

Comparison of early bacterial colonization of PEEK and titanium healing abutments using real-time PCR

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This study found no differences in total bacterial load at PEEK or titanium Neoss healing abutment surfaces or their adjacent peri-implant pockets/ sulci. The number of periodontal pathogens was low and there was no significant difference between the abutment materials. The findings support the use of PEEK as abutment material in dental implant care.

INTRODUCTION

PEEK (polyetheretherketone) is a synthetic polymer with high biomechanical strength and inert chemical properties, which make it attractive for use in industrial and medical applications (for review see Kurtz & Devine 2007). Healing abutments made of commercially pure titanium have been the “gold standard” in dental implant care for many years. Wound healing studies have documented the formation of a healthy mucosal barrier adhering to the titanium abutment surface after abutment connection (e.g. Berglundh et al 1991). Yet, it has been shown that peri-implant pockets are colonized by bacteria, including periodontal pathogens, already within 2 weeks after abutment connection (Koka et al 1993, Quirynen et al 2006). The Neoss implant system offers both titanium and PEEK healing abutments.

The aim of the present study was to evaluate the biocompatibility of PEEK abutments to that of titanium abutments by comparing the bacterial colonization of the abutment surfaces and the surrounding peri-implant pocket/sulcus using real-time PCR.

MATERIALS AND METHODS

Patient and sampling sites

Fourteen (14) partially edentulous patients (9 women and 5 men with a mean age of 58 years) with need of implant treatment volunteered for the study. All patients were of good general health and had not received any antibiotic therapy within the previous 3 months. Every patient received 2 submerged Neoss implants in one edentulous area. Second stage surgery was performed after 3-6 months of healing. Each patient received one

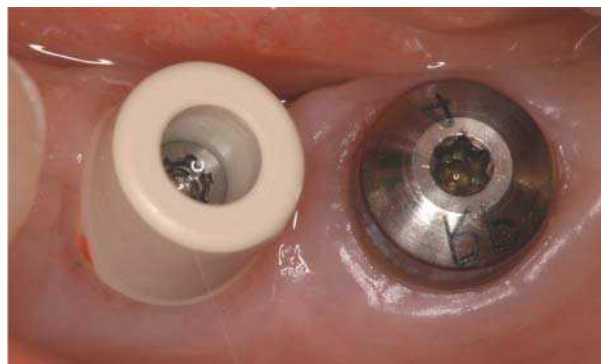


Figure 1. Clinical photograph showing the PEEK (left) and titanium (right) healing abutments

titanium and one PEEK healing abutment. A chlorhexidine rinse regimen was instituted during the first postoperative week. Sutures were removed after 7 days.

Bacterial sampling was performed two weeks after abutment connection using a commercial test system (Meridol[®] Perio Diagnostics, GABA International, Münchenstein, Switzerland). Each test kit contains 4 paperpoints for sampling. All samples were taken at the distal surface of the abutments in order to stay as far as possible away from the neighbouring anterior teeth. Two paperpoints were used at each titanium and PEEK abutment site. The first paperpoint was positioned in close contact with the abutment surface at the mucosal margin. The second paperpoint was placed in the peri-abutment sulcus/pocket area after removal of the abutment. Each paperpoint was held in position for 10 seconds and immediately thereafter placed in a test tube (accompanying the test kit). The samples were sent to a specialized microbiological laboratory (Carpagen GmbH, Münster, Germany).

Real-time PCR

Real-time polymerase chain reaction (PCR) by the Meridol® Perio Diagnostics (GABA International, Münchenstein, Switzerland) detects and quantifies six periodontal pathogens (*A. actinomycetemcomitans*, *F. nucleatum* ssp., *P. gingivalis*, *P. intermedia*, *T. forsythensis* and *T. denticola*) and the total bacterial load.

Statistical analysis

The Wilcoxon signed rank test was used to calculate the significance of the differences found between numbers of bacteria at titanium and PEEK abutment sites.

RESULTS

The study involved 28 healing abutments (14 PEEK and 14 titanium abutments) in 14 patients. At the day of bacterial sampling all sites showed clinically healthy tissue conditions (Fig. 1 and 2).

The total bacterial load at the mucosal margin was on the average $13 \cdot 10^6$ (median $5 \cdot 10^6$) at titanium abutments and $14 \cdot 10^6$ (median $7 \cdot 10^6$) at PEEK abutments (table 1). The corresponding value for the peri-implant pocket/sulcus was $9 \cdot 10^6$ (median $2 \cdot 10^6$) at titanium abutments and $3 \cdot 10^6$ (median $1 \cdot 10^6$) at PEEK abutments (table 2). The differences were not statistically significant.

