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Evaluation of the marginal fit of cast and prefabricated cylinders on abutments for implant-supported prostheses

AVALIAÇÃO DA ADAPTAÇÃO MARGINAL DE CILINDROS FUNDIDOS E PRÉ-FABRICADOS EM INTERMEDIÁRIOS DE PRÓTESES IMPLANTO-SUPORTADA

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The aim of this study was to evaluate the marginal fit of cylinders cast in a cobalt-chromium alloy from plastic patterns, compared to the fit of prefabricated silver-palladium cylinders. An octagonal stainless steel device measuring 16 mm in height and 10 mm in width was used to hold an implant replica. A 4-mm high standard abutment was screwed to the replica, using a torque force of 20 N/cm^2. Over the abutment, 5 cylinders made up of silver-palladium and 5 of cobalt-chromium alloy were fixed by means of titanium screws, using a torque force of 10 N/cm^2. Each cylinder was analyzed three times in eight different locations determined by the octagonal faces of the holder device. After the first measurements, the cylinders were loosened and once again screwed under 10 N/cm^2. The whole procedure was repeated a third time, counting up 24 readings of the interface for each abutment/cylinder set. The analysis of the abutment/cylinder interface was carried out in light microscope under magnification of 150X, with a green background light. All silver-palladium and cobalt-chromium cylinders were considered to present a satisfactory fit to the abutment. All results were considered as acceptable fit, thus both types of cylinders studied presented the same characteristics regarding their adaptation.

UNITERMS: Marginal adaptation; Cast cylinders; Cobalt-chromium alloy; Silver-palladium cylinders.

INTRODUCTION

In early times of implantology with osseointegrated implants, the technique used to fabricate frameworks for implant-supported prostheses consisted on casting bars of a gold alloy directly onto the gold cylinders. Considering the high costs inherent to gold alloys, an alternative technique was proposed, using silver-palladium (Ag-Pd) alloy cast onto the cylinders[5]. The latter technique provided consistent clinical outcomes

regarding precision of fit, ability to support load, and cost reduction in relation to the gold alloys[7]. Nevertheless, the rising utilization of the silver-palladium alloy increased its price to an even more expensive degree than gold alloys, what has limited its employment. Thus, the study of new alternatives was initiated.

Due to their properties such as high elasticity modulus, biocompatibility, resistance to corrosion, low specific weight and low cost, the cobalt-chromium alloys were suggested for the fabrication of frameworks for implant-supported prostheses.[3,6] Because of their high melting temperature, their casting over prefabricated gold cylinders is impossible, bringing about the need for the utilization of castable plastic cylinders. This yields problems related to adaptation and pre-load, when compared to the prefabricated cylinders[2,4].

The studies conducted by Skalak[9] in 1983, Benzing; Gall; Weber[1] in 1995 and Sertgöz[8] in 1997 highlighted that the utilization of materials which are able to better absorb and distribute the loads is advisable, and cantilever frameworks fabricated with alloys, which presenting a low elasticity modulus, induce mechanical overload on the more distal implants.

Considering the possibility of using the cobalt-chromium alloy for fabrication of frameworks for implant-supported prostheses, this study aimed at evaluating the marginal adaptation of cylinders cast with this alloy from plastic patterns, compared to the adaptation of prefabricated silver-palladium cylinders on standard abutments.

MATERIALS AND METHODS

Sample selection

A Branemark compatible implant system (Conexão Sistemas de Prótese Master LTDA- São Paulo – SP) was employed in this study, consisting of the following components: 1 standard abutment measuring 4 mm in height, 5 silver-palladium cylinders (Group 1 or control group), 5 plastic cylinders that were cast with cobalt-chromium alloy (Rexillium NBF – Jeneric Pentron) (Group 2) and 30 titanium screws.

Mounting of test specimens

An implant replica with a 3,75-mm diameter and an external hexagon was positioned on an octagonal stainless steel device measuring 16 mm in height and 10 mm in width (Fig 1). Care was taken to keep the coronal portion exposed, and fixation was kept by means of locking provided by an "allen" screw.

The abutment was positioned and screwed using a torque force of 20 N/cm^2, with an electronic torque controler (Nobelpharma –Torque Controler™, Gotemburg, Sweden) (Figure 2). The cylinders were fixed on the abutments using a torque force of 10 N/cm^2 (Figure 3).

