Comparative Analysis of Biofilm Formation on Dental Implant Abutments with Respect to Supra- and Subgingival Areas: Polytetrafluoroethylene Versus Titanium

Cornelius Elter, Dr[a]/Wieland Heuer, PD Dr[a]/Anton Demling, PD Dr[b]/Matthias Hannig, Prof Dr[c]/
Torsten Heidenblut, Dr Ing[d]/Meike Stiesch, Prof Dr[e]

The aim of the present in vivo study was to examine the effect of polytetrafluoroethylene (PTFE) surfaces on biofilm formation on dental implant abutments in comparison to titanium surfaces. Fifteen modified abutments with incorporated PTFE plates were inserted in 10 patients for 14 days. Scanning electron microscopy techniques were used to examine biofilm formation on different surfaces and to determine the percentage of surface coverage. Significantly less biofilm was detected on PTFE surfaces than on titanium surfaces. The results of this study reveal that PTFE surfaces reduce biofilm formation to a minimum on dental implant abutments. *Int J Prosthodont 2011;24:373–375.*

The long-term success of dental implants is believed to be strongly dependent on the presence of a healthy peri-implant mucosa.[1] Even though implant failure is a multifactorial process,[2] formation of bacterial biofilms containing periopathogens on implant surfaces may play a crucial role.[3] Therefore, transmucosal implant surfaces should ideally inhibit adherence of periopathogens to the surface and permit the adherence of epithelial cells from the mucosa to establish a tight peri-implant barrier.

The aim of this study was to analyze adherent biofilms grown under clinical conditions on polytetrafluoroethylene (PTFE) surfaces embedded in titanium healing abutments (control) with respect to supra- and subgingival areas. Furthermore, gingival cell attachment in subgingival areas on PTFE surfaces was determined.

Materials and Methods

This study was approved by the ethics committee of Hannover Medical School, Hannover, Germany (no. 3791), and each subject gave their informed consent.

[a]*Doctor and Senior Research Associate, Clinic of Prosthetic Dentistry and Biomedical Materials, Hannover Medical School, Hannover, Germany.*
[b]*Doctor and Senior Research Associate, Department of Orthodontics, Hannover Medical School, Hannover, Germany.*
[c]*Head, Clinic of Operative Dentistry, Periodontology, and Preventive Dentistry, Saarland University, Homburg/Saar, Germany.*
[d]*Doctor and Senior Research Associate, Institute of Materials Science, Leibniz University, Hannover, Garbsen, Germany.*
[e]*Professor and Chair, Clinic of Prosthetic Dentistry and Biomedical Materials, Hannover Medical School, Hannover, Germany.*

Correspondence to: *Dr Wieland Heuer, Clinic of Prosthetic Dentistry and Biomedical Materials, Hannover Medical School, Carl-Neuberg-Str. 1, 30625, Hannover, Germany. Fax: +49-511-532-4790. Email: Heuer.Wieland@MH-Hannover.de*

Fifteen healing abutments (Zebra, Astra Tech) exhibiting supra- and subgingival areas were replaced 4 weeks after abutment surgery with modified healing abutments in 10 healthy patients (5 women and 5 men, age range: 20 to 63 years, mean age: 47.1 years) with at least one two-stage implant by the same clinician. No gingival trimming was performed.

Patients were instructed not to use any antimicrobial mouthrinses and to continue with their habitual oral hygiene procedures.

The modified healing abutments were removed after 14 days. To reproduce the course of the gingival margin around healing abutments, the protocol of Elter et al[4] was used.

Abutment Modification

All healing abutments (Uni, Astra Tech) were prepared by milling a cavity that was roughened via sandblasting with 110-µm aluminum oxide particles (EWL 5423, KaVo). PTFE plates were glued into the cavities using Tetric-Flow adhesive (Ivoclar Vivadent). The glue joints and titanium surfaces were polished, resulting in a surface roughness of 0.2 ± 0.05 µm. Then, the abutments were cleaned with ethanol and autoclaved at 134°C for 14 minutes (Cassette Autoclave, SciCan; profilometer LV-50-E, Hommelwerke). The unprepared titanium surfaces remained untreated as a control (Fig 1).

Scanning Electron Microscopy

Biofilm formation on healing abutments was analyzed through scanning electron microscopy (LEO 1455 VP, Carl Zeiss). The Rutherford backscattering detection method was used to detect surfaces covered with biofilm (Fig 2). The secondary electron method in the variable

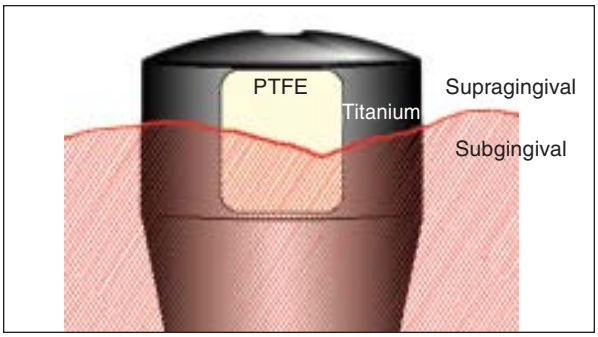

Fig 1 Position of a healing abutment prepared with a PTFE plate and titanium surface (control) with respect to the gingival margin.

