Retentive Strength of Zirconia Implant Crowns on Titanium Bases Following Different Surface Treatments

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ABSTRACT

Screw-retained zirconia implant crowns with an internal titanium base have favorable mechanical properties compared to single piece zirconia implant crowns; however, they require adequate bonding between the zirconia crown and the titanium base. A possible weak link in the fabrication of two-piece zirconia implant crowns is the bond between the zirconia crown and the titanium base.

The purpose of this study is to determine if alumina airborne airborne particle abrasion and/or the use of an 10-MDP primer on the bonded surfaces of a zirconia crown and titanium base will affect their bond.

The results of this research will provide clinical guidelines for a cementation protocol to optimize the performance of zirconia/titanium base implants abutments in the oral environment for cement/screw retained implant restorations. It is hypothesized that the retention force between the zirconia crown and titanium abutment will be similar for all surface treatments.

MATERIALS AND METHODS

Full contour zirconia implant crowns were fabricated to fit a 3.5mm BioHorizons titanium base. The crowns were bonded to the titanium bases following 4 protocols (n=15): no surface treatment (Group 1), MDP-primer on the intaglio of crown and exterior of base (Group 2), alumina particle abrasion of the intaglio of crown and exterior of base (Group 3), and alumina particle abrasion and an MDP-primer on the intaglio of crown and exterior of base (Group 4). All crowns were bonded to the base with resin cement. Specimens were stored in water for 24 hours at 37°C and then thermocycled between 5°- 55°C water for 15,000 cycles with a 15 second dwell time. Crowns were separated from the titanium bases using a universal testing machine. The four protocols were compared using a one-way ANOVA, followed by Tukey's post-hoc tests (alpha=0.05). Sectioned specimens were examined with SEM.

MATERIALS AND METHODS

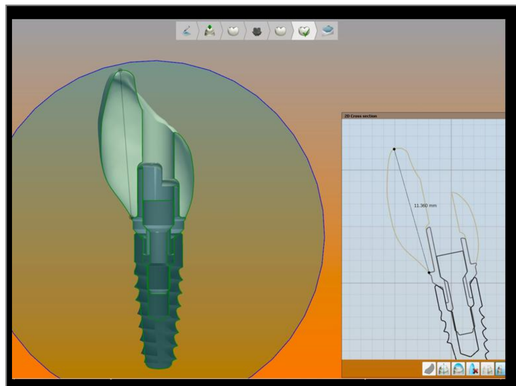

Fig 1. Design of zirconia implant crown on titanium base connected to implant.

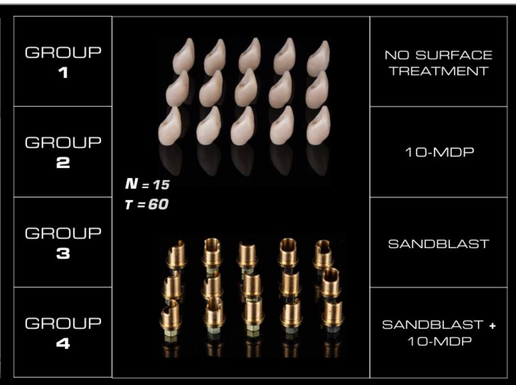

Fig 3. Resin cement utilized and 10-MDP primer

Fig 6. Fixation device during cementation

Fig 7. Pull-Out Device for crown retention testing

Level	#	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
No Tx	15	737.802	148.892	38.444	655.35	820.26
MDP	15	804.133	114.474	29.557	740.74	867.53
SB	15	428.206	93.815	24.223	376.25	480.16
SB-MDP	15	595.485	122.230	31.560	527.80	663.17

One-way ANOVA

Fig 8. Retention values and statistical analysis

Fig 9. Cross section of crowns for SEM analysis

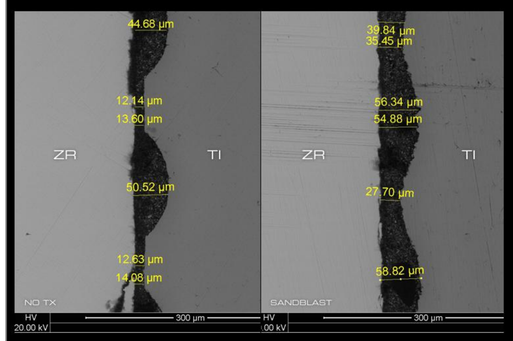

Fig 10. SEM of microgrooves in unaltered titanium base and sandblasted base

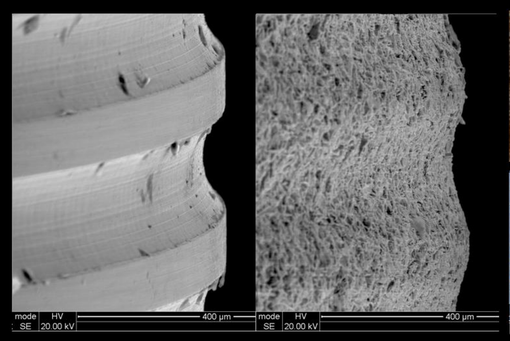

Fig 11. SEM of microgrooves in unaltered titanium base and sandblasted base

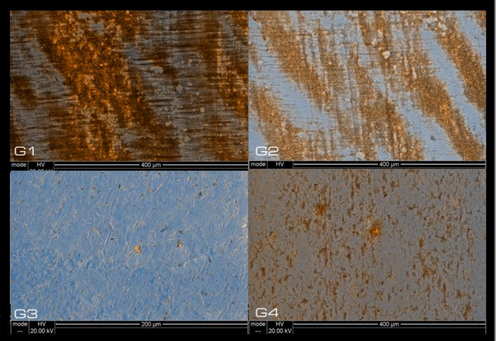

Fig 12. EDS of different groups with cement remnants in the zirconia surface

RESULTS

Retention forces for Control (737.8±148.9 N) and MDP (804.1 ±114.5 N) were significantly greater than Alu+MDP (595.5 ±122.2 N) which was significantly greater than Alu (428.2 ±93.8 N). Visual inspection of the debonded specimens showed that the majority of the cement remnants were seen on the external surface of the titanium bases. Microscopic examination of the interface between the crown and the unaltered base shows that the cement gap is approximately 13µm at the crest of the microgrooves and 50µm within the channel of the microgrooves. After airborne particle abrasion, the microgrooves become significantly dulled and the cement gap increased to 27-40µm at the crest and 55-58µm in the channels.

CONCLUSIONS

The results of the present study showed that retention forces between the titanium base and zirconia components of two-piece crown can be significantly affected by application of selected preconditioning techniques which are not currently recommended by the manufacturers of the components. Therefore the null hypothesis is rejected.

Airborne particle abrasion of titanium bases that contain retentive microgrooves prior to bonding is contraindicated. Application of an MDP primer demonstrated limited improvement in the retention of the zirconia implant crowns.

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