FIGURE 1 – Test specimen

FIGURE 2 – Abutment at screwing

FIGURE 3 – CoCr cylinder being screwed

Analysis of the abutment/cylinder interface

For the analysis of the abutment/cylinder interface (A/C) a light microscope (Mitutoyo TM – model 5050, code 176-811A) was employed, with a magnification of 150 times and a precision of 1µm.

Each cylinder was evaluated in eight different positions determined by the octagon of the holder device (Figure 4). After the eight measurements had been obtained, the cylinder screw was loosened and once again screwed with a new screw, using a torque force of 10 N/cm^2. This step was performed twice again, summing up to 24 readings of the interface of each set. A period of 2 hours was allowed between the reading sequences, to avoid the operator's sight fatigue.

Aware of the fact that the microscopic analysis of the components of implant systems reveals different configurations of the abutment edges, which are shown to be predominantly rounded or beveled, precluding an "edge-to-edge" junction, adjustment was considered as the occurrence of close contact at the interface abutment/cylinder, with no space to be measured (Alfa). On the other hand, disadjustment was considered the occurrence of a space at the abutment/cylinder interface, microscopically visible through the passage of the background green light (Bravo).

FIGURE 4 – CoCr cylinder in place for microscopic analysis

RESULTS

The occurrence of close contact at the interface abutment/cylinder or Alfa value could be verified on all 120 readings, 60 for group 1 and 60 for group 2 (Figure 5) and none of cylinders presented disadjustment or Bravo value. Therefore, all readings were considered as "adjustment".

As expected, the microscopic analysis disclosed different configurations of union between the cylinder and abutment edges. Some times the cylinder edge overlapped the abutment edge and vice-versa, and some times it established an almost perfect junction, or "edge-to-edge" union. This was observed for both types of cylinders studied. The statistical analysis were performed with ANOVA and it disclosure that there were no statistical difference between the 2 groups.

DISCUSSION

Considering the high costs of gold alloys, alternative alloys have been evaluated for the fabrication of frameworks for implant-supported prostheses. According to Chao et al.[3], the cobalt-chromium alloys demonstrate to be quite promising, due to their stiffness and higher resistance to deformation than the silver-palladium alloys, thus allowing the fabrication of a more delicate framework with a lighter weight of metal. This is a great advantage in cases of limited intraoral space, without sacrificing the framework's ability to resist loads, thus allowing a more uniform distribution of stress along the entire body of the framework. Besides, it is a biocompatible material, which is resistant to corrosion and presents good casting properties. Nevertheless, in the same study, Chao et al.[3] reports that frameworks made with cobalt-chromium alloys are inferior to those cast in silver-palladium alloys regarding adaptation. This is due to the fact that casting a cobalt-chromium bar directly onto the prefabricated cylinder

FIGURE 5 - Table with the results of readings performed on groups 1 and 2

GROUPS	ALFA VALUE	BRAVO VALUE	TOTAL OF READINGS
GROUP 1	60	0	60
GROUP 2	60	0	60

is impossible because of differences in melting temperature, thus requiring waxing on plastic cylinders for posterior casting. This way, the adaptation of the frameworks to the abutments occurs by means of a cast piece, instead of a machined one, which is possible just with gold or silver-palladium cylinders.

According to Goll[4], the utilization of prefabricated components is preferable to the employment of castable plastic components. Nevertheless, this study demonstrated that the cast cobalt-chromium cylinders presented similar results to the machined silver-palladium cylinders, regarding adaptation.

The microscopic analysis of the components included in this study, for both groups of cylinders, revealed that most of them presented a lateral mismatch (Figures 6, 7 and 8). Despite of the fact that this lateral mismatch may cause plaque accumulation and make clinical inspection difficult, it does not necessarily means lack of adaptation. In this way, the results considered adjustment disadjustment corresponded to the analysis of the space between the interface abutment/cylinder.

In a clinical study, Hulterström, Nilsson[5] concluded, after a three-year follow-up of patients treated by means of implant-supported prostheses with cobalt-chromium frameworks, that this material provides a favorable combination of biocompatibility, resistance, castability, weight, stiffness and low cost. The present study, yet it is a laboratory study instead of a clinical one, adds to the above-mentioned characteristics, the feature of a good adaptation, similar to that presented by the machined components. Other variables must be studied, though. Casting results in a more rough surface compared to a machined one, what impacts directly on obtaining and keeping the preload of screws. As rougher the surface, as more likely the occurrence of loosened screws. This issue has yet to be investigated.

