Evaluation of linear alteration of NiCr castings using two phosphate - bonded investments with different compositions*

Avaliação da alteração linear de fundições com liga de NiCr, obtidas por meio de dois revestimentos fosfatados de diferentes composições

Carlos Magno GOSHI; Eduardo Eugênio Santos ALMEIDA
Post-graduated student – Restorative Dentistry Program – Prosthesis Especiality. Fixed Partial Prothesis concentration – Dental School of Dentistry of São José dos Campos – UNESP, São Paulo – Brazil

Fernando Eidi TAKAHASHI
Professor – Department of Dental Materials and Prothesis – Dental School of Dentistry of São José dos Campos – UNESP, São Paulo – Brazil

Alexandre Henrique de Moura DIAS
Doctor of Philosophy's student. Fixed Partial Prothesis concentration – Dental School of Dentistry of São José dos Campos – UNESP, São Paulo – Brazil

Abstract

The aim of this work was to verify the linear alteration of castings using two phosphate – bonded investments, one with granuled ceramic – based refractory (Microfine 1700), and the other by cristobalite (Bellavest – T). Forty wax patterns were obtained through direct molding from a stainless steel matrix. Twenty wax patterns were invested with Microfine and twenty with Bellavest – T. A profile projector measured the distance between two points pre- established on the matrix. The same two points were measured later on the metal casting reproduced in NiCr, thus obtaining the measurement of possible dimensional changes. Along the experiment, wax patterns were measured and compared to the stainless steel matrix and to the NiCr castings. The results show that the two investments could not compensate the contraction of the alloy and wax in the casting process. The mean distance of the castings obtained with Microfine 1700, despite the fact of being smaller than the matrix and the castings of Bellavest – T, showed more constant dimensions.

Uniterms

Dental casting investment; dental casting technique; chromium alloys

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Introduction

Since Taggart[15] until nowadays, the casting process used in Dentistry based on wax-loss technique has been receiving continuous investigations exploring the behavior of different dental materials. The difficulty to compensate wax and casts dimensional alteration is a restriction for precision and fidelity castings.

Schnell et al.[13] (1963) and Cooney et al.[2] (1979) verified that castings misfit included in phosphate-bonded investments were lower than in gypsum-based investments.

Fernandes et al.[4] (1989) studied the mold investments expansion and did not find a proportional relationship between the normal setting expansion and colloidal silex concentration. In another study, Hutton & Marshall[5] (1993) found a higher setting expansion, when using 100% colloidal silex concentration.

Konstantoulakis et al.[6] (1998) and Schilling et al.[12] (1999) compared marginal adjustment of casting crowns with accelerated and conventional technique included in phosphate-bonded investments. Castings with both techniques were considered clinically acceptable but it was noted that a few variation in the accelerate technique can cause defects on casting.

Phosphate-bonded investments are the most indicated and used investiment for casts with high fusion point as NiCr alloy and ceramic Au (De Armas[3] 1986). To achieve desirable expansion, it is necessary a cycle of thermal expansion that includes a gradual increase in temperature during certain periods of time, starting from enviromental temperature until reaching the final desirable temperature. This process is normally slow and demands that the laboratories work with a small amount of castings or have a lot of ovens to realize this kind of operation.

In order to avoid this disadvantage, the industries have introduced in the market granuled ceramic-based refractory investments that dispense the conventional cycle of thermal expansion (according to the manufacturers' instructions). This granuled ceramic-based refractory investment can be inserted in a pre-heated casting ring at 750ºC, obtaining the desirable expansion to realize the casting in a small period of time. Because of that, dental prosthesis technicians have largely used this material. The aim of this study was to compare granuled ceramic-based refractory investment with conventional ones, observing the linear dimensional fidelity of NiCr casting alloy.

Materials and Methods

Forty wax patterns (Bredent life-color-wachs), with rectangular design and rounded edges (20x5x2 mm), were obtained through direct molding from a stainless steel matrix as used by Arruda[1]. These wax patterns have on its surface two series of seven wrinkles of similar width. Two vertical wrinkles pass through all plate extension, perpendicularly cutting the two series of seven wrinkles (Figure 1).

A metallic tray with the pattern dimensions was prepared, perfectly adjusted to the steel plate and with the central wrinkle placed in the medium line of the pattern (Figure 2). The inlay wax was liquefied and poured into the tray in a single time. The excess was cut off after cooling in order to equalize the wax patterns and immediately included in the investments. Twenty wax patterns were invested in MICROFINE 1700 (Talladium, Inc. Califórinia USA.), with granuled ceramic-based refractory and the other twenty patterns were invested in BELLAVEST-T (Bego, Importadora Defama Ltda – Porto Alegre) conventional type with cristobalite-based refractory. In order to standardize the patterns position inside the ring, a parallelism device was used. Therefore it was possible to include all patterns in the same position and with the same injection angle (Martignoni & Schönenberger[9] 1998).

