Osmotic forces are important in disc biomechnics: have they been accounted for in FE simulations?

Citation for published version (APA):
Schröder, Y., Wilson, W., Huyghe, J. M. R. J., & Baaijens, F. P. T. (2004). Osmotic forces are important in disc biomechnics: have they been accounted for in FE simulations?. 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.
Osmotic forces are important in disc biomechanics—have they been accounted for in FE simulations?
Y. Schroeder, W. Wilson, J.M. Huyghe, F.P.T. Baaijens
Department of Biomedical Engineering, Eindhoven University of Technology

Introduction
The intervertebral discs are believed to be a key element of back pain and back pain disorders has a serious impact on the European economy [1]. Intervertebral discs have a primarily mechanical role in transmitting loads through the spine. They degenerate far more rapidly than other tissues [2]. The disc is thus subjected to a combination of elastic, viscous and osmotic forces [3]; previous models have typically neglected osmotic forces. The cells of the intervertebral discs are sensitive to pressure and osmotic pressure, quantification of these stresses is important.

Methods
The validated fibril-reinforced poroviscoelastic swelling model of Wilson [4] was used for the computations. The kidney shape like mesh resembles one forth of a full disc, hence saving computation time. It was created with the preprocessor Mentat and consisted of 8952 3D 8-nodes elements. Simulations of the effects of changes in osmotic and mechanical load on hydrostatic pressure and disc shape were performed with Abaqus 6.3.

Results & Discussion
Applying a linear increasing axial load of 500N raised the hydrostatic pressure to 0.33 MPa while an axial load of 1000N increased the pressure to almost 0.7 MPa (fig.2):

Figure 2. color plot showing the hydrostatic pressure

these results compared well with the experimental ranges measured by Nachemson and Wilke [5]. Loading the disc decreased the height of the disc and resulted in an outward bulging of the outer annulus. Fiber stresses were highest on the most outward bulging on the posterior-lateral side.

Conclusion
Osmotic forces play an important role in disc biomechanics and can be calculated successfully using finite-element methods.

Future Work
For a finite element simulation the boundary conditions of the disc model should be kept clearly in mind:
- Influence of the vertebral endplate permeability (calcification) on the fluid flow from the disc

Acknowledgement
This research is made possible through the support of the European Union (Project Number: QLRT-2001-02852).

Reference
[2] www.physiol.ox.ac.uk/EURODISC
[3] Huyghe et al., Biomech Mod Mechanobiol, 2003, 2, pp3-19,

PO Box 513, 5600 MB Eindhoven, the Netherlands