The influence of disinfectant agents on the dimensional stability of elastomeric impression materials and surface durability of odontological gympsun*

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Abstract

The dental office is a means of cross-microbrial contamination, requiring disinfection of impressions and models through disinfectant solutions. The impression materials can absorb water and the salts from the disinfectant agents, eventually these impregnate the surface of the impressions and are transferred to the surface of the gympsum, damaging its properties. This study evaluated the dimensional change of two elastomers immersed in two different disinfectant solutions and the Rockwell hardness of the stone cast after contact with the disinfected impression. For each elastomeric material fifteen impressions were made from a stainless steel matrix: five were immersed for 10 minutes in a solution of glutaraldehyde 2%, five in formaldehyde 20 g and the other five formed the control group. With a measuring microscope the dimensional change was verified. Using type IV gypmsum casts applied to the surface of the models and separated 40 minutes after its pouring, after 24 hours the Rockwell hardness was obtained with a Hardness Tester. In regard to dimensional change, the results obtained allowed for the following conclusions: a) all groups suffered contraction; b) there was no statistically significant difference (p<0.05) between the Xantopren VL plus and the 3M Express, with the exception of the group immersed in the glutaraldehyde, in which the 3M Express suffered greater contraction; c) for the Xantopren VL plus there was no statistically significant difference (p<0.05) among all the groups; d) for the 3M Express there was only a statistically significant difference (p>0.05) between the control group and those immersed in glutaraldehyde. There was no statistically significant difference (p<0.05) in the surface hardness of the odontological gypmsums.

Uniterms

Elastomers for moulding, disinfection

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Resumo

O consultório odontológico é um meio de contaminação microbiana cruzada, exigindo desinfecção de moldes e modelos mediante soluções de desinfecção. Os materiais de moldagem podem absorver água e os sais dos agentes de desinfecção eventualmente impregnam a superfície dos moldes e são transferidos para a superfície do gesso, prejudicando as suas propriedades. Este trabalho avaliou a alteração dimensional de dois elastômeros imersos em duas diferentes soluções de desinfecção e a dureza Rockwell do modelo de gesso após o contato com o molde desinfectado. Para cada elastômero foram confeccionados quinze moldes a partir de uma matriz de aço inoxidável: cinco foram imersos por 10 minutos em solução de glutaraldeído 2%, cinco em formaldeído 20 g e os outros cinco formaram o grupo controle. Com microscópio medidor verificou-se a alteração dimensional. Usando modelos de gesso tipo IV aplicados à superfície dos moldes avaliou-se a dureza Rockwell com o microdurômetro por 24 horas. Quanto à alteração dimensional, os resultados obtidos permitiram concluir: a) Todos os grupos sofreram contração; b) Não houve diferença estatisticamente significativa (p<0,05) entre o Xantopren VL plus e o 3M Express, com exceção do grupo imerso em glutaraldeído, em que o 3M Express sofreu maior contração. c) Para o Xantopren VL plus não houve diferença estatisticamente significante (p<0,05) entre todos os grupos; d) Para o 3M Express só houve diferença estatisticamente significante (p>0,05) entre os grupos controle e imersos em glutaraldeído. Não houve diferença estatisticamente significante (p<0,05) na dureza superficial dos gessos odontológicos.

Unitermos

Elastômeros para moldagem, desinfecção

Introduction

The dental office is considered a risk factor in regard to infectious diseases, which can be transmitted by direct contact through blood, saliva or by indirect contact through contaminated instru-

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ments, equipment, accessories, impression materials or by inhalation of aerosol. The transmission of Hepatitis B, AIDS (Acquired Immune Deficiency Syndrome), herpes and tuberculosis, among others are know to have occured[1-6, 9, 12, 15].

The survival of microorganisms is known to have taken place in impression materials and gypsum casts, the latter being a means of cross transmission between patient and laboratory professional.

The control of microbial populations has been applied to the most diverse sectors of our life, from the conservation of perishable products to the sterilization of surgical instruments. There are two forms through which agents utilized in this control can act, physically or chemically.

