

Electrospinning versus knitting: two scaffolds for tissue engineering of the aortic valve

Citation for published version (APA):

Lieshout, van, M. I., Vaz, C. M., Rutten, M. C. M., Peters, G. W. M., & Baaijens, F. P. T. (2004). *Electrospinning versus knitting: two scaffolds for tissue engineering of the aortic valve*. 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.

Electrospinning versus knitting: two scaffolds for tissue engineering of the aortic valve

M.I. van Lieshout, C.M. Vaz, M.C.M. Rutten, G.W.M. Peters, F.P.T. Baaijens

Eindhoven University of Technology; Department of Biomedical Engineering

Introduction

State-of-the-art tissue engineered aortic valves are not strong enough to withstand aortic blood pressure levels. We hypothesize that current scaffolds do not have enough mechanical integrity and that they degrade too fast.

Objectives

Design of a valvular scaffold needs to focus on strong commissures, since they are high-stress regions in a valve (Fig. 1). Scaffold material must degrade slowly, to enable the seeded cells to create their own strong matrix that eventually replaces the degrading scaffold.



Figure 1. a) A natural valve leaflet. The load-bearing collagen fiber architecture is clearly visible. b) Maximal principal strain distribution over an aortic valve model leaflet in diastole, with strains increasing towards black (with permission from N. Driessen).

Materials and Methods - scaffolds

Valvular scaffolds were fabricated by electrospinning or by knitting of polycaprolactone (Fig. 2). Strong commissures for the spun valves were realised by electrospinning a leaflet and a corresponding sinus out of one piece and for the knitted valves by knitting the leaflets to the scaffold wall.



Figure 2. a) an electrospun scaffold, seen from the side, b) seen from the bottom, c) a knitted scaffold pulled over a mould and d) released from the mould, covered with fibrin.

The scaffolds were placed inside a physiologic flow simulator with an inserted scope, to study the opening and closing (Fig. 3).

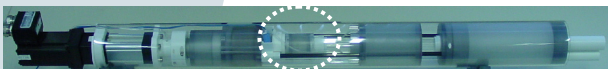


Figure 3. The valve exerciser (1:5), simulating physiological flow, with a valve in the middle.

Materials and Methods - valve culture



Figure 4. The bioreactor; in the back six culture chambers with valves and in the front three medium vessels.

Human Vena Saphena (HVS) myofibroblasts were enclosed in fibrin gel and cultured on the electrospun or knitted scaffold in a bioreactor that provided continuous medium perfusion (Fig. 4).

Results - scaffolds

The electrospun scaffold tore within six hours, whereas the knitted scaffold remained intact (Fig. 5).

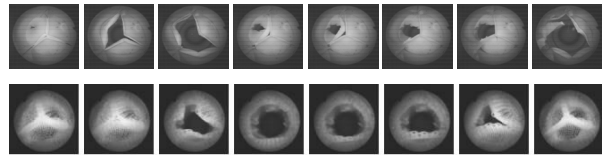


Figure 5. The scaffolds inside the physiologic flow simulator over the course of 6 hours. Top) spun scaffold, bottom) knitted scaffold.

Results - valve culture

Because of small pores in the spun scaffold, the majority of the cells remained on top of the scaffold. In the knitted scaffold cells penetrated well, as can be seen in Fig. 6.

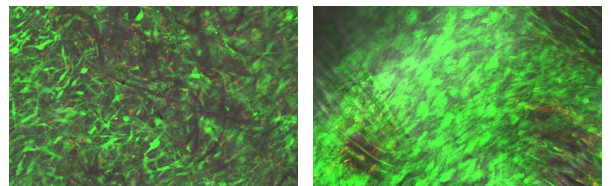


Figure 6. Confocal laser scanning microscope images of a) cells on an electrospun leaflet and b) cells on a knitted leaflet.

Cells that had been seeded on the spun scaffold had made less glycosaminoglycans and less collagen, as can be seen in Figure 7.

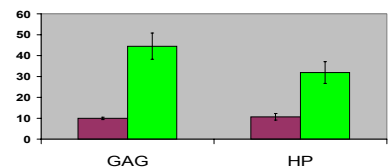


Figure 7. Glycosaminoglycan and hydroxyproline production of the cells in a spun (purple) and a knitted (green) scaffold, in $\mu\text{g}/\text{mg}$ tissue without scaffold \pm standard error of the mean.

Discussion

The knitted scaffold has strong commissures and allows good cell penetration. The spun scaffold is not very strong, which does not have to be a problem if seeded cells make enough extracellular matrix. In that case however, the spun scaffold must be adapted to enable proper cell penetration.

References

1. Circulation 102 (2000), (19 Suppl 3): III-44-49
2. Eur J Cardiothorac Surg 19 (4) (2001), 424-30
3. J Biomed Mater Res 60 (4) (2002), 607-12