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Retention Characteristics of Implant-Supported Milled Bar Attachments – a comparative in vitro study

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Introduction

In implant dentistry different anchorage systems (locators, balls, telescopes, bars) have been proved successful [1]. Milled bars are an alternative option for the retention of implant supported overdentures [2]. They present a rigid anchorage system between the implants. The individual manufactured suprastructures adjust precisely and rigidly to the milled bars. Lateral and rotary movements are limited. In addition to standard treatment (Fig. 1,2) the prosthodontic rehabilitation of compromised situations (cleft palate, maxillary ablation) using this retention concept promises excellent results in individual cases (Fig. 3) [3]. Different materials maybe used for the fabrication of milled bars such as precious and non-precious metals or zirconium. There are different retention concepts for the suprastructure like electroplated matrices (Fig. 4,5) or spark eroded friction pins (Fig. 6,7). In literature retention forces of different attachments average 1-40N [4]. There are no data in literature describing retention forces of milled bars. Furthermore wear of the retention system components can clinically causes loss of retention.

Objectives

The aim of this study was to compare initial and long-term retention characteristics and wear of milled bars from different materials and different retention concepts used to retain overdentures to dental implants.

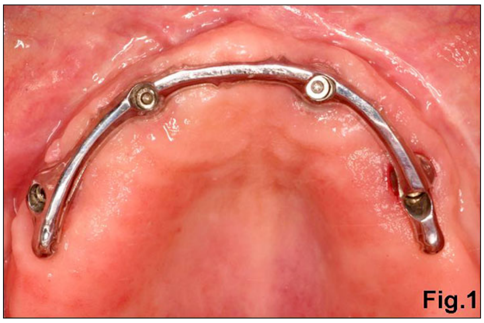

Fig. 1

Fig. 2

Fig. 3

Fig. 4

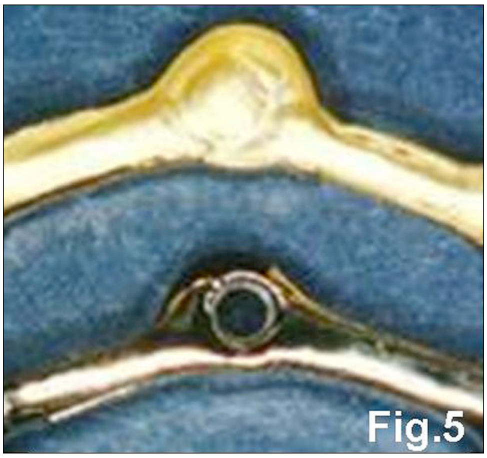

Fig. 5

Fig. 6

Fig. 7

	bar	electroplated suprastructure	sparkeroded suprastructure
group	material / alloy	material / alloy	material / alloy
GG	gold	gold	
EG	cobald-chromium	gold	
TG	titanium	gold	
ZG	zirconium	gold	
EF	cobald-chromium		cobald-chromium
TF	titanium		titanium
ZF	zirconium		gold

Tab. 1

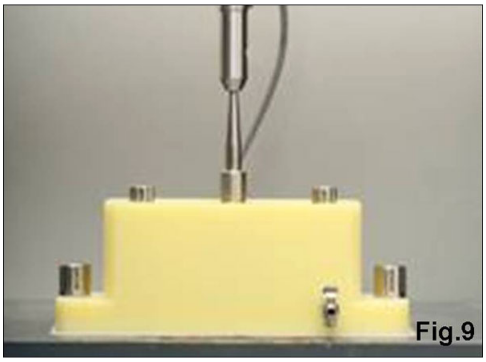

Fig. 8

Fig. 9

Fig. 10

Material and Methods

Seven different milled-bar (Fig. 8) suprastructure combinations with different retention concepts (Tab.1) were fabricated. The test model was made from epoxy resin (RenCast CW 2428-1, Vantico) in which 2 implants (Xive, Friadent) were polymerized. Five specimens (20x7x2mm) of each group (n=35) were produced according to manufacturer's data and screwed to the implants. Electroplated gold suprastructures with a layer thickness of 300µm (Solaris, Degudent) were luted (Panavia F, Kuraray) to the individual framework (Fig. 4,5). Spark eroded friction pins (7x0,9/0,95) were fixed using laser welding (Fig. 6,7). In an universal testing machine (Z 005, Zwick, Fig. 9) retention forces were constantly recorded at a constant cross head speed of v=40mm/min, deflection of s=2mm and a pre-load of Fmax=50N (Fig. 10).
Long-term tests (5000 cycles in artificial saliva=23°C) simulated an approximal wear of 5 years. Retention forces were constantly recorded.
Milled-bar-suprastructure combinations were analysed for superficial degradation (SEM).
For evaluation of the total wear the mean-retention-force [MRF] of the first and last 250 cycles were calculated and statistically compared (ANOVA, Bonferroni, $P < 0.05$).

