Conical Implant Abutment Respositioning After Dynamic Cyclic Loading and Relation to Screw Torque Reduction. A Pilot Study. Part 1

Are All Conical Abutment Connections Equal?

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Introduction/ Background

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%[1]. Screw loosening of 37 % of the 4.0 Astra Osseospeed implant at 5 years was reported in one study, with 23/43 IAC loosening in 6 months [2.] Introduction of the anti-rotational component with conical IAC changes the biomechanical relationship compared to non-rotational conical IAC [3]. While some studies support the use of conical interfaces due to decrease micro-gap and inflammatory markers between the implant-abutment interface, other evidence suggests an increase in the micro-gap after cyclic loading [4]. 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- abutent 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 deformation compared to flat-to-flat IACs.

Materials & Methods

Control Group:
- Neoss ProActive Straight (4.0x 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)

Fig. 1: test sample Following ISO 14801

- 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 100mm loading device (Zwick/Roell L 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)
- After testing, SEM imaging (Fig. 5) was completed and then samples were reassembled and loaded to failure with an Instron testing device (Fig. 6)
- Kruskal-Wallis test and Dunn's Pairwise Comparison were used for statistical analysis

Results

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

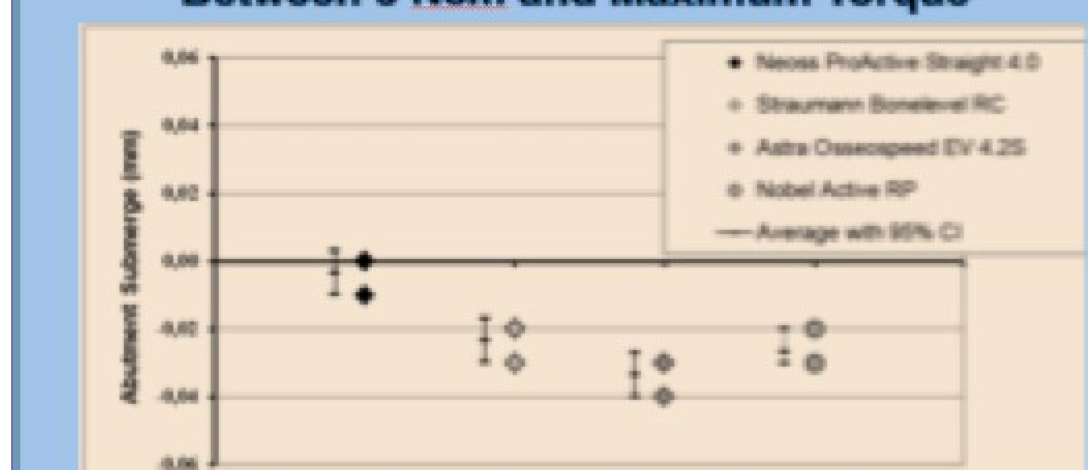


Figure. 4: Residual Tightening Torque

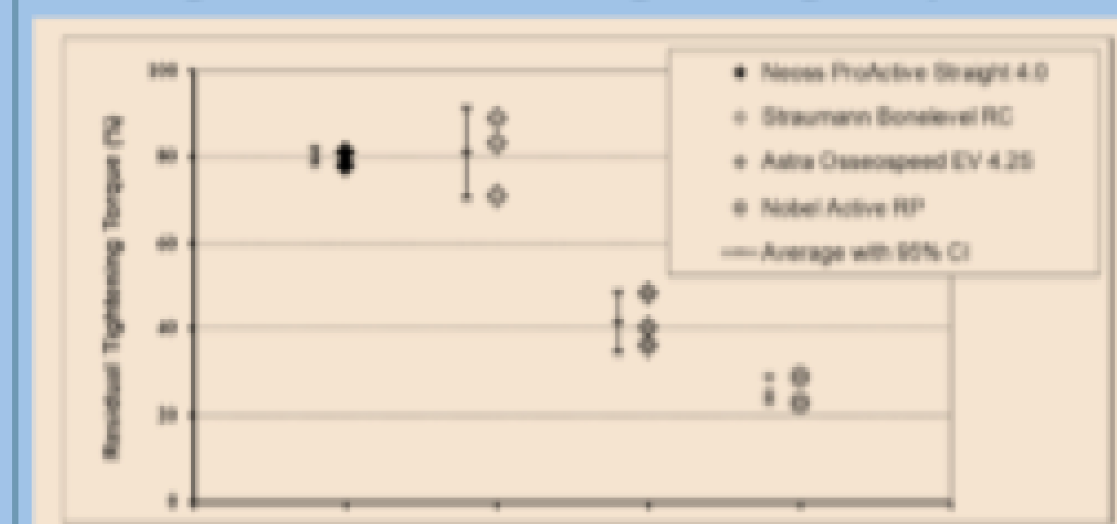
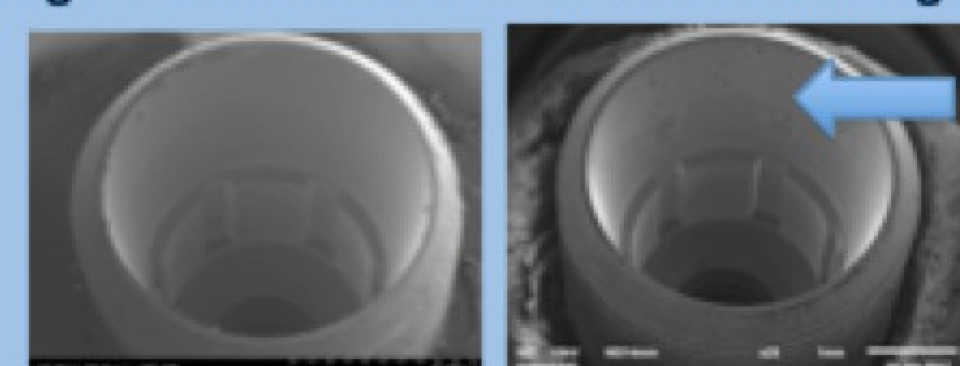
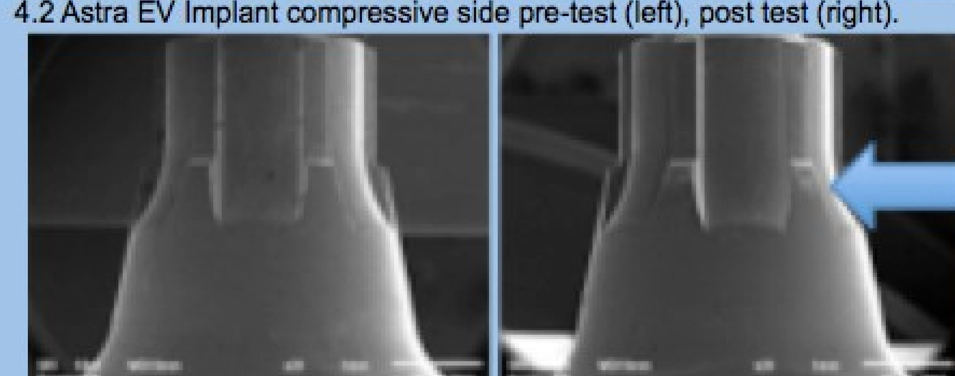


