International Poster Journal IPJ of Dentistry and Oral Medicine

Int Poster J Dent Oral Med 2009, Vol 11 No 2, Poster 449

Structure design examinations of 3-dimensional textile scaffolds using for tissue engineering in vitro

Language: English

Authors:
Dr. med. dent. Frank Bäumchen, PD Dr. med. Hans-Georg Gräber,
Department of Conservative Dentistry, Periodontology, and Preventive Dentistry, University Hospital Aachen, Germany
Dr. med. dent. Daniel Koch,
Dental practice, Drs. Stammen, Grevenbroich, Germany

Date/Event/Venue:
22.- 24. November 2007
Jahrestagung der deutschen Gesellschaft für Biomaterialien e.V. DGBM
Hannover

DGZMK-Poster-Award 2010 für das beste Poster 2009

Introduction

The apical growth of epithelium is a common complication following surgical parodontal therapy. Absorbable and non-absorbable membranes have been used over the last three decades as mechanical barriers to this undesired epithelial growth.
Textile scaffolds seem all the more applicable, in that they allow for the local regeneration of lost tissue when colonized with autologous cells.

Type of PGA non woven Ø 6mm	Thickness [mm]	Area-mass [g/m²]	Porosity [Vol-%]	Texturising method (knit-de-knit)
V1	5	166.9	86	hot water
V2	1.4	143.7	86	hot water
V3	1.0	130.15	85	hot water
V4	1.5	83.5	89	rough (10 needle gauge)
V5	1.5	58.7	91	middle (16 needle gauge)
V6	5	191	87	fine (28 needle gauge)
V7	3.36	116	98	fine (28 needle gauge)
V8	2.51	83	98	fine (28 needle gauge)
V9	2.57	152	96	fine (28 needle gauge)
V10	1.45	56.6	97	fine (28 needle gauge)
V11	1.56	99.7	96	fine (28 needle gauge)
V12	3.21	155	97	fine (28 needle gauge)

Table 1: Production setting parameter of used non woven fleeces

Objectives

The aim of this study was to examine the proliferation behaviour of human gingival fibroblasts on poly glycolide (PGA) fleece samples of various thickness and porosity (tab. 1). The fleece samples were produced in cooperation with the Institute for Textile Technology (ITA) RWTH Aachen (fig. 1, 2).

Material and Methods

Proliferation was examined by determining the live cell count (WST-1-test), and total protein content (BCA-test). These results were subsequently verified with a proliferation analysis (BrdU-test) of each of the fleece samples. In order to standardise the results, all experiments were conducted using human fibroblasts of a single cell line at passage five (fig. 3). Likewise, the initial colonisation of the fleece samples was standardised with $5x10^5$ cells/fleece. The live cell count and total protein content were determined after 0, 1 hours, and 14 days. The proliferation analysis was conducted after 14 days.

