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Research paper

PVA hydrogel properties for biomedical application

Shan Jiang*, **Sha Liu**, **Wenhao Feng**

Centre for Advanced Mechanisms and Robotics-CAMAR, School of Mechanical Engineering, Tianjin University, Tianjin, 300072, China

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ABSTRACT

PVA has been proposed as a promising biomaterial suitable for tissue mimicking, vascular cell culturing and vascular implanting. In this research, a kind of transparent PVA hydrogel has been investigated in order to mimic the creatural soft tissue deformation during mini-invasive surgery with needle intervention, such as brachytherapy. Three kinds of samples with the same composition of 3 g PVA, 17 g de-ionized water, 80 g dimethyl-sulfoxide but different freeze/thaw cycles have been prepared. In order to investigate the structure and properties of polyvinyl alcohol hydrogel, micro-structure, mechanical property and deformation measurement have been conducted. As the SEM image comparison results show, with the increase of freeze/thaw cycles, PVA hydrogel revealed the similar micro-structure to porcine liver tissue. With uniaxial tensile strength test, the above composition with a five freeze/thaw cycle sample resulted in Young's modulus similar to that of porcine liver's property. Through the comparison of needle insertion deformation experiment and the clinical experiment during brachytherapy, results show that the PVA hydrogel had the same deformation property as prostate tissue. These transparent hydrogel phantom materials can be suitable soft tissue substitutes in needle intervention precision or pre-operation planning studies, particularly in the cases of mimicking creatural tissue deformation and analysing video camera images.

1. Introduction

Polyvinyl Alcohol (PVA), a hydrophilic, biodegradable and biocompatible synthetic polymer, has been widely used in different areas of the biomedical field (Paradossi et al., 2003). Recently, PVA hydrogels have become especially attractive to the field of 'tissue engineering' for repairing and regenerating a wide variety of tissues and organs (Woerly et al., 1996), (Hubbell, 1998), including arterial phantom (Chu and Rutt, 1997), heart valves (Jiang et al., 2004), corneal implants (Vijayasekaran et al., 1998), and cartilage tissue substitutes (Stammen et al., 2001).

In tissue engineering, PVA based scaffold has been studied to substitute the current available artificial grafts. Vrana focuses their investigation on the evaluation of the response of the vascular cells to the changes in the hydrogel structure by increasing freeze–thaw cycle number (Vrana et al., 2008). Hoffman has successfully used PVA hydrogels to cultivate living cells, because such hydrogels have large pores and are capable of degradation (Hoffman, 2002).

Hydrogels are water-swollen crosslinked polymer networks, which often exhibit characteristics, such as tissue-like elasticity and mechanical strength, and the appearance and feel of PVA hydrogel are similar to those of native arterial

* *Corresponding address:* School of Mechanical Engineering, Tianjin University, 92 Weijin Road, Nankai District, Tianjin 300072, China. Tel.: +86 22 27890307; fax: +86 22 27890307.
E-mail address: shanjiang@tju.edu.cn (S. Jiang).

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