Figure 5: Pre-Test vs. Post- Test SEM Imaging



4.2 Astra EV Implant compressive side pre-test (left), post test (right).

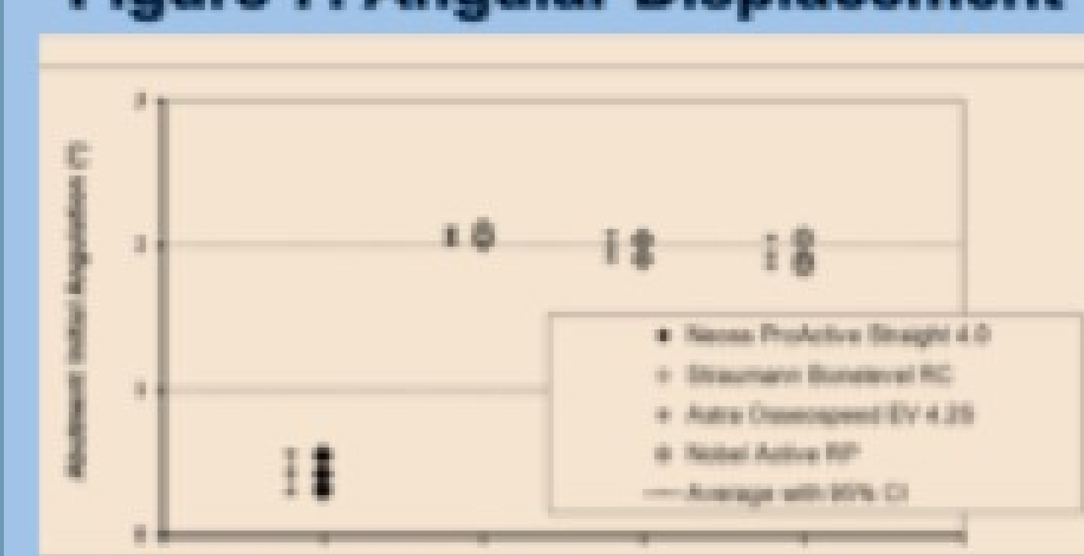


4.2 Astra EV Abutment compressive side pre-test (left), post test (right).

Figure 6: Load Displacement

Implant Systems	Average Load to Failure (N)
Neoss ProActive Straight	549.3
Straumann Bonelevel Roxolid	857.6
Astra Osseospeed EV	507
Nobel Active RP	606

Figure 7: Angular Displacement



- Neoss and Straumann had the greatest residual tightening torque percentage and were statistically significantly better than Astra and Nobel IAC ($p<.05$) Fig. 4.
- There was no statistical significant difference between the flat to flat control and the Straumann conical IAC with regard to vertical settling. The Neoss and Straumann system was statistically significantly different than the Nobel and Astra IAC ($p<.05$) Fig. 3.
- Angular deflection was statistically significantly better for the flat to flat IAC compared to the conical IACs . (Fig. 7).
- SEM imagine: Wear was noted on all compressive and tensile surfaces of all conical abutments. Rotational wear was noted on the flat-to- flat systems.

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 .

Potential permanent IAC deformation with some conical systems may render the IAC unable to maintain anti-rotation and recommended toque values. 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 / Summary

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 to flat IACs

References

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