–0.1% agarose concentration nanostructured construct might serve as an adequate candidate for the generation of an artificial complete cornea, not only for transplanting use but also for conducting pharmaceutical testing and biomedical research.

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1. Introduction

The cornea is a transparent avascular tissue comprising three major cellular layers: an outermost stratified squamous

epithelium (about 50 μm thick), a stroma with keratocytes (central thickness about 500 μm), and an innermost monolayer of specialized endothelial cells (about 10 μm thick) (Cohen et al., 2001).

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