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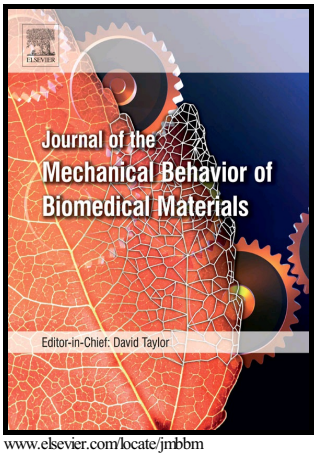

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Factors Affecting the Mechanical Behavior of Collagen Hydrogels for Skin Tissue Engineering

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Abstract

The effect of the production factors yielding a functional dermal substitute was investigated by means of monotonic and cyclic uniaxial tensile tests, as well as electron microscopy visualizations. The role of (i) plastic compression, (ii) product incubation, and (iii) cell permanence in the collagenous matrix in order to achieve a skin-like behavior were characterized in terms of material and structural stiffness, in-plane kinematics, and cyclic response, as well as pore size and network density. The plastic compression resulted in a denser and stiffer material, while no corresponding change was observed in the behavior of the entire structure. This was related to the progressive reduction in product thickness and amount of excess water, rather than to formation of new crosslinks between fibers. Contrary, irrespective of the presence of human fibroblasts, the product incubation induced both material and structural stiffening, indicating the formation of a denser network. These results were confirmed by similar evolutions in the construct in-plane kinematics and cyclic stress reduction. Finally, comparison of constructs incubated in different culture media indicated a determinant contribution of the biochemical environment, rather than of the seeded cells, to the achieved mechanical properties. The observed features are relevant in terms of mechanical biocompatibility of the implant and might direct future optimizations of the production process in order to rapidly attain the desired mechanical properties.

Keywords: Skin Substitute; Multiscale Biomechanics; Tissue Engineering; Collagen Hydrogel; Uniaxial Testing

1. Introduction

1.1. Collagen Hydrogels for Skin Tissue Engineering