The electrochemical properties of four dental casting suprastructure alloys coupled with titanium implants.

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Abstract

OBJECTIVES: As the choice of suprastructure alloy to be combined with titanium for the oral cavity is still a much debated issue, the aim of this study was to investigate the electrochemical interaction of the suprastructure/implant couples under the determined experiment conditions.

MATERIAL AND METHODS: The potentiodynamic polarization curves and open-circuit potentials (OCP) of four UCLA type suprastructures coupled with straight Swiss Plus implant fixtures were taken in Afnor type artificial saliva solution at 37 degrees C. The concentration of ions leached into artificial saliva solutions was estimated with ICP-MS. SEM images of the margins of suprastructure/implant couples were obtained before and after the electrochemical tests.

RESULTS: The OCP value of titanium became passive at the most negative potential. The lowest difference between the initial and constant OCP value was exhibited by the Au based suprastructure. Suprastructures made greater contributions to the potentiodynamic polarization curves of the implant/suprastructure couples. According to the ICP-MS results, Pd based and Au based couples dissolved less than Co-Ni based and Co-Cr based couples.

CONCLUSIONS: Within the conditions this study, it may be concluded that the titanium implant forms a stable passive oxide layer in artificial saliva exposed to open air and does not affect the corrosion properties of the suprastructures. Pd based and Au based couples have been found to be more corrosion-resistant than base alloy couples.

Galvanic corrosion behavior of implant suprastructure dental alloys.

Taher NM, Al Jabab AS.

Dent Mater. 2003 Jan;19(1):54-9.

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Abstract

OBJECTIVE: The purpose of this study was to evaluate and compare in vitro, the galvanic corrosion behavior of Co-Cr alloys (R2000, R800), Ni-Cr (RCS), silver-palladium (Jelstar), Gold (Pontallor-4) and Ternary Ti (experimental Ter Ti) when coupled with endosseous Ti implant abutment material. Amalgam alloy and commercially pure Ti cylinders (SSTi) were coupled with endosseous Ti implants as negative and positive controls, respectively.

METHODS: An EG&G Model 263 Scanning Potentiostat was used for this purpose. Specimens were prepared and fresh artificial saliva was used as an electrolyte solution. The experiment run time was 24h for each couple. The common potential, galvanic current and current integration during the last 6h were recorded for each couple.

RESULTS: The results showed that the best couples were Ti/Pontallor-4, Ti/Ter Ti, Ti/R800 and Ti/Jelstar. The least acceptable couples were Ti/amalgam, SSTi/SSTi and Ti/R2000, while the Ti/RCS couple showed unstable galvanic corrosion behavior.

SIGNIFICANCE: It is concluded that the following alloys can be used as suprastructure alloys with Ti implants: Pontallor-4, R800, Jelstar and Ter Ti. Although Ter Ti alloy is an experimental alloy, it showed good results, but cannot be used in the clinical field unless extensive investigations are carried out. The SSTi/SSTi couple showed unexpected galvanic corrosion behavior which needs further investigation.

Evaluation of restorative and implant alloys galvanically coupled to titanium.

Venugopalan R, Lucas LC.

Dent Mater. 1998 Jun;14(3):165-72.

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Abstract

OBJECTIVES: As the success of implants leads to their increasing use in restorative dentistry, attention should be devoted to the galvanic combination of restorative materials with titanium. This paper used continuous corrosion potential monitoring in conjunction with zero-resistance ammetry to obtain galvanic corrosion properties of restorative and implant materials coupled with titanium (ASTM F67-Grade II).

METHODS: Direct coupling or galvanic experiments were conducted on eight restorative and implant materials coupled to titanium. Deaerated artificial saliva solution in a specifically

designed corrosion cell simulated an oral crevice situation. Open circuit potentials (Eo.c.) of each material in the couple, coupled corrosion potentials (Ecouple corr), coupled corrosion current density (Icouple corr) and the resultant charge transfer were monitored. The results were analyzed using single factor ANOVA and Duncan's multiple range tests.

RESULTS: Noble restorative (Au-, Ag-, and Pd-based) alloys coupled to titanium were found to be least susceptible to galvanic corrosion. Co-Cr-Mo, Ni-Cr and Fe-based alloys coupled to tatanium were found to be moderately susceptible to galvanic corrosion due to mechanical-electrochemical interaction. Ni-Cr-Be alloy coupled to titanium was found to be highly susceptible to galvanic corrosion. The in vitro test results for the titanium/Disperalloy combination does not concur with the published clinical performance of this combination, and thus warrants further investigation.

