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Dimensional accuracy of different impression techniques of partially edentulous mandibular arch

Precisão dimensional de diferentes técnicas de moldagem de uma mandíbula parcialmente edêntulo

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ABSTRACT

Objective
The purpose of this in vitro study was to assess and compare the dimensional accuracy of three impression techniques: 1-step putty/light-body, 2-step putty/light-body, and the monophase technique.

Methods
A partially edentulous standard stainless steel mandibular arch cast with reference points on the teeth was used to make the impressions. The anteroposterior and transverse distances were measured. All impressions were made with a polyvinyl siloxane using stock metallic (1- and 2-step putty/light-body techniques) or acrylic resin (monophase technique) trays. The monophase impressions were made using a light-body material and the 1- and 2-step putty/light-body impressions with putty and light-body materials. After impression procedures, the accuracy of each technique was assessed measuring the stone casts (n = 5) poured from the impressions using a microscope at 30x magnification and at 0.5 µm accuracy. The data were analyzed statistically using 2-way ANOVA and Tukey's test (p<0.05).

Results
Stone casts made by all techniques had significantly negative linear changes (shrinkage). The anteroposterior distances showed more dimensional changes than the transverse distances. The edentulous side showed more shrinkage than the anteroposterior side.

Conclusion
No differences between the impression techniques were found, but significant dimensional changes were observed.

Indexing terms: *Dental impression technique. Elastomers. Jaw, edentulous, partially.*

RESUMO

Objetivo
Avaliar e comparar a precisão dimensional de três técnicas de moldagem: dupla mistura, reembasamento e moldeira individual.

Métodos
Um modelo metálico inferior parcialmente edêntulo foi fabricado com pontos de referência nos dentes e usado para fazer as moldagens. As distâncias ântero-posteriores e transversais foram medidas. Todas as moldagens foram feitas com um silicone por adição utilizando moldeiras metálicas (técnicas da dupla mistura e reembasamento) ou de resina acrílica (técnica da moldeira individual). Na técnica da moldeira individual foi utilizado apenas o elastômero de viscosidade leve e nas técnicas da dupla mistura e reembasamento foram usados os elastômeros nas viscosidades denso e leve. Após os procedimentos de moldagem, a precisão dimensional de cada técnica de moldagem foi avaliada aferindo os modelos de gesso (n = 5) em um microscópio comparador com 30x de aumento e 0,5 µm de precisão. Os dados foram analisados estatisticamente por ANOVA dois fatores e teste de Tukey (p<0,05).

Resultados
Os modelos de gesso feitos com todas as técnicas de moldagem apresentaram alterações lineares negativas (contração). As distâncias ântero-posteriores apresentaram maiores alterações dimensionais que as distâncias transversais. O lado parcialmente edêntulo teve maior contração que o lado ântero-posterior oposto.

Conclusão
Não foram encontradas diferenças entre as técnicas de moldagem, mas foram observadas significantes alterações dimensionais.

Termos de indexação: Técnica de moldagem odontológica. Elastômeros. Arcada parcialmente edêntula.

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INTRODUCTION

A denture fitted to the oral cavity is important for long-term prosthetic treatment success[1]. A complete prosthetic treatment involves several clinical and laboratory procedures, such as impressions, cast/die pouring and prosthesis fabrication[1-2]. Errors can occur at any of these steps and may result in a prosthetic misfit[1,3-4]. Therefore, the impression material plays an important role in minimizing errors when producing accurate replicas of the oral structures[1,4].

The elastomeric impression materials are materials with high accuracy and have been used in dentistry since the 1950s. There are four types of elastomeric impression materials: polyether, polysulfide, condensation and addition silicones (polyvinyl siloxanes). Each one of these displays individual physical properties and specific chemical and setting reactions[5-6].

The polyvinyl siloxanes are elastomeric and polymerized by an addition reaction. They were introduced to dentistry in the 1970s. These impression materials are hydrophilic and present adequate properties, such as good tear strength and quick elastic recovery, along with excellent accuracy and dimensional stability[5-6]. The different viscosities allow them to be used in three impression techniques: 1-step putty/light-body, 2-step putty/light-body, and monophase[6-8].

Several factors affect the dimensional accuracy of elastomeric impression material molds, such as the type of impression material used and its adhesion to the tray, viscosity, hydrophilicity, thickness, by-product formation, the time spent during cast pouring, incomplete elastic recovery, and polymerization/thermal shrinkage[7-8].

