INFLUENCE OF RE-USING REVERSIBLE HYDROCOLLOIDS ON THE LINEAR ALTERATION OF COATING MODELS

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ABSTRACT

Reusing reversible hydrocolloids too many times may cause alterations of the coating model and produce unsatisfactory RPPs. The aim of this study was to analyze the linear alterations of coating models reproduced from molds obtained with two commercial brands of reversible hydrocolloid (RH) with 15 re-use cycles of the material. A metal model was used with 4 marks (A, B, C and D) on which the distances AB, BC, CD, DA, BD and AC could be measured lineally. Ten models were divided into two groups according commercial brand of RH: group VIPI - Duplicator VIPI® and group K27 - Duplicator K27l®. The RH was heated in a microwave oven and poured into a flask containing the model. The mold was filled with the ethyl silicate coating, and after crystallization, refractory models were obtained. This was repeated in the 15 re-use cycles of each RH. The refractory models obtained from the 1st, 5th, 10th and 15th times of re-use of RHs were measured under a measuring microscope. The means were submitted to the Analysis of Variance, Tukey and Dunnet tests, to a 5% level of significance. Group VIPI showed linear alterations in relation to the plaster models, for distances AB (1st use=-1.25% and 5th re-use=-1.20%); AD (1st use=0.76%, 10th re-use=0.65% and 15th re-use=0.52%); BD (1st use=0.58%). Both commercial brands analyzed produced coating models with acceptable linear alterations in up to 15 re-use cycles, no statistical difference being observed between them.

Key words: Colloids; Dental Materials; Prosthodontics.

INFLUÊNCIA DA REUTILIZAÇÃO HIDROCOLÓIDES REVERSÍVEL SOBRE A ALTERAÇÃO LINEAR DE MODELOS DE REVESTIMENTO

RESUMO

Reutilizações de hidrocolóides reversíveis em um excessivo número, podem causar alterações nos modelos de revestimentos e consequentemente nas próteses parciais removíveis obtidas a partir destes modelos. O objetivo deste trabalho foi avaliar a alteração linear de modelos refratários obtidos a partir de moldes de hidrocolóide reversível (HR) de duas marcas comerciais (DUPLICADOR VIPI® – Dental VIPI Ltda. e DUPLICADOR K27® – Knebel Produtos Dentários Ltda.), submetidos a 15 ciclos de reutilizações. Para isto, foi utilizado um modelo metálico com 4 marcações (A, B, C e D) que quando unidas, admitiam a mensuração linear das distâncias AB, BC, CD, DA, BD e AC. A partir deste modelo, foram confeccionados 10 modelos em gesso tipo IV, divididos aleatoriamente, para cada marca comercial de HR, em dois grupos com 5 modelos cada um. O HR foi fluidificado em forno de microondas de acordo com as instruções dos fabricantes e vertido no interior da mufla que continha o modelo de gesso. O molde era preenchido com revestimento de silicato de etila (REFRADENT® - Knebel Produtos Dentários Ltda.), e deste eram obtido os modelos refratários, respectivos a cada marca comercial. Esta metodologia foi repetida nos 15 ciclos de reutilizações de cada HR. Os modelos refratários gerados pela 1ª fluidificação, 5ª, 10ª e 15ª reutilizações dos HRs foram mensurados em um microscópio mensurador (Mesuring Microscope STM – Olympus®). As médias foram submetidas à análise estatística pelos testes de Análise de Variância, Tukey e Dunnett, ao nível de 5% de significância. Os resultados evidenciaram que os modelos refratários obtidos pelo HR da marca VIPI® apresentaram alterações lineares em relação ao Grupo Controle, nas distâncias AB (1ª fluidificação=-1,25% e 5ª reutilização=-1,20%); AD (1ª fluidificação=0,76%, 10ª=0,65% e 15ª=0,52% reutilizações); BD (1ª fluidificação=0,58%). De acordo com os resultados obtidos, foi possível concluir que, mesmo havendo diferença significativa após 15 ciclos de reutilizações do HR, esta foi irrelevante quanto à finalidade protética a que se propõe o HR, gerando modelos de revestimento aceitáveis para ambas marcas comerciais investigadas.

Palavras chave: Hidrocolóide Reversível – Revestimentos – Prótese Parcial Removível.

INTRODUCTION

There is currently a wide variety of prosthetic alternatives for replacing missing teeth. Removable partial prostheses (RPP) are a good option when properly indicated, planned and installed, restoring the function and health of the stomatognathic system, aesthetics and phonetics[1].