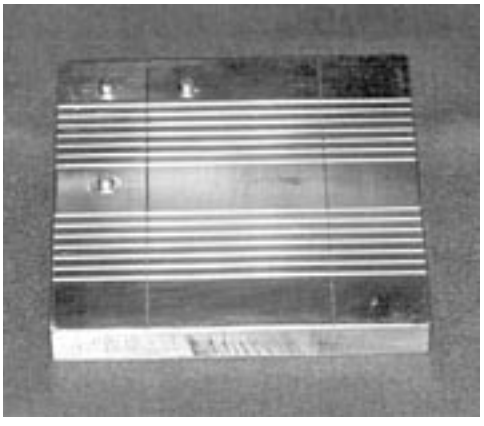

FIGURE 1 – Stainless steel matrix.

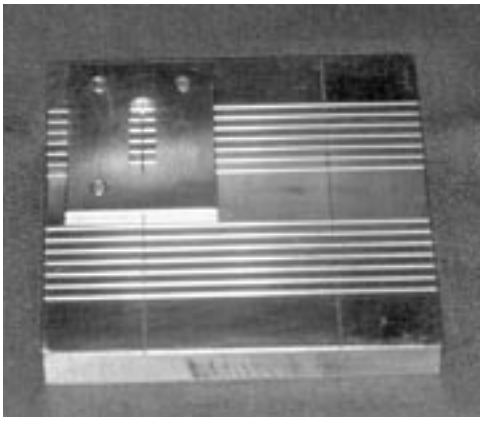

FIGURE 2 – Tray adjusted to the matrix.

Before wax patterns had been included into the investments, a tension reduction agent (Waxit, Degussa) was applied during 20 minutes. Investments manipulation followed manufactures instructions for both materials. Colloidal silex concentration varied from 75% to 100% for Microfine and Bellavest-T investments, respectively. All wax patterns were included in a medium size silicon ring. The waiting time of casting after the cure of each investment varied according to manufactures' recomendation: Microfine 1700 1h and Bellavest-T 3h 10min. A manual centrifuge and a blowlamp were used as a source of heat and oxygen for NiCr alloy fusion (Verabond II – Aaba Dent Inc, Cordelia, Ca, USA.). The removal of the embedding material was realized after complete casting cooling. After that all patterns were cleaned with 33% hydrochloric acid during four hours and ultra-sound baths during teen minutes.

Measurement

A profile projector (Epic 30 E, digital electronic – Springtiel, Vermont) with a precision of 0,001mm was used to measure the distance between the second and the sixth vertex (Figure 3).

This distance had been measured initially matching the horizontal line of the profile projector with the vertex that divided horizontally the pattern in the middle, at the same time that the vertical line of the profile projector matched with the apex of the second vertex. Afterwards, the table was dislocated horizontally until the sixth vertex crossing and data was registered. The final result was calculated using the mean value of the three reading to each pattern. Subsequently, it was compared the mean value of castings' distances with the distances between the middle of the second and sixth wrinkle of the metallic matrix, obtaining the dimensional alteration mean value. Lower mean values indicate that a better compensation was obtained with both investments. Along the experiment, wax patterns were analyzed in the profile projector to measure wax contraction mean value compared to the metallic matrix.

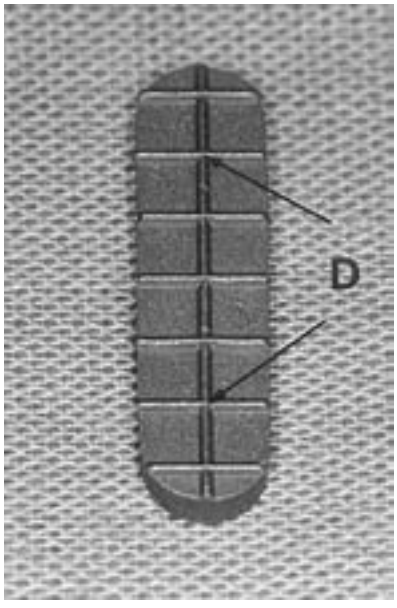

FIGURE 3 – Pattern casting with the indicated distance measured.

Results

The mean values, standard deviations, maximum and minimum values (mm) for wax patterns and castings with both investments were calculated based on data collected, as shown in Table I.

It was observed that mean distances using both investments and for the wax patterns were lower than the values obtained with the matrix (11,587mm).

Wax patterns and castings measurements obtained with the two investments tested were calculated with Student-t Test to verify if the distance mean values were close or not to the matrix values (11,587mm) (Table II).