Several studies showing differences in dimensional accuracy between the impression techniques are found in literature[8-15]. Conversely, other studies show similar outcomes between different impression techniques[7,16-17] or only small differences within a specific group of elastomeric impression materials[18]. Therefore, there is conflicting evidence on impression techniques. In addition, the majority of these studies use a cast with abutments and grooves to assess the linear accuracy of impressions and not a cast simulating clinical situations. Another issue within the evaluation of impression procedures is the volume of impression material used[9,13]. A mold with a non-uniform thickness of impression material, either by excessive or thin zones in the same impression, may show different shrinkage levels, thereby decreasing the dimensional accuracy of the stone casts[13]. This is commonly observed with partially edentulous patients, a common situation in clinical dentistry.

The aim of this study was to evaluate the dimensional accuracy of 1-step putty/light-body, 2-step putty/light-body and monophase techniques on stone casts made from a stainless steel cast simulating a partially edentulous mandibular arch and using a polyvinyl siloxane impression material. The hypotheses were that (1) differences would exist in the dimensional accuracy between the impression techniques and (2) differences would exist between the distances used in the measurement of dimensional accuracy.

METHODS

A partially edentulous standard stainless steel mandibular arch cast was made with reference points[19] on the mandibular right second molar, mandibular left second molar, mandibular right canine and mandibular left canine. The transverse distances between the mandibular right canine/mandibular left canine (distance 1) and mandibular right second molar/mandibular left second molar (distance 2), and the anteroposterior distance between mandibular right canine/mandibular right second molar (distance 3) and mandibular left canine/mandibular left second molar (distance 4) were measured using a stereomicroscope (Olympus Measuring Microscope STM, Olympus Optical Co., Tokyo, Honshu, Japan) at 30x magnification.

A polyvinyl siloxane (Aquasil, Dentsply, Petrópolis, Rio de Janeiro, Brazil) was handled according to the manufacturer instructions and the impressions were made in an environment with controlled temperature and relative humidity (23°C ± 2°C and 50% ± 10%).

The monophase technique was performed using acrylic resin trays (Vipi Flash, VIPI, Pirassununga, São Paulo, Brazil) with internal relief (2 mm)[7]. Initially, an adhesive layer (Universal Adhesive, Heraeus Kulzer GmBH, Hanau, Hesse, Germany) was applied to each acrylic resin tray and allowed to dry for five minutes[7]. The elastomeric impression material (type III) was placed on the internal surface of the acrylic resin tray. For the 1-step putty/light-body technique, the putty (type 0) and light-body (type III) materials were handled at the same time. Metallic stock trays (I-3) were used (Tecnodent, Casalecchio di Reno, Bologna, Italy). Both viscosities (putty and light-body) were handled with plastic gloves to avoid inhibition of the polymerization reaction by contaminants of the latex gloves. For the 2-step putty/light-body technique, a 2 mm thick polypropylene spacer was

placed on the stainless steel cast to form a space (relief). A preliminary impression using a metallic stock tray (I-3) with putty (type 0) material was performed. The polypropylene spacer was removed and the light-body (type III) material was handled and placed on the putty material. The tray was reseated on the stainless steel cast to make the second impression.

For the three impression techniques, the prepared impression tray was seated on the stainless steel cast using a pneumatic device to control the seating positioning and load. Moreover, the tray removal was standardized using the same pneumatic equipment to avoid deformations in the mold[7,20].

A ratio of 150 g of type IV dental stone (IV Durone, Dentsply) to 28.5 ml of water was used to fill the molds (n = 5). The sample size was determined according to previous studies[17,21-22] which demonstrated that 5 samples had an adequate power to detect statistical differences between groups. Three readings were performed for each distance by a single calibrated operator and the means were recorded.

The original values of dimensional changes were converted to percentages. Negative values indicated a decrease of the distances (shrinkage) and positive values indicated a volume increase (expansion). The data were tabulated statistically and descriptively using tables and analyzed using 2-way ANOVA with Tukey's test ($p<0.05$)

RESULTS

Table 1 shows the means of the dimensional changes for each impression technique and distance. Two-way ANOVA showed that distance 3 presented the highest values of dimensional change, for all impression techniques, followed by distances 4 and 1, which were also statistically different ($p<0.05$). For the 1-step putty/light-body and monophase techniques, distance 2 showed the lowest values of dimensional change ($p<0.05$); however, in the 2-step putty/light-body technique, this distance was not different from distance 1 ($p>0.05$). No significant difference was found ($p>0.05$) within each distance when the impression techniques were compared.