Manufacturing an RPP involves several clinical and laboratory stages, and inattentiveness or negligence of professionals or technicians may lead to the failure of rehabilitation[2]. The clinical and laboratory factors with greatest propensity to errors are: design of the metal framework, duplication of the working model with reversible hydrocolloid, obtaining the refractory model in coating and the casting process[3-6].

The material of choice for duplicating the working model is reversible hydrocolloid (RH)[4], due to its advantages such as the possibility of being reused, compatibility with plasters and coatings, precision in reproducibility and low cost[7]. RH was recommended for use in dentistry in 1937 and has an excellent cost-benefit ratio, provided its manipulation is strictly controlled. Studies analyzing reproduction of details, storage time and temperature, and dimensional alterations[8-11] have been carried out for an effective analysis of the characteristics of the material and the consequences of alterations in its constitution and processing variables such as increased viscosity and decreased pH[12]. Repeating the melting-setting cycle also leads to a reduction in its crushing time and decreases its viscosity[13]. This could be explained theoretically by the occurrence of stronger bonds within and between molecular hydrogen[13].

The practice of reusing RH is common in prosthetic laboratories, however, disregard of suitable heating techniques, inappropriate number of times of reuse and inadequate storage may alter its physical and chemical properties[14,15], leading to errors in the manufacture of the metal framework[4].

Researchers estimate the useful life of the reversible hydrocolloid at 15-20 melting cycles and consider that the dimensional changes of duplication will vary depending on the material and technical procedure[16].

In view of the importance of the precision of the cast metal framework through controlling the dimensional changes resulting from the process of melting the duplicator material, the aim of this study was to analyze the linear alterations of coating models, reproduced from molds made with two commercial brands of RH, by means of fifteen re-use cycles.

MATERIALS AND METHODS

A metal model was used simulating an edentulous jaw with 1.8 cm projections located in the regions of the canines and molars[3], called A, B, C and D. The figure formed by joining up these projections allowed the linear measurement of 6 distances: AB, BC, CD, DA, AC and BD (Fig. 1).

The metal model was duplicated with addition silicone (REMA®-SIL Dentaurum J.P. Winkelstroeter KG, Germany) and the mold was filled with type IV stone plaster (Herostone® - Vigodente, Rio de Janeiro, Rio de Janeiro, Brazil) thus producing 10 models, which were distributed randomly into 2 groups of 5: group VIPI - reproduced with Duplicator VIPI® (Dental VIPI Ltda., São Paulo, São Paulo, Brazil) and group K27 - reproduced with Duplicator K27® (KNEBEL Produtos Dentários, Porto Alegre, Rio Grande do Sul, Brazil). The plaster models were used as controls with regard to the measurements taken.

To duplicate the plaster models, 2 kg of RH were used, fragmented to an average size of 0.5 x 0.5 x 0.5 cm for each commercial brand analyzed. RH was heated in a conventional microwave oven (AW42 – Continental, São Paulo, São Paulo, Brazil) according to the manufacturer's instructions. For the complete heating and homogenization of the RH, a cycle of 8 minutes at maximum power was necessary – 100%, followed by a cycle of 8 minutes at 50% power, and RH melting temperature of about 91°C[4]. The RH was heated in a plastic refractory container with a lid, so that there would be no loss of water to the medium during heating, and all the water contained in the lid would be put back into the container[10,17]. It was cooled on the bench until it

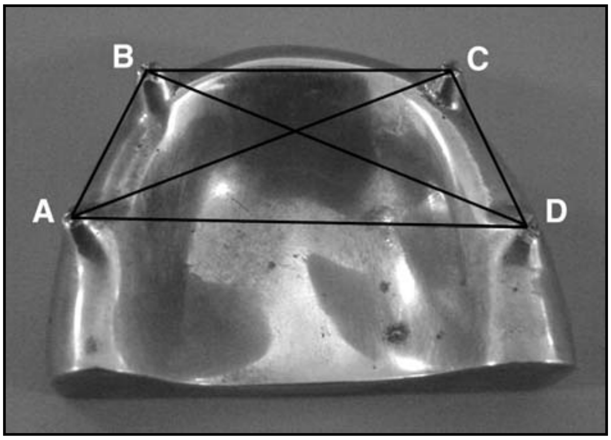

Fig. 1: Diagram of irregular polygon formed by the union of the projections, indicating the distances to be measured.

reached the temperature of 57°C[4] and poured into the flask containing the plaster model that would be duplicated[1].

After 60 minutes, the set RH was separated from the plaster model, thus obtaining the mold which was filled with the ethyl silicate coating (REFRADENT®, KNEBEL Produtos Dentários Ltda., Porto Alegre, Rio Grande do Sul, Brazil), ensuring that the edges of the models were flat and without any inclinations in the forward-backward and side to side directions. After complete crystallization of the coating, the refractory model was removed from inside the RH mold and dehydrated at 180°C - 200°C for approximately 30 minutes[1], and the model was put into a wax bath to increase its hardness and surface smoothness.

