

Matrix distribution and the functional development of tissue engineered cartilage

Citation for published version (APA):

Sengers, B. G., Oomens, C. W. J., & Baaijens, F. P. T. (2004). *Matrix distribution and the functional development of tissue engineered cartilage*. Poster session presented at Mate Poster Award 2004 : 9th Annual Poster Contest.

Document status and date:

Published: 01/01/2004

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Matrix Distribution and the Functional Development of Tissue Engineered Cartilage

B.G. Sengers, C.W.J. Oomens, F.P.T. Baaijens
Biomechanics and Tissue Engineering

Introduction

Assessment of the functionality of engineered cartilage is hampered by the lack of correlation between mechanical properties and tissue constituents. Molecular organization and crosslinks play a role, but it has also been proposed that functionality arises when contact occurs between zones of matrix associated with individual cells [1,2], see Fig. 1,2.

Objective:

Determine whether the microscopic distribution of newly synthesized matrix contributes to the development of the functional properties of tissue engineered cartilage.

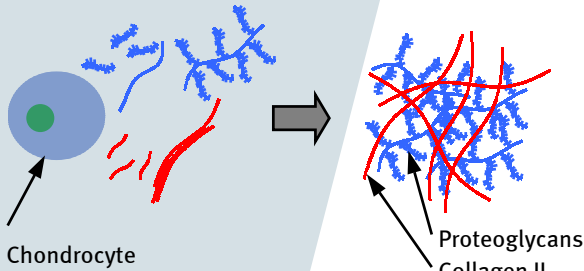


Figure 1 Extracellular matrix components, synthesized by chondrocytes, undergo an assembly process to form a mechanically functional extracellular matrix.

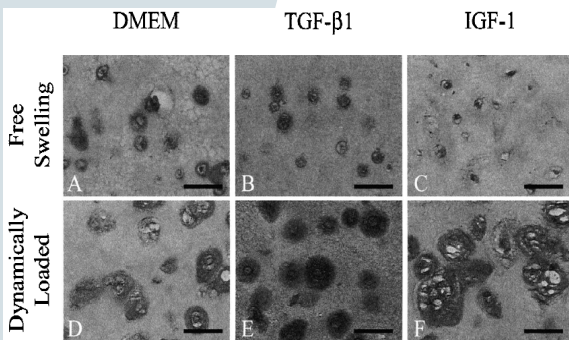


Figure 2 Example experimental matrix distribution [1]. Cells embedded in an agarose hydrogel stained for proteoglycans at 28 days. Matrix deposition proceeds outwards from the cells.

Methods

A finite element approach, based on a representative part of the microstructure, was adopted, see Fig. 3. Matrix synthesis, diffusion, binding and degradation were described [3]. Local stiffness and permeability were taken dependent on the bound matrix concentration. Subsequently global tissue properties were derived [4].

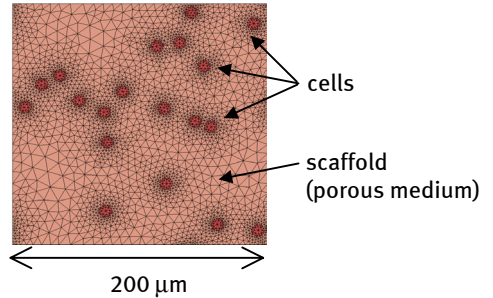


Figure 3 Finite element model of a representative microstructure. Periodical boundary conditions were applied.

Results

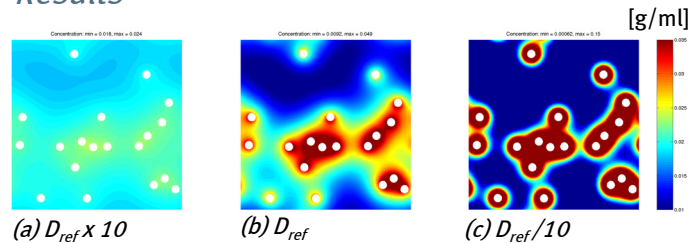


Figure 4 Computed matrix distribution for different diffusion coefficients, ranging from homogeneous (a) to very localized (c).

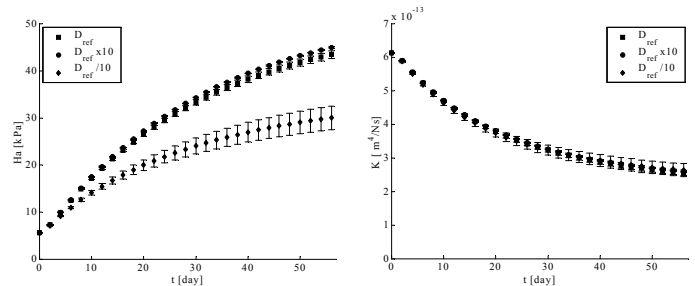


Figure 5 Resulting aggregate modulus H_a and permeability K over time. Averaged over 5 different microstructures in two directions.

Conclusions

Overall stiffness and permeability are to a large extent insensitive to the local matrix distribution. Results underline the need for caution in interpreting functionality from histology and the importance of complementary measurements of intrinsic matrix organization.

References:

- [1] Mauck RL, 2003, *Tissue Engineering*, 9(4), pp. 597-611.
- [2] Quinn TM, 2002, *Biorheology*, 39, pp. 27-37.
- [3] Dimicco MA, 2003, *J. Orthop. Res.*, 20, pp. 842-848.
- [4] Breuls RGM, 2002, *J. Biomech. Eng.*, 124, pp. 198-207.