There are many terms related with the control of microorganisms, such as: sterilization, disinfection, asepsis, pasteurization and sanitization. Because we are dealing with the control of microorganisms in impression materials and casts we will utilize the terms sterilization and disinfection, which in turn should be defined.

Sterilization is a process of the destruction of all life forms present in a material, through chemical agents or physical agents. Although sterilization is obtained with chemical agents such as toxic gases, generally physical agents are used, such as heat (hot or humid, depending on the material to be utilized), radiation and filtration.

The main objective of disinfection is to reduce the number of microorganisms present in an object or corporal surface. An ideal disinfectant would be able to act instantly on microorganisms, without causing damage to material or tissue. In practice such an agent does not exist and the choice of the compound depends on the characteristics of the area to be treated.

Two widely used disinfectants related to impression materials are glutaraldehyde and formaldehyde.

Formaldehyde is limited because of its strong, irritating and penetrating odor. The use of formaldehyde at 10% is very common for the disinfection of surgical instruments and contaminated environments. In addition to formaldehyde being an efficient bactericide it is also a sporicide and virucide, its strong coagulating action on proteins is responsible for bacteriostatic characteristics.

Formaldehyde in solution is utilized for the sterilization of some instruments. In gaseous form it can be utilized for the disinfection and sterilization of closed areas. Humidity and temperature have a great influence on the germicidal action of formaldehyde. Used in the gaseous form it presents a low strength of penetration and acts very slowly.

Approximately eleven years ago testing began on glutaraldehyde 2%, it has demonstrated rapid bactericide, fungicide, sporicide, and virucide action and also has the advantage of not attacking instruments in general (metalic, plastic and optical). It does not have an irritating odor, and is even more efficient than formaldehyde. As of this period, glutaradehyde began to be used in the sterilization of delicate objects such as fiber optic instruments[1-4, 9, 15].

Sterilization is unfeasible when we deal with impression and cast materials and in view of their chemical composition, disinfection is left for the control of cross-infection, however, the action of these disinfection agents with chemical action, many times presented in solution form, can influence the chemical composition of impression and cast materials.

The difference of hydric concentration in the contact of model with the disinfection agent can allow for a search for hydric balance with the gain or loss of water of the elements in contact, which many times generates a dimensional change in the impression material. In addition, the chemical agent employed in the disinfection can remain impregnated in the surface of the model and react on the surface of the cast material, of which the most commonly used are odontological gypsum products.

The disinfection agents can interfere in the chemistry of the setting reaction of the gypsum products, consequently altering their physical properties. Within these reactions, the surface hardness is of great influence in laboratories; the hardness prevents degradation during the wax sculpture, which requires cutting with sharp instruments.

The impression material should be a faithful negative copy of the patient's anatomical structures and the cast material should be a faithful positive copy so that any prosthesis may have perfect adaptation.[5] Any dimensional change in the impression or any degradation in the cast generate maladaptation in the prosthesis. Any lack of adaptation of the prosthesis decreases its longevity, many times with early loss because of the reoccurrence of decay. Clinical success for a prosthesis depends on the fidelity of the impression reproduction and cast details, therefore the knowledge of the physical properties, such as dimensional stability for impression material and surface hardness for cast material, is important, because, during laboratory procedures these materials face problems related to contraction, expansion and fractures.

In view of the recent problems mentioned, it was decided to evaluate the dimensional changes which can take place, especially in condensation and addition type silicones, when immersed in chemical disinfectant solutions such as: glutaraldehyde 2% and formaldehyde 20g with the purpose of decreasing or even eliminating contaminations, and still, evaluate the hardness of the odontological gypsum product which will make contact with them.

MATERIALS AND METHODS

Materials

The dental materials, which were utilized, are elastomeric impression materials, more specifically addition type and condensation silicones mentioned in Picture 1. Gypsum was used for the Type IV cast indicated (Picture 2).

Silicones are currently the most utilized impression materials for obtaining a faithful copy of hard tissues of the oral cavity. These materials have evolved a great deal with the search for greater facilities in use and greater affinity with the stone and with mouth tissues.