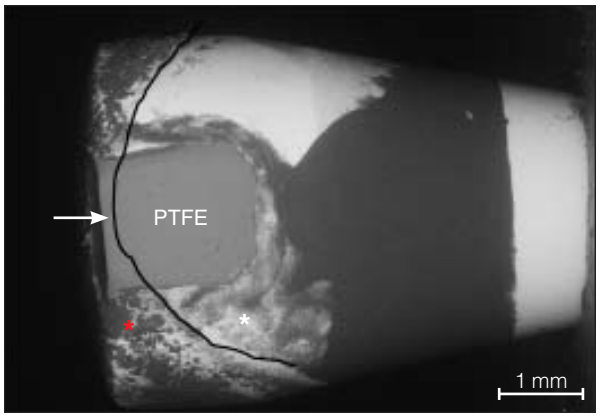

Fig 2 No adherent cell structures were detected on the PTFE surface in subgingival areas using the micrograph produced by the Rutherford backscattering detection method. Arrow = reproduced gingival margin; white asterisk = adherent cell structures of the subgingival peri-implant mucosa; red asterisk = supragingival biofilm formation.

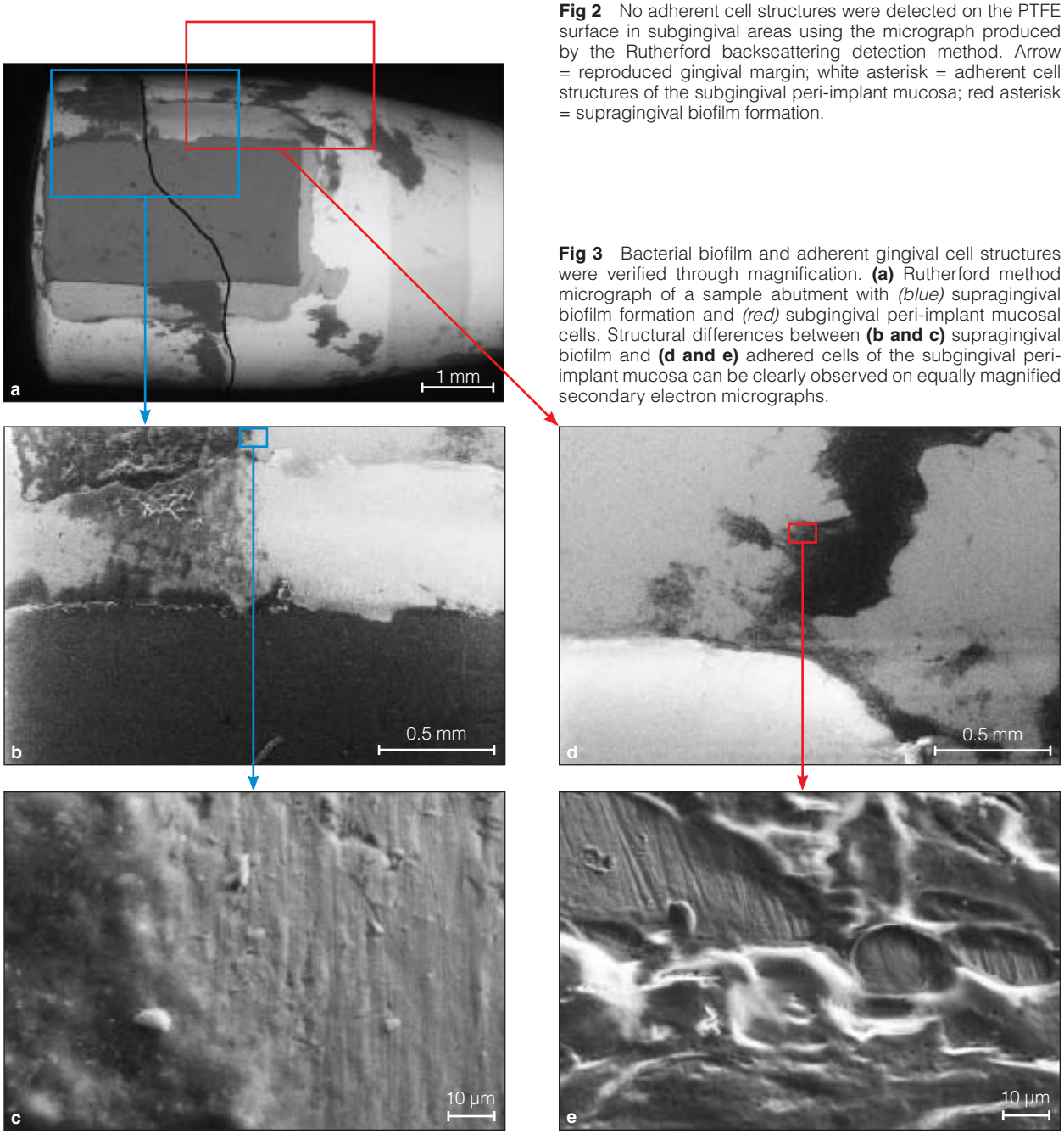

Fig 3 Bacterial biofilm and adherent gingival cell structures were verified through magnification. **(a)** Rutherford method micrograph of a sample abutment with *(blue)* supragingival biofilm formation and *(red)* subgingival peri-implant mucosal cells. Structural differences between **(b and c)** supragingival biofilm and **(d and e)** adhered cells of the subgingival peri-implant mucosa can be clearly observed on equally magnified secondary electron micrographs.

pressure mode was used to identify bacterial biofilm and cellular structures attached to abutment surfaces (Fig 3).

Quantitative Analysis of Biofilm Formation

Biofilm coverage of supra- and subgingival surfaces was measured separately using surface analysis software (Image J 10.2, National Institutes of Health). Statistical analysis was performed using SPSS version 16.0 for Windows (IBM). Since data were not distributed normally (Kolmogorov-Smirnov test), the Wilcoxon test was used to compare supra- and subgingival biofilm formation for the control and PTFE surfaces and to compare biofilm formation on both surfaces for the same location (supra- and subgingival). All tests were performed using the two-tailed method with a significance level of $P < .05$.

Results

Biofilm covered 27.0% ± 20.4% of all supragingival titanium surfaces compared to only 1.3% ± 1.3% of subgingival titanium areas. Biofilm covered 1.2% ± 1.5% of all supragingival PTFE areas compared with only 0.2% ± 0.3% of subgingival PTFE areas (Fig 4). These differences between location and materials were statistically significant ($P < .05$; Table 1).