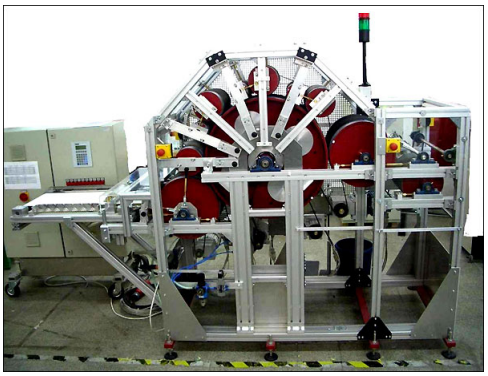

Fig. 1: Laboratory Carding Machine

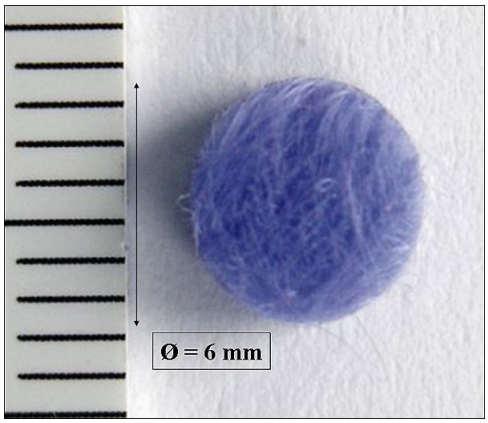

Fig. 2: Non woven scaffold made of PGA

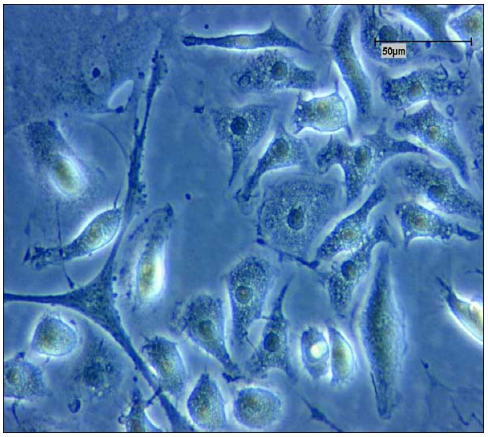

Fig. 3: Primary gingival fibroblasts, 5th. passage

Results

Large pore structure had a negative effect on the proliferation of gingival fibroblasts, the initial cell loss was between 40% and 80% (fig. 4), cytotoxicity could not be demonstrated. Increasing thickness also negatively influenced proliferation. All fleece samples showed cell growth at 14 days, however, the cell growth rates varied significantly from fleece to fleece (fig. 5, 6).

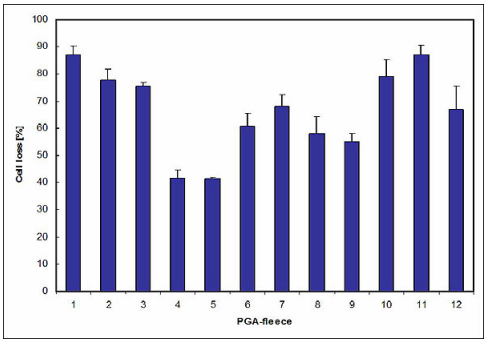

Fig. 4: Cell loss rates of the PGA fleece samples

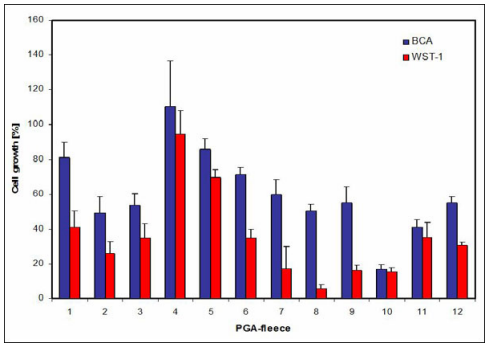

Fig. 5: Protein accretion and cell growth of the PGA fleece samples at day 14

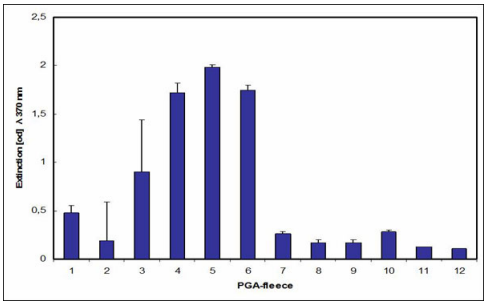

Fig. 6: Cell proliferation after 14 days (BrdU-test)

Conclusions

Textile PGA fleece is suitable as a scaffold structure for human gingival fibroblasts, however, its structural parameters have a significant influence on the proliferation of these cells (fig. 7, 8). Fleece constructed from knit-de-knit textured fibres with a low porosity of 90% and a thickness of 1.5 mm is recommended for scaffold structures Investigations using copolymers, which allow the adsorption time to be controlled in order to allow for tissue regeneration, would be worthwhile. The PGA fleece structures used in this study are not suitable for in vivo studies, due to their very short absorption times.