Table 1. Mean dimensions (SD) of stone casts according to impression technique.

Technique	Monophase	1-step	2-step
distance 1	-0.041 (0.015) c, A	-0.037 (0.008) c, A	-0.034 (0.012) c, A
distance 2	-0.026 (0.010) d, A	-0.022 (0.006) d, A	-0.035 (0.009) c, A
distance 3	-0.293 (0.014) a, A	-0.303 (0.012) a, A	-0.252 (0.007) a, A
distance 4	-0.185 (0.009) b, A	-0.146 (0.013) b, A	-0.172 (0.011) b, A

Note: Means followed by different small letters in column and capital letters in row are statistically different at 5% by Tukey's test.

DISCUSSION

The results of the present study corroborate with other studies[7,12-13] which claim that dimensional accuracy is not affected by the impression technique. Thus, the first hypothesis was rejected. All transverse distances were observed to have had less percentage change than the anteroposterior distances, so the second hypothesis was accepted. This study utilized a polyvinyl siloxane that showed that all of the impression techniques provided similar dimensional accuracy while also producing accurate stone casts. The polyvinyl siloxanes are impression materials used in clinical dentistry due to several factors, such as handling characteristics, physical properties, and dimensional stability[5]. Moreover, impressions created with this type of elastomeric impression material can be obtained by different impression techniques[7-8].

Some authors[8,10-15] have demonstrated that the impression technique is a critical factor which directly influences the dimensional accuracy. However, in this study, the dimensional accuracy of a partially edentulous mandibular arch is related more to the type of impression material than the impression technique[7,16-17]. The 2-step putty/light-body technique was initially developed to decrease the problems of polymerization shrinkage for condensation silicones[18]. Therefore, this technique is also recommended for polyvinyl siloxanes to promote better dimensional stability.[5,18] The controversial findings in previous investigations regarding impression techniques may be explained partly by the different protocols and materials used, such as the presence or absence of adhesive

on the trays[10].

It is known that polymerization shrinkage occurs toward the center of the mold, resulting in negative linear variation (shrinkage) in the stone casts[23]. The bilateral adhesion of the elastomeric impression material in the tray can explain the small shrinkage of the transverse distances. The free border of the mold (posterior of the mandibular tray) could promote less strength to restrictive shrinkage, allowing greater dimensional change in these distances[10]. Different results can be found when maxillary trays were used. In addition, the absence of three teeth caused the highest dimensional accuracy change in distance 3. The larger volume of impression material in the edentulous zone promoted larger shrinkage.

It is advised that many clinical and laboratory parameters should be considered when choosing the impression technique[6-8]. Some of these parameters are the correct replacement of mold in the patient's mouth, the need of a relief due to stress in the impression material causing an increase in the procedure time (2-step putty/light-body technique), and shrinkage at the same time of materials with different viscosities. Furthermore, the impression of oral structures could occur for the putty material when using high pressure applied during the impression procedure and leakage of light-body material. Moreover, the aid of a second person when handling the materials (1-step putty/light-body technique), applying the tray adhesive, or make the first impression in order to manufacture the individual tray increases the chair time (monophase technique)[6,9-10].

The edentulous side showed more shrinkage than the opposite anteroposterior side and no statistical differences were noted between the impression techniques for the tested materials; however, special attention must be paid to the limitations of each technique, since laboratory studies control many factors that may lead to mold distortion in the clinical situation. Further studies using different impression techniques with other types of elastomeric impression materials are necessary to increase the knowledge regarding the impression techniques.

CONCLUSIONS

No differences were observed for dimensional accuracy of the 1-step putty/light-body, 2-step putty/light-body, and monophase impression techniques using a partially edentulous mandibular arch. The edentulous side showed more shrinkage than the opposite anteroposterior side.

Collaborators

MAC SINHORETI and RP VITTI, concept and design. RP VITTI, definition of intelectual contente and data acquisition. ME MIRANDA and RP VITTI, literature search. A BACCHI, RP VITTI and VP FEITOSA, experimental studies. RP VITTI and WC BRANDT, data analysis. MAC SINHORETI, statistical analysis. A BACCHI and RP VITTI, manuscript preparation. ME MIRANDA and VP FEITOSA, manuscript editing. MAC SINHORETI and WC BRANDT, manuscript review.

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