Fifteen cycles reusing the RH, as described above were performed for each plaster model in the two groups analyzed. At the end of each cycle, the RH was washed under running water and chopped for subsequent reuse.

Measurement of the distances analyzed were taken of the refractory models coming from the 1st, 5th, 10th and 15th re-use cycles of both groups, using a 0.005mm digital counter for measuring microscope (Measuring Microscope STM – Olympus®, Chiyoda-ku, Tokyo, Japan). All measurements were taken by a second operator and each distance was measured 3 times, and means were calculated and transformed into variation percentage data, when compared to the plaster models. The means and the percentage data were submitted to the Analysis of Variance, Tukey and Dunnet, to a 5% level of significance.

RESULTS

The means, standard deviations and percentages of alterations of the distances analyzed, according to the number of times of reuse and commercial brand are shown in Tables 1 and 2.

Results indicate that there was no statistical difference ($p>0.05$) between the groups of RH analyzed in the experiment. However, statistical differences ($p<0.05$) were observed when comparison was made among the RH reuse cycles of group VIPI (Table 1). For the distance AB, dimensional alteration was noted in the refractory models coming from the first and fifth RH reuse cycles of group VIPI. These values correspond to a contraction percentage of 1.25% and 1.20% respectively (Table 2). For the distance AD, dimensional alteration was noted in the refractory models coming from the first, tenth and fifteenth

Table 1: Means (mm), standard deviations (mm) of the distances analyzed, according to the number of cycles (1, 5, 10 and 15) of reuse and groups.

Distances	AB		BC		CD		AD		BD		AC	
Brands	VIPI	K27	VIPI	K27	VIPI	K27	VIPI	K27	VIPI	K27	VIPI	K27
1	19.95 (0.11) A*	19.78 (0.80) A	35.77 (0.27) A	35.67 (0.10) A	21.55 (0.16) A	21.57 (0.12) A	51.67 (0.16) A*	51.58 (0.12) A	47.72 (0.21) A*	47.60 (0.08) A	47.73 (0.22) A	47.70 (0.06) A
5	19.91 (0.06) A*	20.05 (0.39) A	35.34 (0.21) A	35.29 (0.37) A	21.47 (0.18) A	21.37 (0.32) A	51.23 (0.03) A	51.12 (0.39) A	47.38 (0.07) A	47.19 (0.50) A	47.26 (0.23) A	47.31 (0.43) A
10	20.23 (0.15) A	20.14 (0.12) A	35.76 (0.14) A	35.73 (0.16) A	21.58 (0.19) A	21.43 (0.05) A	51.61 (0.24) A*	51.50 (0.14) A	47.66 (0.21) A	47.59 (0.08) A	47.85 (0.23) A	47.72 (0.21) A
15	20.27 (0.13) A	20.15 (0.12) A	35.62 (0.12) A	35.58 (0.35) A	21.35 (0.12) A	21.50 (0.98) A	51.55 (0.15) A*	51.35 (0.35) A	47.42 (0.12) A	47.50 (0.38) A	47.83 (0.21) A	47.66 (0.26) A
Plaster Model	20.15 (0.07) A	20.15 (0.02) A	35.47 (0.08) A	35.56 (0.04) A	21.59 (0.08) A	21.50 (0.04) A	51.28 (0.11) A	51.27 (0.04) A	47.44 (0.07) A	47.44 (0.07) A	47.53 (0.10) A	47.55 (0.06) A

Means followed by different letters in the horizontal plane differ according to Tukey's test ($p<0.05$). Means followed by * differ from the plaster cast according to the Dunnett test ($p<0.05$).

Table 2: Percentage alterations (%) of the distances analyzed, according to the number of cycles (1, 5, 10 and 15) of reuse and groups.

Distances	AB		BC		CD		AD		BD		AC	
Brands	VIPI	K27	VIPI	K27	VIPI	K27	VIPI	K27	VIPI	K27	VIPI	K27
1	-1.25 A*	–1.87 A	0.85 A	0.31 A	-0.18 A	0.34 A	50.76 A*	0.59 A	0.58 A*	0.33 A	0.44 A	0.33 A
5	–1.20 A*	-0.54 A	-0.36 A	-0.75 A	-0.58 A	-0.59 A	-0.10 A	-0.30 A	-0.12 A	-0.52 A	-0.56 A	-0.51 A
10	0.37 A	-0.05 A	0.83 A	0.48 A	-0.06 A	-0.34 A	0.65 A*	0.45 A	0.46 A	0.32 A	0.69 A	0.36 A
15	0.58 A	-0.04 A	0.44 A	0.06 A	-1.13 A	0.01 A	0.52 A*	0.16 A	-0.04 A	0.12 A	0.64 A	0.23 A

Means followed by different letters in the horizontal plane differ according to Tukey's test ($p<0.05$).

