Mechanical evaluation of nano-cellulose constructs designed for tissue-engineering of auricular cartilage

Other Conference Item

Author(s):
Nimersken, L.; Martinez, H.; Gatenholm, Paul; Müller, Ralph; Stok, K.S.

Publication date:
2012

Permanent link:
https://doi.org/10.3929/ethz-a-007563456

MECHANICAL EVALUATION OF NANO-CELLULOSE CONSTRUCTS DESIGNED FOR TISSUE-ENGINEERING OF AURICULAR CARTILAGE

Nimeskern L[1], Martinez H[2], Gatenholm P[2], Müller R[1], Stok KS[1]

1: Institute for Biomechanics, ETH Zürich, Switzerland

2: Biopolymer Technology, Department of Chemical and Biological Engineering, Chalmers University of Technology, Göteborg, Sweden

Like any cartilaginous tissue the external part of the ear, the auricle, cannot regenerate once damaged. Tissue engineering (TE) is a potential alternative to surgical reconstruction which would reduce donor site-morbidity. Adequate mechanical properties which allow for daily activities (e.g. sleeping, wearing earphones) are key. Various biodegradable ear-shaped scaffolds have been investigated, yet due to inadequate degradation rates mechanical properties deteriorated with long-term *in vivo* implantation. Nano-cellulose (NC) is a biocompatible but non-biodegradable biomaterial, making it a promising scaffold material for ear reconstruction. This study aims to characterize the mechanical properties of various NC constructs and compare them to human auricular cartilage to decide the best candidate for auricular TE.

Materials and Methods

Fresh human auricular cartilage (n=5) is harvested after reconstructive surgery. Three different NC scaffolds are produced by bacterial synthesis: 5%-NC (95% water, n=5), 2%-NC (n=7), microporous NC (n=6). Samples are cut to 5x5 mm^2, and tested in stress-relaxation (5%-strain steps with 30 minutes relaxation) on a Zwick-Z005 machine (10 N load cell, Ø0.9 mm indenter). Material properties, including equilibrium modulus (E_{eq}), are computed using MATLAB.

Results

Figure 1 shows that native auricular cartilage has a higher E_{eq} (1184.6 ± 676.4 kPa) than 5%-NC (194.7 ± 49.0 kPa) and 2%-NC (92.5 ± 42.5 kPa). The stiffness of microporous NC was below the sensitivity of the system.

Discussion and Conclusions

NC mechanical properties are highly tunable, covering stiffnesses from < 15 kPa up to 200 kPa, where 5%-NC scaffolds have the greatest mechanical potential as a candidate for auricular TE. In future, higher concentrations will be used to further increase scaffold strength. Cell-seeding and subsequent extracellular matrix production will further improve the mechanical properties of the constructs, making them a relevant choice for auricular TE efforts.

Acknowledgements

A Swiss National Science Foundation, NRP63, and ERA-NET/EuroNanoMed project (EAREG-406340-131009/1)