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Correlation between vertical misfits and stresses transmitted to implants from metal frameworks

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ABSTRACT

An inappropriate prosthetic fit could cause stress over the interface implant/bone. The objective of this study was to compare stresses transmitted to implants from frameworks cast using different materials and to investigate a possible correlation between vertical misfits and these stresses. Fifteen one-piece cast frameworks simulating bars for fixed prosthesis in a model with five implants were fabricated and arranged into three different groups according to the material used for casting: CP Ti (commercially pure titanium), Co–Cr (cobalt–chromium) or Ni–Cr–Ti (nickel–chromium–titanium) alloys. Each framework was installed over the metal model with all screws tightened to a 10 N cm torque and then, vertical misfits were measured using an optical microscope. The stresses transmitted to implants were measured using quantitative photoelastic analysis in values of maximum shear stress (τ), when each framework was tightened to the photoelastic model to a 10 N cm standardized torque. Stress data were statistically analyzed using one-way ANOVA and Tukey's test and correlation tests were performed using Pearson's rank correlation ($\alpha = 0.05$). Mean and standard deviation values of vertical misfit are presented for CP Ti (22.40 ± 9.05 μm), Co–Cr (66.41 ± 35.47 μm) and Ni–Cr–Ti (32.20 ± 24.47 μm). Stresses generated by Co–Cr alloy ($\tau = 7.70 \pm 2.16$ kPa) were significantly higher than those generated by CP Ti ($\tau = 5.86 \pm 1.55$ kPa, $p = 0.018$) and Ni–Cr–Ti alloy ($\tau = 5.74 \pm 3.05$ kPa, $p = 0.011$), which were similar ($p = 0.982$). Correlations between vertical misfits and stresses around the implants were not significant as for any evaluated materials.

1. Introduction

Osseointegration could be defined as the connection of a body to a living bone without soft tissue between them, causing direct load transmission to the anchorage bone (Brånemark, 1983). The lack of periodontal ligament limits implant micro movements (Aparício, 1994; Weinberg, 1993). Thus, inappropriate stresses can cause bone resorption once implants are stiffly integrated to the bone tissue (Renner, 2000; Riedy et al., 1997; Waskewicz et al., 1994).

The load transmission to the implants, prosthesis and bone depends on several factors as the number and location of the implants (Karl et al., 2007; Ogawa et al., 2010; Sagat et al., 2010), inclination of the implants (Bevilacqua et al., 2011; Markarian et al., 2007), cantilever length (Bevilacqua et al., 2011), stiffness of the metal framework (Abreu et al., 2010), prosthesis marginal fit (Carr et al., 1996; Markarian et al., 2007; Winter et al., 2010), prosthesis material (Ogawa et al., 2010), extension of the prosthesis base and attachment systems (Sadowsky and Caputo, 2000) and occlusion pattern (Greco et al., 2009).

Non-passive metal framework fixation to the abutments can transmit mechanical stress to the implant/bone interface whose biological response is not well known yet (Karl et al., 2006; O'Mahony et al., 2000; Waskewicz et al., 1994). According to the literature, misfits can result in biomechanical complications such as, fracture of the components in the system, screw loosening, bone resorption, soft tissue alterations and even loss of osseointegration (Goodacre et al., 2003; Gratton et al., 2001; Jansen et al., 1997; Kan et al., 1999; Romero et al., 2000).

However, there are no conclusive scientific reports about how much misfit between prosthetic components and implants can be clinically acceptable without causing complications in treatments

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