Type IV casting stones are obtained from gypsum in a manner that a lower quantity of water is needed for hydration, which consequentially increases its mechanical resistance and surface hardness. In this manner they are utilized for cast where wax is sculptured for the coronary standard in which sharp cutting instruments are used which would cause degradation if there were no surface hardness.

METHOD

Preparation of test specimens

For the test specimens a stainless steel matrix was adapted for our experiment from indications in specification No. 19 of the American Dental Association for elastomeric materials according to Figure 1.

Preparation of individual molds

For each elastomeric impression material 15 individual molds were made, therefore totaling, thirty molds in chemically activated acrylic resin (JET, classic dental articles).

For the preparation of these molds, a sheet of No. 7 wax was cut into the dimensions of the upper cylinder of the metal matrix and served as a spacer where later this space was filled with the impression material.

Picture 1 – Elastomeric impression materials

MATERIAL	TYPE OF ACTIVATION	MANUFACTURER	TYPE OF MIXTURE
3M EXPRESS ®	Addition-reaction	3M of Brail	Mechanical
XANTOPREN VL PLUS ®	Condensation-reaction	Heraus Kulzer	Manual

Picture 2 – Cast material

MATERIAL	MANUFACTURER	TYPE OF MIXTURE
VEL-MIX®	SDS Kerr	Manual

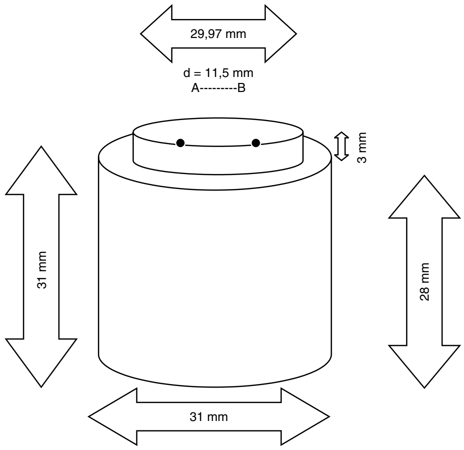

Figure 1 – Steel Matrix.

The acrylic resin was manipulated according to the manufacturer's instructions. The resin was used in the plastic stage. Then the resin was place on a glass slab (2cm) and another glass slab with the same dimensions was placed on top of the first and 1kg of pressure was applied so that a uniform thickness could be obtained. This, then, was immediately taken to the superior part of the matrix, being adapted to 1/3 of the base height of the stainless steel matrix and left to set. Within the work time, a handle in the upper and central part of the mold was formed to facilitate the act of molding. After 24 hours the molds received finishing and polishing and perforations were made in them with a no. 8 spherical bit in a hand piece (Calú) so that these perforations could serve as retentions for the impression material in the act of making the impression.

Impression

The impression material Xantopren VL plus was manipulated according to the manufacturer's instructions with the help of a glass slab and a No. 36 spatula (Duflex).

Still with the assistance of the No. 36 spatula (Duflex), within the work time, according to the manufacturer's instructions, the material was taken to the individual mold and to the surface of the matrix where the two points A and B were located and the impression of the stainless steel matrix was carried out. After the setting time determined by the manufacturer, the impression was removed from the matrix model. The impressions were evaluated regarding quality, in cases where there was error in the impression the step was repeated.

The mixture of the 3M Express impression material was done mechanically in the correct proportions and applied directly onto the mold so that the molding was carried out.

After the time stipulated by the manufacturer, the mold was removed and also evaluated regarding the impression quality. The molds were immediately washed in running water for the period of 1 minute (clocked) simulating a clinical situation.

Experimental treatment: immersion in disinfectant solutions.

The impressions (molds in acrylic resin with elastomeric material) were immersed in disinfectant solutions: glutaradhyde solution 2% (Cidex 28/ J&J) and formaldehyde 20g (Microcide / Odontologia Americana Ltda).