RH reuse cycles of group VIPI, corresponding to an expansion percentage of 0.76% and 0.65% and 0.52% respectively (Table2). The distance BD showed dimensional alteration in the refractory models coming from the first HR use cycle of group VIPI, corresponding to an expansion of 0.58%. The distances BC, CD and AC did not show any linear dimensional alterations when compared to the reuse cycles and the experiment (Table 1).

DISCUSSION

One of the critical phases during the manufacture of an RPP is the phase during which the working model is duplicated with RH, which may be reused, provided that it does not harm its chemical and physical properties or the dimensional stability of the mold obtained[4,7].

This experiment found that the linear dimensions of the refractory models expanded by 0.52% - 0.76% in group VIPI for distances AD (1st use, 10th and 15th reuse) and BD (1st use). According to the literature, expansion values of about 1% are acceptable, and do not lead to any clinical damage[2]. The expansion observed is due to the thermal expansion of the coating. However, even though these values show statistical differences, they are within the values considered acceptable.

It should be taken into consideration that although there was statistical difference in group VIPI ($p<0.05$), there was low variability of samples, so that small variations were significant. However, in clinical terms, these values are negligible[2].

The values for distance AB (1st and 5th reuse) showed a contraction percentage of about 1.25% in group VIPI. This may be due to the process of syneresis that occurs in the RH structure[5] or to an alteration of the mold during the removal of the plaster model, producing an altered refractory model[1].

With regard to the process of syneresis that may influence the RH structure and consequently the model obtained from this RH, RH is a material composed of 8 to 15% agar and over 75% water[5]. Agar is a linear polymer and a hydrophilic colloid, and the change from the solid state to gel is activated thermally, leading to a linking of the colloid particles, forming the fibrils. These become larger molecular networks with water-filled spaces[4]. Thus, the loss of water alters the fibril network, leading to an alteration in its structural composition, causing the material to age and degrading its visco-elastic properties[4]. These alterations possibly induce a one-directional contraction[11], and lead to decreased resistance to the compression of the duplicator material as a result of successive melting-setting cycles.

Heating RH in an open container and storing it in solid sate may be faster methods, which may be why they are more often used in prosthetic laboratories[4]. However, these methods may cause faster deterioration in the RH composition.

Moreover, considering the importance of water in the RH composition, it is essential to preserve it during the duplication process so that dimensional alterations do not occur by syneresis, imbibition or evaporation[5]. In this case, the use of a closed container during RH melting should always be recommended, so that the least amount of water is lost. In this experiment, RH was heated in a microwave oven in a closed container, and upon opening the container, all the water contained in the lid was poured back into the container, in order to preserve the HR water content[15].

Factors such as control of the relative humidity of the air and ambient temperature are commonly reported in literature[5,10,17,18] but when a real situation in a prosthesis laboratory is simulated, such factors are not usually observed. This experiment was carried out under conditions that simulated a conventional prosthetic laboratory with only ambient temperature being controlled at about 20°C. This may also have contributed towards a certain rate of syneresis in RH having occurred during its setting period, resulting in contraction of the mold[5], which may have generated contraction of the distance AB in the 1st use and 5th reuse of group VIPI. On the other hand, the mold was immediately filled by the coating, in order to minimize any further distortions[5,17].

In this experiment, the behavior of group VIPI differed from that of group K27 RH. The compositions of the materials investigated are probably different with regard to the respective proportions of each of their chemical components. These relative proportions are not usually provided by the manufacturer, but may, as a result of the quantity and quality of fibrils formed, admit greater or lesser dimensional contraction[4], thus explaining the results found in this experiment that indicate linear alterations only in group VIPI.

The linear dimensional alterations in refractory models may lead to damage in the RPP, as good adaptation is directly connected to the faithfulness of the working model and the refractory model[19].

This being so, it was found that even after 15 cycles of reuse of the two groups analyzed, they produced refractory models with acceptable linear alterations, reuse being indicated up to the 15th cycle, under the same conditions as those established in this experiment.

CONCLUSION

Within the conditions and limitations of this study, it is concluded that both commercial brands analyzed produced coating models with acceptable linear alterations in up to 15 re-use cycles, no statistical differences being observed between them.

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