2317 Biomechanical properties of custom made zirconium dioxide implant abutments

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Introduction:

Ceramic abutments provide better translucency for the implant restoration than metal abutments. Gray colors of metal abutment can be transmitted through the peri-implant tissues and can cause esthetical problems [1]. First ceramic abutments were introduced in 1994. These first abutments made of Al_2O_3 had some problems like low fracture resistance [2]. Later zirconium dioxide has been used as material for abutments. Soft and hard tissue reaction towards zirconium dioxide abutments is favorable [3].

Aim:

The aim of this study was to evaluate mechanical properties of custom made zirconium dioxide abutments, compared to standard zirconium dioxide abutments.

Materials and Methods:

Yttrium partially stabilized green-stage zirconium dioxide (ICE Zircon, ZirkonZahn, Italy) blocks were ground to abutments and divided into four groups (n=7/group). The abutments were sintered at 1500 °C in the sintering oven (ZirkonZahn). Standard abutments were used as control (groups 1 and 4, n=7/group). Abutments in the study groups were: 1) Astra 3.5/4.0 abutments from the manufacturer, 2) ZirkonZahn-Astra where the Astra-model abutments were ground from ZirkonZahn zirconia block, 3) ZirkonZahn-Astra-short where abutments were shortened to same level than Xive-model, 4) Xive 3.5/4.0 abutments from the manufacturer, 5) ZirkonZahn-Xive where Xive-model abutments were ground from ZirkonZahn zirconia block, 6) ZirkonZahn-Xive-modified where Xive abutments were modified from the bottom of the abutment (Table 1). The abutments were screwed on implant replicas (size 3.5/4.0) to PMMA-sample bases and they were loaded with universal testing machine (LRX, Lloyd Ltd, UK) at room temperature. Testing angle was 45° and the abutments were loaded at the upper end of the sample until the final failure occurred (Figure 1). Also initial failure load and fracture mode of the abutments was evaluated. Statistical analyses were made using One-way-ANOVA- analyses.

Table 1 Abutments in the study groups.

Group	n	Abutment type	Figure
1	7	Astra	
2	7	Zirkonzahn-Astra	
3	7	Zirkonzahn-Astra-short	
4	7	Xive	
5	7	Zirkonzahn-Xive	
6	7	Zirkonzahn-Xive-modified	

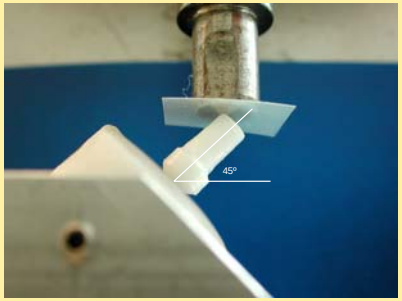

Figure 1 Loading the abutments with universal testing machine.

Table 2 Results from loading test.

Abutment type (Group)	Initial failure load N (SD)	Stat.diff	Final failure load N (SD)	Stat.diff
Astra (1)	534 (137)	a	606 (113)	a
ZirkonZahn-Astra (2)	461 (180)	a	511 (156)	a
ZirkonZahn-Astra-Short (3)	523 (162)	a	624 (103)	a
Xive (4)	369 (31)	a	412 (79)	a
ZirkonZahn-Xive (5)	412 (111)	a	412 (111)	a
ZirkonZahn-Xive-modified (6)	1092 (212)	b	1099 (207)	b

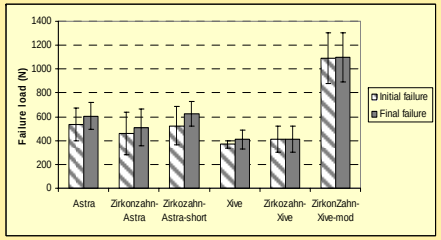

Figure 2 Initial failure load (N) and final failure load (N) of the study groups.

a b

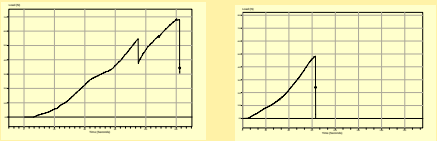

Figure 3 a-b Failure graphs of ZirkonZahn-Astra (a) and ZirkonZahn-Xive (b) abutments, showing initial failure in figure a but not in figure b.

a b c

d e f

Figure 4 a-f Fracture analysis of the abutments: Astra (a), ZirkonZahn-Astra (b), ZirkonZahn-Astra-Short (c), Xive (d), ZirkonZahn-Xive (e), ZirkonZahn-Xive-modified (f)

Results:

The final failure load varied between 412 N to 1099 N (Table 2, Figure 2). ZirkonZahn-Xive-modified abutments were statistically significantly stronger compared to other groups ($p<0.05$). In most of the groups initial failure was seen before the final failure. In ZirkonZahn-Xive groups the initial failure was not detected (Figure 3 a-b). When analyzing the fracture mode of the abutments, Xive-model represented catastrophic failure. Astra-design revealed visually bending supported by the implant screw and revealed minor crack on the bottom of abutment (Figure 4 a-f).

Discussion and Conclusions:

Zirconium dioxide abutments have proved to be strong in previous studies and stronger than Al_2O_3 abutments [4]. Bending strength of the ceramic abutments have been on the same level with the titanium controls [5]. In our study custom made zirconium dioxide abutments showed comparable failure loads to the commercial zirconium dioxide abutments.

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