The total number of the 6 periodontal pathogens detectable by the PCR test was on the average $18 \cdot 10^3$ (median $1 \cdot 10^3$) at titanium abutments and $14 \cdot 10^3$ (median $2 \cdot 10^3$) at PEEK abutments (table 3). The corresponding value for the peri-implant pocket/sulcus was $23 \cdot 10^3$ (median $2 \cdot 10^3$) at titanium abutments and $75 \cdot 10^3$ (median $8 \cdot 10^3$) at PEEK abutments (table 4). No sample showed $\geq 10^6$ of periodontal pathogens. The differences between titanium and PEEK abutments were not statistically significant.

DISCUSSION

The Neoss PEEK abutments showed similar amounts of bacterial adhesion as the Neoss titanium abutments when evaluated using real-time PCR. This method is very sensitive since both living and dead bacteria are detected, which makes it more accurate than cultivation. The detection limit for each periodontal pathogen is as low as 100 bacteria (Jervøe-Storm et al 2005).

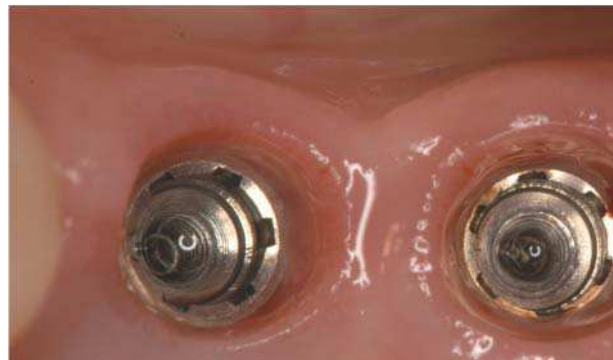


Figure 2. Clinical photograph of the peri-implant mucosa after removal of the healing abutments

Hultin and coworkers (2002) described microbiological findings and host response in partially edentulous patients with peri-implantitis. DNA-probe analysis sensitive for *A. actinomycetemcomitans*, *P. gingivalis*, *P. intermedia*, *T. forsythensis* and *T. denticola* found presence of periodontal pathogens at healthy as well as at diseased implant sites. However, only around implants with peri-implantitis were all 5 species recovered in amounts $\geq 10^6$ of the target bacterial cells in each sample. No sample in the present study showed $\geq 10^6$ of periodontal pathogens indicating healthy conditions at the tested sites.

Table 1. Total bacterial load - surface

Patient	Titanium	PEEK
1	470 000	2 000 000
2	21 000 000	720 000
3	56 000 000	60 000 000
4	2 100 000	47 000 000
5	50 000 000	16 000 000
6	180 000	190 000
7	12 000 000	3 000 000
8	6 000 000	24 000 000
9	4 600 000	12 000 000
10	2 300 000	790 000
11	6 300 000	9 800 000
12	4 200 000	5 000 000
13	12 000 000	12 000 000
14	1 500 000	2 200 000
Mean	12 760 714	13907 143
Median	5 300 000	7 400 000
Min	180 000	190 000
Max	56 000 000	60 000 000
Sum	178 650 000	194 700 000
p = 0,507		

Table 2. Total bacterial load - sulcus

Patient	Titanium	PEEK
1	4 400 000	220 000
2	27 000 000	7 800 000
3	1 500 000	16 000 000
4	10 000 000	3 000 000
5	39 000 000	550 000
6	370 000	1 300 000
7	650 000	310 000
8	1 600 000	430 000
9	1 400 000	2 600 000
10	1 700 000	170 000
11	1 000 000	6 700 000
12	1 600 000	190 000
13	150 000	1 200 000
14	31 000 000	4 300 000
Mean	8669286	3 197 857
Median	1 600 000	1 250 000
Min	150 000	170 000
Max	39 000 000	16 000 000
Sum	121 370 000	44 770 000
p=0,158		

The findings of the present study support continued investigation of PEEK as an abutment material in dental implant care.

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Table 3. Total amount of periodontal pathogens - surface

Patient	Titanium	PEEK
1	1 300	1 490
2	1 450	1 310
3	177 040	145 600
4	2 710	7 400
5	750	750
6	600	600
7	1 380	900
8	920	5 590
9	600	1 050
10	750	3 330
11	1 800	11 790
12	1 170	1 700
13	2 100	6 500
14	53 630	2 410
Mean	17 586	13 601
Median	1 340	2 055
Min	600	600
Max	177 040	145 600
Sum	246 200	190 420
p=0,388		

Table 4. Total amount of periodontal pathogens - sulcus

Patient	Titanium	PEEK
1	6 960	6 350
2	2 000	8 700
3	15 400	895 550
4	20 760	25 530
5	1 340	13 950
6	600	850
7	600	600
8	900	750
9	4 350	67 750
10	5 210	600
11	900	750
12	1 100	10 220
13	750	14 130
14	261 390	1 950
Mean	23 019	74 834
Median	1 670	7 525
Min	600	600
Max	261 390	895 550
Sum	322 260	1 047 680
p = 0,133		