Five impressions of each material were immersed in one of the disinfectant solutions for a period of 10 minutes. Five others did not receive any experimental treatment, which were considered control specimens, and they were taken directly for reading in the measurement microscope, responsible for measuring the dimensional change.

After being immersed 10 minutes in the disinfectant solutions the impressions were washed again in running water for 1 minute.

The excess water was removed with a paper towel and then the measurements of dimensional change were taken and the cast were made.

Preparation of the casts.

Type IV odontological gypsum was manipulated according to the manufacture's guidelines (ratio water/powder = 0.23). The gypsum powder was weighed in a semi-analytical scale (100g) and the water measured in a test tube (23ml).

Vigorous manipulation was executed in one minute with the assistance of a spatula for gypsum and the impression was filled with the assistance of the same spatula for gypsum.

The mixture filled the five impressions with excess; therefore each cast would have a thickness of at least 1.5cm. After executing the stone casting, it was left to set for 40 minutes and stored for a period of 24 hours to acquire its dry resistance and then the casts were tested in a Hardness Tester.

Experimental test: dimensional stabilityand Hardness

Dimensional Stability.

The dimensional change of the impression materials was verified by means reading of the distance between points A and B, in a comparison microscope ERNEST LEITZ (Germany).

The readings were made on the casts submitted to experimental treatment and the control specimens. In this manner, with the data collected, comparative values could be obtained for the dimensional evaluation.

Surface hardness.

The gypsum casts were taken to a microdurometer Mitutoyo (Japan) whose measurements were given in Rockwell hardness.

The pre-load (adjustment load) was10Kgf and the main load 100kgf for the penetrating spherical point of the stainless steel (3.17mm.) utilized for this experiment (scale 17E red).

For each gypsum cast two readings were made, one in the center of the model and the other at a distance of 1 cm from the first. Following, the arithmetic mean of the two readings was calculated (the impressions of Rockwell hardness should be spaced at least 3 times the diameter one from the other to avoid interference between them).

Statistical analysis

The results obtained in this study of dimensional change and surface hardness were submitted to an analysis of multifactoral variance and for individual comparisons, they were applied to the Tukey Test ($p < 0.05$).*

Results

The results obtained from the readings of dimensional change and surface hardness are demonstrated in Pictures 3 and 4 and in Figures 1, 2, 3 and 4.

Picture 3 - Measurement of experimental test readings

IMPRESSION MATERIAL	IMMERSION SOLUTION	READING MEASUREMENTS OF DIMENSIONAL CHANGE (mm)	FINAL MEASUREMENTS OF SURFACE HARDNESS (HR)
XANTOPREN	CONTROL	11.38 (s=0.21)	45,50 (s=4.56)
	GLUTARALDEHYDE	11.40 (s=0.07)	46,75 (s=4.99)
	FORMALDEHYDE	11.36 (s=0.07)	45,85 (s=4.28)
3M EXPRESS	CONTROL	11.34 (s=0.14)	47,00 (s=1.43)
	GLUTARALDEHYDE	11.02 (s=0.32)	46,50 (s=5.64)
	FORMALDEHYDE	11.14 (s=0.17)	49,80 (s=10.63)

* SANEST – SISTEMA DE ANALISE ESTATÍSTICA (System of Statistical Analysis) - Authors: Elio Paulo Zonta – Amauri Almeida Machado – Empresa de Pesquisa Agropecuária de Minas Gerais (Minas Gerais Agricultural Research Company) – EPAMIG – CALCULATION OF STATISTICS – FILE: ANAP1