Results

Initial mean retention force differed from 5.35N [TF] to 21.68N [EG] (Tab. 2). Throughout the first cycles retention forces changed dramatically. After long-term cycling the resulting mean retention force differed from 2.41N [TF] to 18.45N [EG]. Each milled bar suprastructure combination produced a characteristic curve (Fig. 11). The change of the mean retention force (Delta F=Fmax final - Fmax initial) differed from -10.13N [EF] to +2.14N [GG] ($p < 0.001$). The alteration of the mean retention force differed from -54.95% [TF] to +17.09% [GG]. All combinations except GG offered retention loss. SEM-analysis revealed characteristic degradations of the corresponding material surfaces.

group	initial force [N]	final force [N]	Δ force [N]	Δ force [%]
GG	12.52	14.66	2.14	117.11
EG	21.68	18.45	-3.23	85.11
TG	9.61	9.4	-0.21	97.81
ZG	6.37	6.1	-0.26	95.87
EF	21.15	11.02	-10.13	52.09
TF	5.35	2.41	-2.93	45.13
ZF	10.46	7.65	-2.8	73.19

Tab. 2: Mean retention force after 5000 cycles

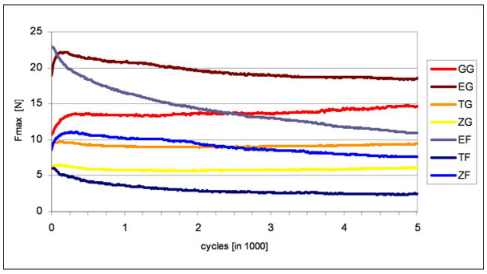

Fig. 11: Long-term mean retention forces

Conclusions

There were differences between the initial pull-off-forces of the tested milled bar suprastructure combinations. Standardized long-term-cycling exposed specific changes of the retention characteristics and resulting pull-off-forces in regard to bar material and retentive suprastructure designs. Electroplated suprastructures showed minimal retention loss. However the manufacturing is sensitive and later maintenance is complex. Although spark eroded suprastructures loose retention force it can be reconstructed easily chairside. The use of milled zirconium bars proofed good results. All tested combinations fulfilled the basic requirements according to retention forces of established implant abutments. However, this in vitro study takes no account of inappropriate handling by the patients. According to the limitation of this in vitro study milled bars of different materials in combination with different retention concepts are functioning. To proof the different retention concepts under clinical conditions in-vivo studies are preferable.

Literature

1. Cehreli MC, Karasoy D, kökat AM, Akca K, Eckert S: A systematic review of marginal bone loss around implants retaining or supporting overdentures. Int J Oral Maxillofac Implants 2010; 25:266-77
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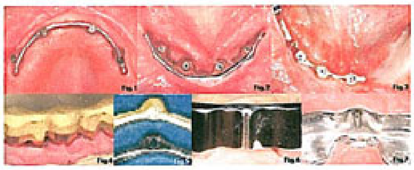

Fig.1 Fig.2 Fig.3 Fig.4 Fig.5 Fig.6 Fig.7

Tab.1 Tested milled bar suprastructure combinations

	bar	electroplated suprastructure	sparkeroded suprastructure
group	material/ alloy	material/ alloy	material/ alloy
GG	gold	gold	
EG	cobalt-chromium	gold	
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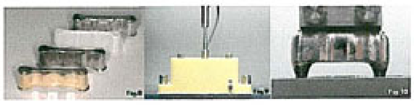

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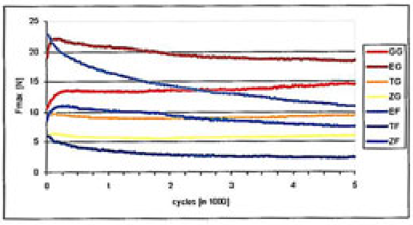

Fig. 11 Long-term mean retention forces

Conclusion

There were differences between the initial pull-off-forces of the tested milled bar suprastructure combinations. Standardized long-term-cycling exposed specific changes of the retention characteristics and resulting pull-off-forces in regard to bar material and retentive suprastructure designs. Electroplated suprastructures showed minimal retention loss. However the manufacturing is sensitive and later maintenance is complex. Although spark eroded suprastructures loose retention force it can be reconstructed easily chairside. The use of milled zirconium bars proofed good results. All tested combinations fulfilled the basic requirements according to retention forces of established implant abutments. However, this in vitro study takes no account of inappropriate handling by the patients. According to the limitation of this in vitro study milled bars of different materials in combination with different retention concepts are functioning. To proof the different retention concepts under clinical conditions in-vivo studies are preferable.

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