No adherent cell structures could be detected on any PTFE surfaces in subgingival areas, even when adjacent titanium surfaces showed adhesion of the peri-implant tissue (Figs 2 and 3a).

Discussion

This study design was used to investigate biofilm formation in supra- and subgingival areas on different materials, with dental implant healing abutments as the supporting material. The results of the present study reveal that PTFE surfaces inhibit biofilm formation on abutments in supra- and subgingival areas. Consequently, the adhesion of periopathogens might be prevented. This material property is apparently counteracted by the reduced cell attachment to PTFE. Therefore, it seems to be expedient to use PTFE coatings in supragingival areas, eg, on healing abutments, bar attachments, or orthodontic appliances.[5]

Conclusion

Biofilm formation covering titanium dental implant abutment surfaces may endanger the integrity of the implants by an association with peri-implant disease. PTFE abutment surfaces reduced biofilm formation significantly. Although PTFE surfaces prevent cell attachment, the results of this study are encouraging. In the future, PTFE surfaces could contribute to reduced biofilm accumulation on dental implant abutments.

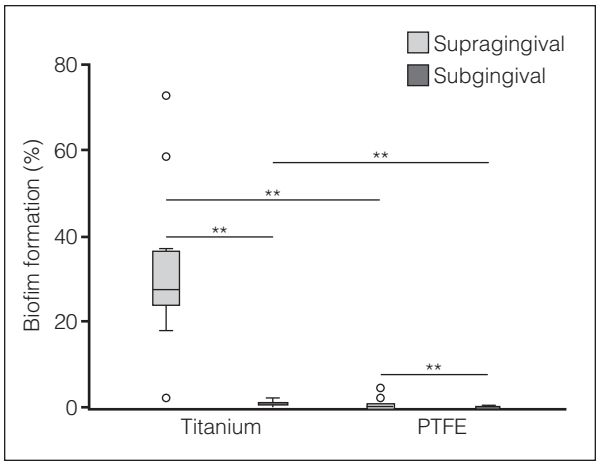

Fig 4 Boxplots showing significantly different biofilm formation on PTFE and titanium surfaces in different locations (supra- and subgingival). $^{**}P < .05$.

Table 1 Mean Biofilm Formation on PTFE and Titanium Surfaces

	Titanium (%)	PTFE (%)	*P*
Supragingival	27.0 ± 20.4	1.2 ± 1.5	.001
Subgingival	1.3 ± 1.3	0.2 ± 0.9	.005
P	.001	.017	

Acknowledgments

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