Introduction

One common complication of the single unit implant-supported prosthesis is screw loosening which leads to prosthesis loosening and potential wear of the implant abutment connection (IAC). After 5 years the reported cumulative incidence of screw or abutment loosening is 12.7%. Screw loosening of 37% of the 4.0 Astra Osseospeed implant at 5 years was reported in one study, and 6.2% of IAC loosening in 6 months. Introduction of the anti-rotational component with conical IAC changes the biomechanical relationship compared to non-rotational conical IAC. While some studies support the use of conical interfaces due to decreased micro-gap and inflammatory markers between the implant-abutment interface, other evidence suggests an increase in the micro-gap after cyclic loading. Significant clinical issues including screw loosening, microbial invasion, and subsequent bone loss with conical implant interfaces sparked interest in exploring abutment settling and residual torque values after loading. The design of the conical IAC may be the causative factor of screw torque reduction and vertical settling with single tooth restorations. Vertical displacement, rotational freedom and angular deflection have all been identified as causative agents.

Purpose

The purpose of this in vitro study is to investigate screw torque reduction, vertical settling, angular deformation, and wear of implant abutment interfaces. This study compares conical implant-abutment connections (IAC) “test” to flat-to-flat implant abutment connections “control” after dynamic cyclic loading.

Null Hypothesis

Conical IACs will exhibit equal screw torque reduction, vertical settling, wear of IAC, and angular deflection compared to flat-to-flat IACs.

Materials and Methods

Control Group:
- Neos ProActive Straight (4.0x 13mm)
- Straumann Bone Level Tapered Roxolid (4.1 x 13mm)
- Astra Osseospeed EV (4.2 x 13mm)
- Nobel Active RP (4.3x 13mm)

Test Groups:
- Straumann Bone Level Tapered Roxolid (4.1 x 13mm)
- Astra Osseospeed EV (4.2 x 13mm)
- Nobel Active RP (4.3x 13mm)

Results

Fig. 3: Vertical Movement in System Between 5 Ncm and Maximum Torque

• The fatigue testing was performed in accordance with ISO 14801 in air, at room temperature, at 15 Hz for 1 million cycles under a load of 240N. (Fig. 1)
• SEM imaging was used to record implants and abutments at tensile and compressive surfaces prior to assembly and cyclic loading. (Fig. 5) The abutment screw was tightened to 5 Ncm and manufacturer-recommended tightening torques for each IAC. Vertical measurements were taken to establish the amount of abutment settling (Fig. 3).

• A 1000mm loading device (Zwick/Roell LT TM1000) was used to load the implant system with a maximum force of 240 N (Fig. 2).
• After 20 seconds abutment angulation was calculated. (Figs. 7, 8)
• Samples underwent 1,000,000 cycles and were reverse torqued. (Fig. 4)

• Kruskal Wallis test and Dunn’s Pairwise Comparison were used for statistical analysis.

Discussion

The control flat to flat system performed equal or better than all the conical test groups. One reason the Straumann system may have outperformed the other conical systems is the incorporation of 13-17% Zirconia into the Ti alloy. There also appears to be a significant effect with the addition of the anti-rotational component of conical IACs that decrease the residual tightening torque with some conical implant systems. Potential permanent IAC deformation with some conical systems may render the IAC unable to maintain anti-rotation and recommended torque values. This research is limited to single tooth implants as multunit restorations are not subject to the same biomechanical forces. Clinicians should choose IACs that are stable and predictable. It is inevitable that some single tooth restorations may come loose. Protection of the IAC with flat to flat systems may only require replacement of the retaining screw, whereas some conical IAC’s may be irreparably damaged.

Conclusions

Conical IAC besides the Straumann system exhibited greater vertical settling and angular deformation compared to flat-to-flat IACs. Residual screw torque reduction of conical IACs besides the Straumann system were less after dynamic cyclic loading compared to flat IACs.

References