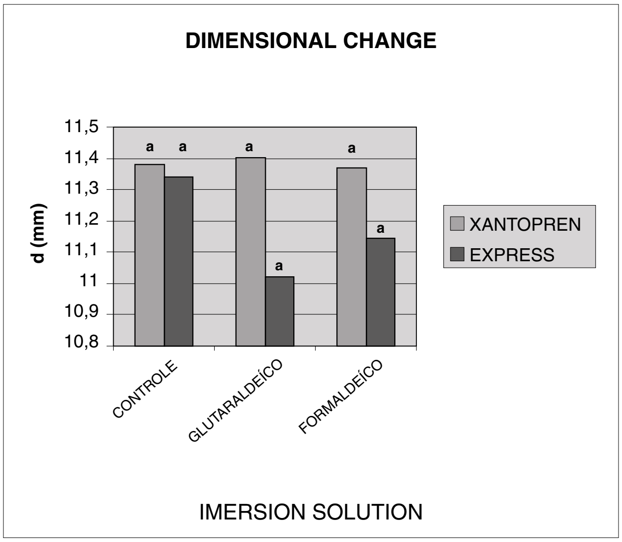

FIGURE 2 - Graphic illustration of the dimensional change measurements of impression materials due to desinfection agent. Measurements followed by distinct letters differ among themselves at a level of 5% significance indicating D.M.S. 5% = 0.24629. The letters are only valid for bars linked graphically together.

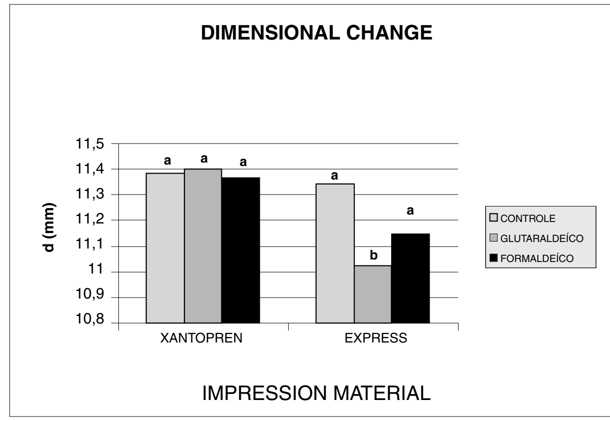

FIGURE 3 - Graphic illustration of the dimensional change measurements of impression materials for each desinfection agent. Measurements followed by distinct letters differ among themselves at a level of 5% significance indicating D.M.S. 5% = 0.29774. The letters are only valid for bars linked graphically together.

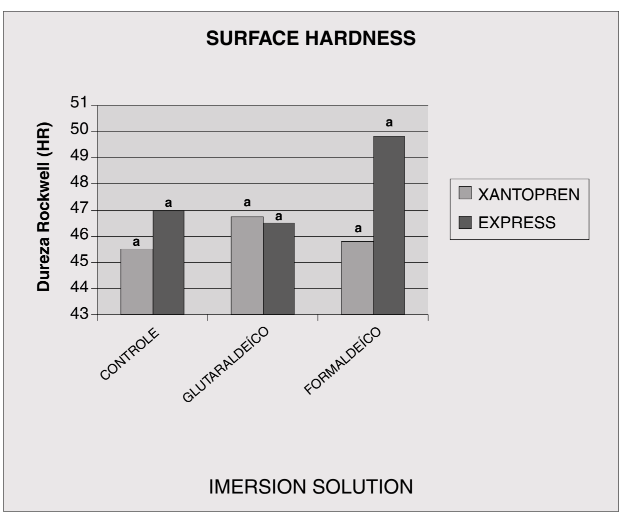

FIGURE 4 - Graphic illustration of the surface hardness measurements of gypsum (cast material) that was contacted with impression material due to immersion solution. Measurements followed by distinct letters differ among themselves at a level of 5% significance indicated D.M.S. 5% = 7.74511. The letters are only valid for bars graphically linked among themselves.

