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Bending moments of zirconia and titanium abutments with internal and external implant–abutment connections after aging and chewing simulation

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Abstract

Objectives: To test the fracture load of zirconia abutments with different types of implant–abutment connections after chewing simulation and to compare their bending moments to internally connected identical titanium abutments.

Materials and methods: Forty-eight identical customized zirconia abutments with different implant–abutment connections were fabricated for four different test groups: one-piece internal implant–abutment connection (BL; Straumann Bonelevel), two-piece internal implant–abutment connection (RS; Nobel Biocare Replace Select), external implant–abutment connection (B; Brånemark MK III), two-piece internal implant–abutment connection (SP; Straumann Standard Plus). Twelve titanium abutments with one-piece internal implant–abutment connection (T; Straumann Bonelevel) served as control group. After aging by means of thermocycling (5–50°C, 120 s) and chewing simulation (1,200,000 cycles, 49 N load, 1.67 Hz), static load was applied at a 30° angle to the palatal surface until failure. Bending moments were calculated for comparison of the groups. Data were analyzed descriptively and by performing the Kruskal–Wallis test with Bonferroni correction.

Results: The mean bending moments of the abutments were 714.1 ± 184.9 N cm (T), 331.7 ± 57.8 N cm (BL), 429.7 ± 62.8 N cm (RS), 285.8 ± 64.4 N cm (B) and 379.9 ± 59.1 N cm (SP). The bending moments of control group T were significantly higher than those of all other groups. The values of group RS were significantly higher than those of group B but within the value range of groups SP and BL.

Conclusion: The bending moments of the different tested types of zirconia abutments vary with different implant–abutment connections after chewing simulation. The use of a secondary metallic component might have a beneficial influence on the stability of zirconia abutments.

The replacement of missing teeth with implant-supported single crowns and fixed dental prostheses has become a standard treatment modality exhibiting high survival rates (Pjetursson et al. 2004, 2007; Jung et al. 2008). For the fixation of the reconstruction on the implant, different types of implant abutments are used. Metal abutments made out of titanium have proven to be durable and are therefore considered as ''gold standard'' (Andersson et al. 1995; Pjetursson et al. 2007; Sailer et al. 2007a, 2007b). Because of their dark color, however, metal abutments were reported to cause a grayish discoloration of the peri-implant mucosa compromising the esthetic outcome of the implant-borne reconstruction (Sailer et al. 2007a, 2007b; Jung et al. 2008). For this reason, all-ceramic abutments made out of high-strength ceramics such as alumina or zirconia have been developed (Prestipino & Ingber 1993a, 1993b). Laboratory and clinical studies demonstrated a superior performance of zirconia over alumina abutments (Andersson et al. 2001; Yildirim et al. 2003; Glauser et al. 2004; Att et al. 2006a, 2006b). Furthermore, a recent randomized controlled clinical trial comparing implant-borne reconstructions supported by zirconia and titanium abutments demonstrated similar outcomes for both types of abutment materials (Zembic et al. 2009). Therefore today, zirconia can be considered as the ceramic abutment ''material of choice.''

Zirconia abutments with various implant–abutment connection geometries exist for the currently available different types of implants. These implant–abutment connections encompass external (e.g. hexagonal) and internal (e.g. conical) connections. Furthermore, the internal connection of zirconia abutments can be obtained