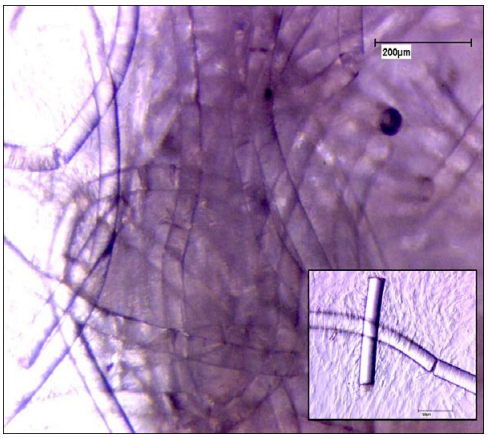

Fig. 7: Light microscopy picture of a PGA fleece seeded with human primary fibroblasts

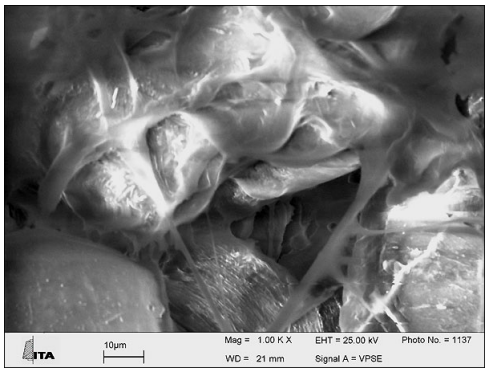

Fig. 8: Raster electron microscope picture of a PGA fleece seeded with human primary fibroblasts

Literature

1. Minuth W W, Strehl R, Schumacher K: Zukunftstechnologie Tissue Engineering. Von der Zellbiologie zum künstlichen Gewebe. Wiley-VCH 2003.
2. Wiesemann U: Neuartige Vliesstrukturen für den Einsatz in der Zell- und Gewebezüchtung: Untersuchung des Einflusses von Hydrophilie und Vliesstruktur auf die Nasseigenschaften der Vliesstruktur und biologische Zellreaktion. Diss. RWTH Aachen 2006.
3. Bäumchen F: Die Einflüsse definierter Strukturparameter textiler Polyglykolid-Trägermaterialien auf das Proliferationsverhalten gingivaler Fibroblasten in-vitro. Med. Diss. RWTH Aachen 2006

This Poster was submitted by Dr. Frank Bäumchen.

Correspondence address:
Dr. med. dent. Frank Bäumchen
University Hospital Aachen
Department of Conservative Dentistry, Periodontology, and Preventive Dentistry
Pauwelsstrasse 30
52074 Aachen
Germany

Poster Faksimile:

Klinik für Zahnerhaltung, Parodontologie
und Präventive Zahnheilkunde
University Hospital Aachen
Director: Univ.-Prof. Dr. med.dent. F. Lampert

Structure design examinations of 3-dimensional textile scaffolds using for tissue engineering in vitro.

F. Bäumchen, HG. Gräber

Introduction

The apical growth of epithelium is a common complication following surgical parodontal therapy. Absorbable and non-absorbable membranes have been used over the last three decades as mechanical barriers to this undesired epithelial growth.
Furthermore textile scaffolds seem to be applicable for a local regeneration of lost tissue after colonization with autologous cells.

Table 1: Production setting parameter of used non woven fleeces.

Type of PGA non woven Ø 6 mm	Thickness [mm]	Area-mass [g/m²]	Porosity [Vol-%]	Texturising method (knit-de-knit)
V1	5	166,9	86	hot water
V2	1,4	143,7	86	hot water
V3	1,0	130,15	85	hot water
V4	1,5	83,5	89	rough (10 needle gauge)
V5	1,5	58,7	91	middle (16 needle gauge)
V6	5	191	87	fine (28 needle gauge)
V7	3,36	116	98	fine (28 needle gauge)
V8	2,51	83	98	fine (28 needle gauge)
V9	2,57	152	96	fine (28 needle gauge)
V10	1,45	56,6	97	fine (28 needle gauge)
V11	1,56	99,7	96	fine (28 needle gauge)
V12	3,21	155	97	fine (28 needle gauge)