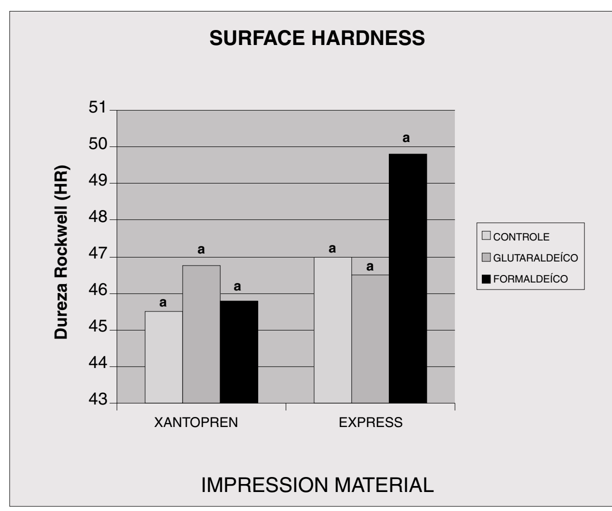

FIGURE 5 - Graphic illustration of the surface hardness measurements of gypsum that was contacted with immersion solutions for each impression material. Measurements followed by distinct letters differ among themselves at a level of 5% significance indicated D.M.S. 5% = 9.36310. The letters are only valid for bars graphically linked among themselves.

DIMENSIONAL CHANGE

It can be observed through Table 3 that all materials suffered contraction.

Figure 1 demonstrates that there was no statistically significant difference ($p<0.05$) between the Xantopren VL Plus and 3M Express materials, with the exception of the group where the materials were immersed in glutaraldehyde, where the 3M Express suffered greater contraction than the Xantopren VL Plus with a statistically significant difference ($p>0.05$).

Figure 2 demonstrates that for the Xantopren VL Plus material there was no statistically significant difference ($p<0.05$) between the control groups and those immersed for 10 minutes in the experimental solutions: formaldehyde 1% and glutaraldehyde 2%.

However, for the 3M Express material, the immersion in glutaraldehyde 2% solution favored contraction, demonstrating the greatest dimensional change, followed by the formaldehyde solution and then the control group, which suffered the least contraction. There was a statistically significant difference ($p>0.05$) between the control group and the glutaraldehyde group, however the group where the material was immersed in the formaldehyde did not differ statistically ($p<0.05$) from the control group and the group immersed in the glutaraldehyde.

SURFACE HARDNESS

It can be observed by Figure 4 and 5 that the immersion of the casts in the gularaldehyde and formaldehyde solutions did not interfere in the surface hardness of the gypsum, because there was no statistically significant difference ($p<0.05$) between the control immersed in glutaraldehyde and formaldehyde group to the Xantopren VL Plus and 3M Express materials.

DISCUSSION

The elastomeric impression materials are divided into polysulfides, silicones and polyethers. These materials have use in Odontology as impression materials for delicate retentative anatomical structures and precision structures. The polysulfides and polyethers, because they do not present good elastic recovery, among other proprieties, are less utilized. The silicones have been widely used and are divided into addition reaction silicones and condensation reaction silicones, because of their polymerization. The condensation reaction silicone, as opposed to the addition reaction silicone, presents the formation of by-products, which can volatilize and favor dimensional change, however both silicones have a hydrophobic nature.[17]

The aversion to water of the silicones can harm the act of impression, because the buccal cavity is an aqueous environment. In addition to this, the impression could be damaged, because the most utilized cast material is dental gypsum and this requires water for its manipulation and presents water in its composition.[17]

Due to these problems hydrophillic addition reaction silicones were developed, however these silicones can suffer greater dimensional changes when immersed in aseptic solutions, the topic of this study.[17]

In this study condensation reaction silicone Xantopren VL Plus and 3M Express addition reaction silicone, both hydrophobic, were used. The addition reaction hydrophillic silicones were not used due to the elevated cost and non-donation of these materials on the part of manufacturers.

These materials were not statistically different ($p<0.05$) in relation to the dimensional change after setting (control), as well as when immersed in formaldehyde 1% solution (Graph 1). These findings agree with Lagenwalter[10] et al who in their 1990 study did not find a statistically significant difference between the materials, and the association of desinfection agent/impression material did not demonstrate significant linear dimensional change. This author, however, analyzed elastomeric materials, which were very different chemically. When the materials were immersed in glutaraldehyde 2% solution there was a statistically significant difference ($p>0.05$) where the 3M Express changed more than the Xantopren VL Plus.