CONCLUSION

According to the criteria established in this study, the data analysis allowed the conclusion that cylinders cast with cobalt-chromium alloys presented similar outcomes, regarding marginal adaptation, to prefabricated silver-palladium cylinders.
Therefore, the cobalt-chromium alloy seams to be a very promising alloy for the fabrication of frameworks for implant-supported prostheses, although other issues like surface roughness have to be investigated.

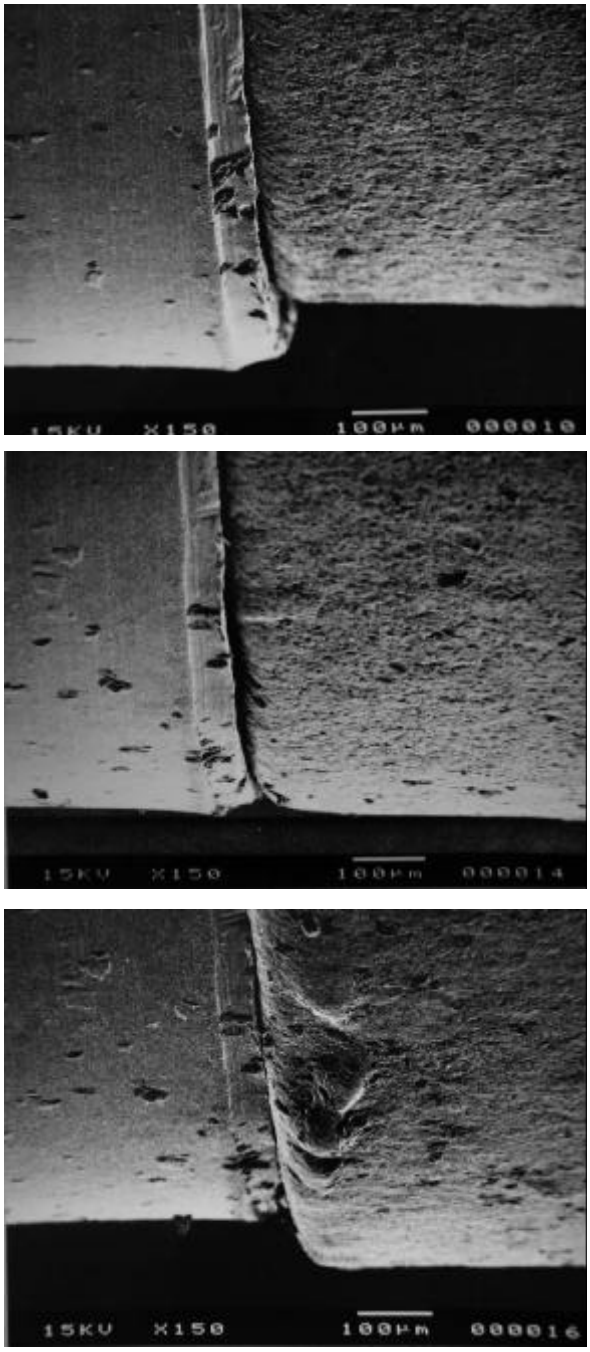

FIGURE 5, 6 e 7 – Scanning electronic microscope imaging illustrating the different configurations of union between the cylinder and abutment edges

RESUMO

Avaliou-se a adaptação marginal de cilindros fundidos em liga de cobalto-cromo a partir de matrizes plásticas, comparada com a adaptação de cilindros pré-fabricados em prata-paládio. Foi utilizada uma base octagonal de aço, inoxidável medindo 16mm de altura e 10mm de largura, para prender uma re-

plica de implante. Um intermediário convencional com 4mm de altura foi fixado à replica usando-se uma força de torque de 20N/cm^2. Sobre o intermediário, 5 cilindros de prata-paládio e 5 cilindros de cobalto-cromo foram fixados por meio de parafusos de titânio com uma força de torque de 10 N/cm^2. Cada cilindro foi analisado três vezes em oito diferentes locais determinados pelas faces octogonais do dispositivo de suporte. Após as medidas iniciais, os cilindros foram soltos e novamente parafusados com 10 N/cm^2. Todo o processo foi repetido uma terceira vez, perfazendo 24 leituras de interfaces de cada conjunto intermediário/cilindro. A análise da interface intermediário/cilindro foi feita em um microscópio óptico sob magnificação de 150X, com uma luz de fundo verde. Todos os cilindros de prata-paládio e de cobalto-cromo apresentaram adaptação ao intermediário portanto, todos os cilindros estudados apresentaram a mesma característica em relação à adaptação.

UNITERMOS: Adaptação marginal; Cilindros fundidos; Liga de cobalto-cromo; Cilindros de prata-paládio.

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