Figure 1: Laboratory Carding Machine

Methods

The aim of this study was to examine the proliferation behaviour of human gingival fibroblasts on poly glycolide (PGA) fleece samples of various thickness and porosity. The fleece samples were produced in cooperation with the Institute for Textile Technology (ITA) RWTH Aachen (fig. 1, 2).
Proliferation was examined by determining the live cell count (WST-1-test), and total protein content (BCA-test). These results were subsequently verified with a proliferation analysis (BrdU-test) of each of the fleece samples. In order to standardise the results, all experiments were conducted using human fibroblasts of a single cell line at passage five (fig. 3). Likewise, the initial colonisation of the fleece samples was standardised with 5x10⁵ cells/fleece. The live cell count and total protein content were determined after 0, 1 hours, and 14 days. The proliferation analysis was conducted after 14 days.

Figure 2: Non woven scaffold made of PGA

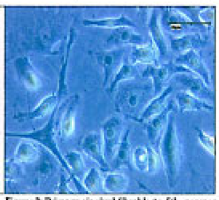

Figure 3: Primary gingival fibroblasts, 5th. passage

References

[illegible]

Results

Large pore structure had a negative effect on the proliferation of gingival fibroblasts, the initial cell loss was between 40% and 80% (fig. 4), cytotoxicity could not be demonstrated. Increasing thickness also negatively influenced proliferation. All fleece samples showed cell growth at 14 days, however, the cell growth rates varied significantly from fleece to fleece (fig. 5, 6).

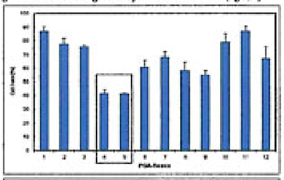

Figure 4: Cell loss rates of the PGA fleece samples.
(BCA λ =550 nm; WST-1 λ = 450 nm)

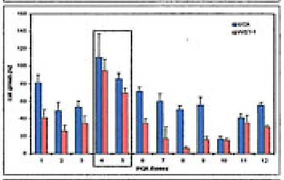

Figure 5: Protein accretion and cell growth of the PGA fleece samples at day 14.
(BCA λ =550 nm; WST-1 λ = 450 nm)

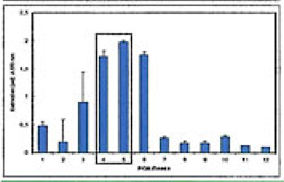

Figure 6: Cell proliferation after 14 days (BrdU-test λ =370 nm)

Discussion & Conclusions

Textile PGA fleece is suitable as a scaffold structure for human gingival fibroblasts, however, its structural parameters have a significant influence on the proliferation of these cells (fig. 7, 8). Fleece constructed from hot water textured fibres with a low porosity of 90% and a thickness of 1.5 mm is recommended for scaffold structures Investigations using copolymers, which allow the adsorption time to be controlled in order to allow for tissue regeneration, would be worthwhile. The PGA fleece structures used in this study are not suitable for in vivo studies, due to their very short absorption times.

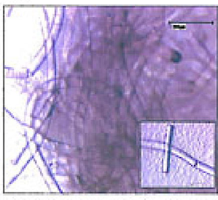

Figure 7: Light microscopy picture of a PGA fleece seeded with human primary fibroblasts

Figure 8: Raster electron microscope picture of a PGA fleece seeded with human primary fibroblasts

Corresponding authors

Dr. med. dent. Frank Bäumchen fbaeumchen@ukaachen.de
OA Priv.-Doz. Dr. med. Hans G. Gräber hgraeber@ukaachen.de
Klinik für Zahnerhaltung, Parodontologie und Präventive Zahnheilkunde, Universitätsklinikum RWTH Aachen
Pauwelsstrasse 30, D 52074 - Aachen,