It can be observed for all the groups, in relation to dimensional change (Pictures 1 and 2), there was contraction of material, which agrees with the reports from Oda[15] in 1995. All polymerization is accompanied by contraction.[17] Part of this contraction occurs while the material is still plastic, which would not have clinical significance, and part would be occurring with the advance of the setting process after the impression act.

When we consider that the material had set, there was not always contact and chemical reaction among all the reagents. The contraction, which occurred during the advance of setting after of impression, is observed with the removal from the mold due to the elasticity of the material.

Possible reagents not having reacted after the removal of the mold could be lost to the environment depending on the reagents affinity with it.

This could explain what happened with the 3M Express immersed in the glutaraldehyde 2%, which differed statistically from the other groups (Graph 1 and 2), which disagrees with Adabo et al.[1], who did not find statistically significant differences among the materials immersed in the disinfectant solutions.

The majority of asepsis agents are aqueous solutions with some chemical additive, in which, upon contact of two hydrophilic non-soluble substances, there would be permeability of one with the other in search of hydric balance. This could demonstrate the effect on the dimensional change, especially if a hydrophilic silicone had been utilized. Future study could evaluate a situation like this [12].

Also in relation to the surface hardness of the odontological gypsum, it can be observed through Graphs 3 and 4, that there was no statistically significant difference ($p<0.05$) in the surface hardness of the gypsums which set in contact with the elastomeric materials Xantopren VL Plus and 3M Express, immersed or not in the glutaraldehyde 2% and formaldehyde 1% solutions for asepsis.

It is known that some aqueous saline solutions are chemical additives in odontological gypsum, controlling the velocity of the chemical reaction and expansion of setting of this material, however they are substances, which affect the physical-mechanical properties such as the surface hardness[16]. These substances deposit themselves among the crystals in formation during setting of the gypsum preventing its interception and with this decrease its mechanical resistance, as well as the surface hardness.

These products are utilized by manufacturers, which make a balance in the properties.

Chemical additives, which remained impregnated on the surface of the mold could affect the resistance of the surface of the cast[14]. This did not occur in this study due to the hydrophobicity of the impression material or due to the short period of exposure of the mold to the asepsis agents.

Also Alves-Rezende & Lorenzato[2], in 1999, found that spraying disinfectants does not affect the adaptation of stone and the impression material, however their study did not evaluate the surface hardness of the stone and impression material. However Bombonatti et al.[4], in 1996, found that the immersion of models in aseptic solutions longer than 10 minutes caused damage in the adaptation of the gypsum, but this study also did not evaluate the surface hardness.

Garcia et al.[6] witnessed change in the surface quality of gypsum, which set in contact with molds previously immersed in disinfectant solutions.

Therefore, this study demonstrated the necessity of additional studies in dimensional change of elastomers and surface hardness of gypsum, which come into contact with them, which includes other elastomeric material, especially hydrophilic addition silicones, as well as other aseptic solutions with varied immersion times, because we know that it is possible to obtain even sterilization with certain solutions with immersion times which vary from 10 to 24 hours.

CONCLUSIONS

Dimensional Change

All groups suffered contraction

There was no statistically significant difference ($p<0.05$) between Xantopren VL plus and 3M Express with the exception of the group immersed in the glutaraldehyde, where the 3M Express suffered greater contraction.

For the elastomeric impression material Xantopren VL plus, there was no statistically significant difference ($p<0.05$) among the control groups and those specimens immersed in glutaraldehyde and formaldehyde.

For the elastomeric impression material 3M Express, there was no statistically significant difference ($p<0.05$) between the control groups and the groups immersed in formaldehyde nor between the groups immersed in glutaraldehyde and formaldehyde, however there was statistically significant difference ($p>0.05$) between the control groups and the groups immersed in glutaraldehyde.

Surface Hardness

There was no statistically significant difference ($p<0.05$) in the surface hardness of the odontological gypsum when in contact with the elstomeric impression material Xantopren VL plus and 3M Express immersed or not in disinfectant solution.

The results suggest that new studies should be done, analyzing greater immersion times, which guarantee a more efficient disinfection, as well as the use of other elastomeric materials.

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