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Original research

Comparative analysis of the wear of titanium/titanium and titanium/zirconia interfaces in implant/abutment assemblies after thermocycling and mechanical loading

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ABSTRACT

Objectives: Due to its hardness, zirconia abutments may damage the titanium of the implant's connection during its clinical use. This study aimed to assess the wear of the seating platforms of externally hexed titanium implants when connected to zirconia abutments comparing to titanium abutments, after thermocycling and mechanical loading (TCML).

Methods: Six BNT® S4 external connection implants (Phibo® Dental Solutions, Barcelona, Spain) were selected and divided into two groups ($n = 3$): TiCE, screwed to titanium abutments and ZrCE, screwed to zirconia abutments. The samples underwent thermocycling (5000 cycles; 5–55 °C) and mechanical loading (1.2×106 cycles; 88.8 N; 4 Hz). Before and after TCML, the seating platforms of the implants were analyzed by 3D profilometry in two areas to measure their topography based on the superficial analysis parameters (Sa and Sz) parameters, and were studied by scanning electron microscopy (SEM). Data were statistically analyzed by Mann–Whitney test ($p < 0.05$).

Results: No statistically significant differences were observed in the Sa and Sz values between the implants at initial state and after TCML ($p = 0.573 > 0.05$ and $p = 0.059$). The abutment's material (titanium/zirconia) did not statistically significantly influence the Sa and Sz values after TCML ($p = 0.886 > 0.05$ and $p = 0.200$, respectively). However, the SEM analysis reveals a mild wear in some vertices of the hex when connected to zirconia abutments.

Conclusions: After simulating five years of clinical use, the externally hexed implants, analyzed by 3D profilometry, showed similar wear patterns in the corresponding seating

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platforms when connected to zirconia or titanium abutments. The SEM images showed zirconia particles being transferred to the implant, which requires further study.

Análise comparativa do desgaste das interfaces titânio/titânio e titânio/zircónia dos conjuntos pilar/implante após envelhecimento

Palavras-chave:
Implantes dentários
Pilares de zircónia
Pilares de titânio
Envelhecimento

RESUMEN

Objetivos: Devido á sua dureza, os pilares de zircónia podem provocar danos sobre o titânio da conexão do implante durante a utilização clínica. O presente trabalho pretendeu avaliar o desgaste das plataformas protéticas de implantes de titânio com conexão hexágono externo quando conectados com pilares de zircónia em comparação com pilares de titânio, após carga cíclica e termociclagem (TCML).

Métodos: Foram selecionados 6 implantes de conexão externa BNT® S4 Phibo® Dental Solutions (Barcelona, Espanha), que foram divididos em 2 grupos (n = 3): TiCe aparafusados a pilares de titânio e ZrCe aparafusados a pilares de zircónio. As amostras foram submetidas a TCML (5.000 ciclos; 5–55 °C) e carga cíclica (1,2 × 106 ciclos; 88,8 N; 4 Hz). Antes e após TCML, as plataformas de assentamento de conexão dos implantes foram sujeitas a análise por perfilometria 3 D em 2 localizações para a medição da sua topografia com utilização dos parâmetros de análise superficial (Sa e Sz) e examinadas por microscopia eletrónica de varrimento(MEV). Análise estatística: Mann-Whitney test ($p < 0,05$).

Resultados: Não se observaram diferenças estatisticamente significativas nos valores de Sa e de Sz entre os implantes no estado inicial e após TCML ($p = 0,573 > 0,05$ e $p = 0,059$). O material do pilar (titânio/zircónia) não exerceu influência estatisticamente significativa nos valores de Sa e Sz após TCML (teste U $p = 0,886 > 0,05$ e $p = 0,200$, respetivamente). No entanto, a análise por MEV revelou ligeiro desgaste em alguns vértices do hexágono quando conectados com pilares de zircónia.

Conclusões: Após uma simulação de 5 anos de utilização clínica, os implantes com hexágono externo, analisados por perfilometria 3 D, apresentaram padrões de desgaste das plataformas de assentamento equivalentes quando conectados a pilares de zircónia ou de titânio. As imagens de MEV mostram a passagem de partículas de zircónia para o implante, aspeto que merece investigação suplementar.

Introduction

Currently, dental esthetics criteria are one of the success factors in implantology, especially in the rehabilitation of anterior regions. Accordingly, metal has been replaced by ceramics not only in crowns and bridges but also in the components of implant systems, as titanium abutments might impair esthetics by causing a grayish staining in the peri-implant tissues in patients with thin biotypes.[1–4] Due to their optical, mechanical, and biological properties, high-strength ceramic abutments, such as yttria-stabilized tetragonal zirconia polycrystals (3Y-TZP), have been increasingly used.[5] These abutments have provided high technical and biological success rates and have shown performances similar to those of titanium abutments. This fact has been reported in clinical studies of up to 12 years.[6–10]

Most clinical studies have been focused on abutment/implant assemblies with externally hexed connections.[6,11–13] Recent systematic review supports the use of zirconia abutments in the external connection implants due to their long term performance.[9] In vitro studies show that secondary metallic components (two piece) have a positive influence on the zirconia abutments stability.[14] Other studies advise against direct link abutment to the implant head.[15] Clinical and in vitro studies on the performance of single abutments connected to external connection implants have reported the loosening of the screw as the main technical problem.[1,11,15,16] On the other hand, the stability of the abutment/implant connection is considered the main factor for the implant system to reach clinical success. It is influenced by several factors, such as the material of the abutments, the adjustment and precision in the fabrication of its components, its contamination by saliva, the preload on the retaining screw, the microgap, the connection geometry, and aging.[17–25]

Despite the success reported by clinical studies, some issues are still not clear, including the fact that connecting zirconia to titanium implants subjected to loading

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