Table 1 – Means, standard deviations, minimum and maximum values of the distances for investments and wax patterns (mm)

	Bellavest-T	Microfine 1700	Wax
Mean Values	11,539	11,468	11,548
SD	0,080	0,034	0,011
Minimum	11,431	11,403	11,499
Maximum	11,759	11,525	11,562
% of contraction	-0,4	-1,0	-0,3

Table 2 – Student-t test for wax patterns and castings with the two kinds of investments

Investment	T	Freedom Degree	Significance Level (p)
Wax	-16,751	22	0,00001**
Bellavest-T	-2,683	19	0,0147 *
Microfine 1700	-15,652	19	0,00001**

*: significant to 5%, **: significant to 1%.

Discussion

The objective of this study was to verify the behavior of two phosphate-bonded investments, measured by the linear difference of the distances between two points established in a metallic matrix (11,587mm) and in wax patterns and castings with Ni-Cr alloy.

Although the mean values of the distances in the castings invested with Bellavest-T (11,539mm) have been closer to the matrix values, those castings showed a standard deviation greater than castings invested with Microfine 1700 (Table 1). This may denote that Bellavest-T is more sensitive to the dimensional alterations during the making of the material and castings procedures.

The mean values of the castings' distances of both investments were below the distances in the metallic matrix. Because of that, none of the investments were able to compensate the contraction through their expansion, wax patterns contractions and Ni-Cr alloy. Although Arruda[1] has used in his research phosphate-bonded investments, he also observed that those investments did not compensate the casting contraction with different kinds of metallic alloys used in the study (gold, silver-tin, silver-palladium).

Cooney et al.[2] (1979), Leonardi et al.[7] (1983) e Hutton & Marshall[5] (1993) observed a greater expansion with phosphate-bonded investments as higher as the colloidal silex concentration used. It could explain the higher proximity of the distances when using Bellavest-T investment in comparison to the metallic matrix, once it was used 100% of colloidal silex concentration to Bellavest-T and 75% for Microfine 1700.

It is known that Microfine 1700 decrease the time of casting, but in the present study this investment showed castings with greater contraction than those obtained by the conventional investment tested. Konstantoulakis et al.[6], (1998) Schilling et al.[12] (1999) realized in their study an accelerated technique of castings, using conventional phosphate-bonded investments in order to decrease the time of casting and also

to obtain the desirable expansion. The results of their study showed that there was no statistical difference in the marginal discrepancies on castings crowns obtained through both techniques and that those castings were clinically acceptable.

As the distances of the castings obtained with both investments were always lower than matrix values, it was applied Student-t Test to verify if the mean value was close to the matrix value. It was observed that the difference between the mean value of wax patterns and castings, when compared to the matrix with Microfine 1700, were significant at 1% and with Bellavest-T at 5% (Table 2).

Those results lead to the necessity of new studies of castings behavior with others configurations, as crowns and inlay/onlay designs and its marginal adaptation to a matrix, as observed in other studies (MALUF[8] 1973; MUENCH & MALUF[11] 1973; SHIGETO et al.[14] 1992). Some others variables need to be studied: the influence of the internal die relief and the methods of internal cleaning which could improve crowns and inlays/onlays adaptation (MORI et al.[10] 1994); the ideal relief thickness, once ceramic investment showed lower standard-deviation than conventional investment, originating the expectation that ceramic investments have a more homogeneous behavior between the castings.

Conclusion

The results show that: the two investments could not compensate the contraction of the alloy and wax in the casting process; the mean distance of the castings obtained with Microfine 1700, despite the fact of being smaller than the matrix and than the castings of Bellavest-T, showed more constant dimensions.

Resumo

O objetivo deste trabalho foi verificar a alteração linear de fundições obtidas com dois revestimentos fosfatados, sendo um com carga refratária à base de cerâmica granulada (Microfine 1700) e outro à base de cristobalita (Bellavest-T). Quarenta padrões de cera foram obtidos por meio de moldagem direta de uma matriz de aço inoxidável. Vinte padrões de cera foram incluídos com Microfine 1700 e vinte com Bellavest-T. Com o auxílio de um projetor de perfil, mediu-se a distância entre dois pontos preestabelecidos na matriz. A distância correspondente foi medida posteriormente na peça metálica reproduzida em liga de NiCr., obtendo-se assim, as medidas das possíveis alterações dimensionais. Os padrões de cera também foram mensurados e comparados à matriz de aço inoxidável e às peças metálicas reproduzidas. Os resultados demonstraram que: os dois revestimentos não conseguiram compensar a contração da liga metálica e da cera no processo de fundição; a média das distâncias das fundições obtidas com revestimento Microfine 1700, apesar de apresentarem-se menores que a matriz e as fundições com o revestimento Bellavest-T, revelaram medidas mais constantes.

Unitermos

Técnica de fundição odontológica; revestimento para fundição odontológica; ligas de cromo

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Dr. Fernando Eidi Takahashi
Rua Tertuliano Delphim Junior n° 451
Cep: 12246-080 – Jardim Aquarius
São José dos Campos-SP.
Telefone: (12) 3943-3000.