SIGNIFICANCE: From the data obtained in this study and current literature profiles, acceptable restorative couples were developed for use as clinical guidelines in restorative dentistry.

Study of corrosion between a titanium implant and dental alloys.

Reclaru L, Meyer JM.

J Dent. 1994 Jun;22(3):159-68.

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Abstract

The infiltration of saliva into the multi-metallic structures on titanium implants brings different types of alloys into temporary or permanent contact. In this way a galvanic cell is established as a result of their potential difference. The galvanic cell phenomenon is compounded by another type of corrosion resulting from the geometry of the assembly: localized crevice corrosion. Fifteen galvanic couples (Ti/gold-based alloys, Ti/palladium-based alloy and Ti/non-precious alloys) were studied. Various electrochemical parameters (Ecorr, Ecommon, Ecouple corr, Ecrevice, icorr, icouple corr and Tafel slopes) were analysed. The galvanic currents measured are of the same order of magnitude (except Ti/stainless steel). They remain low. Application of the mixed-potential theory shows that titanium in coupling with the alloys studied will be under either cathodic or anodic control. According to the results obtained, an alloy that is potentially usable for superstructures in a galvanic coupling with titanium must fulfil a certain number of parameters: in a coupling, titanium must have a weak anodic polarization; the current generated by the galvanic cell must also be weak; the crevice potential must be markedly higher than the common potential.

Corrosion at the marginal gap of implant-supported suprastructures and implant failure.

Guindy JS, Schiel H, Schmidli F, Wirz J.

Int J Oral Maxillofac Implants. 2004 Nov-Dec;19(6):826-31.

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Abstract

PURPOSE: Late failure, which occurs after successful osseointegration, is usually attributed to prosthodontic determinants. Corrosion of metallic suprastructures and incorrectly handled materials are often primary causes of late implant failure. In this study, 6 implants whose failure was related to suprastructure metal corrosion and adjacent bone were investigated.

MATERIALS AND METHODS: Six implants as well as their suprastructures were analyzed for surface corrosion using light and scanning microscopy. Metal alloys and soldering compounds were analyzed using energy-dispersive x-ray analysis. Bone adhering to the implants was removed and analyzed for metal content using atom absorption spectroscopy.

RESULTS: Extensive corrosion lesions and areas of oxidation were detected on all 6 of the implants and inner crown surfaces. Bone tissue collected from 5 of the implants showed higher contents of metal ions in comparison to physiologic baseline values detected in healthy bone.

DISCUSSION: In spite of the high gold content of the suprastructure, corrosion occurred. Bonding oxides necessary for the process of fusing porcelain to gold will initiate corrosion. Apparently, once corrosion is initiated it rapidly progresses at the gap crevices, and toxic metal ions are released. These toxic ions diffuse into the peri-implant bone, causing bone structure breakdown and hastening osseodisintegration.

CONCLUSION: Biocompatible metals, alloys, and ceramics should be used for implant-supported suprastructures. It is also essential that gaps between the implant and its suprastructure be avoided by cementing the suprastructure or sealing the gap.

Galvanic corrosion behavior of titanium implants coupled to dental alloys.

Cortada M, Giner L, Costa S, Gil FJ, Rodríguez D, Planell JA.

J Mater Sci Mater Med. 2000 May;11(5):287-93.

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Abstract

The corrosion of five materials for implant suprastructures (cast-titanium, machined-titanium, gold alloy, silver-palladium alloy and chromium-nickel alloy), was investigated in vitro, the

materials being galvanically coupled to a titanium implant. Various electrochemical parameters E(CORR), i(CORR) Evans diagrams, polarization resistance and Tafel slopes) were analyzed. The microstructure of the different dental materials was observed before and after corrosion processes by optical and electron microscopy. Besides, the metallic ions released in the saliva environment were quantified during the corrosion process by means of inductively coupled plasma-mass spectrometry technique (ICP-MS). The cast and machined titanium had the most passive current density at a given potential and chromium-nickel alloy had the most active critical current density values. The high gold content alloys have excellent resistance corrosion, although this decreases when the gold content is lower in the alloy. The palladium alloy had a low critical current density due to the presence of gallium in this composition but a selective dissolution of copper-rich phases was observed through energy dispersive X-ray analysis.