Universidade Estadual Paulista
"Júlio de Mesquita Filho"

Faculdade de Odontologia de Araraquara

Marcelo Antonialli Del'Acqua

Precisão das Técnicas de Moldagem para Próteses Implantossuportadas

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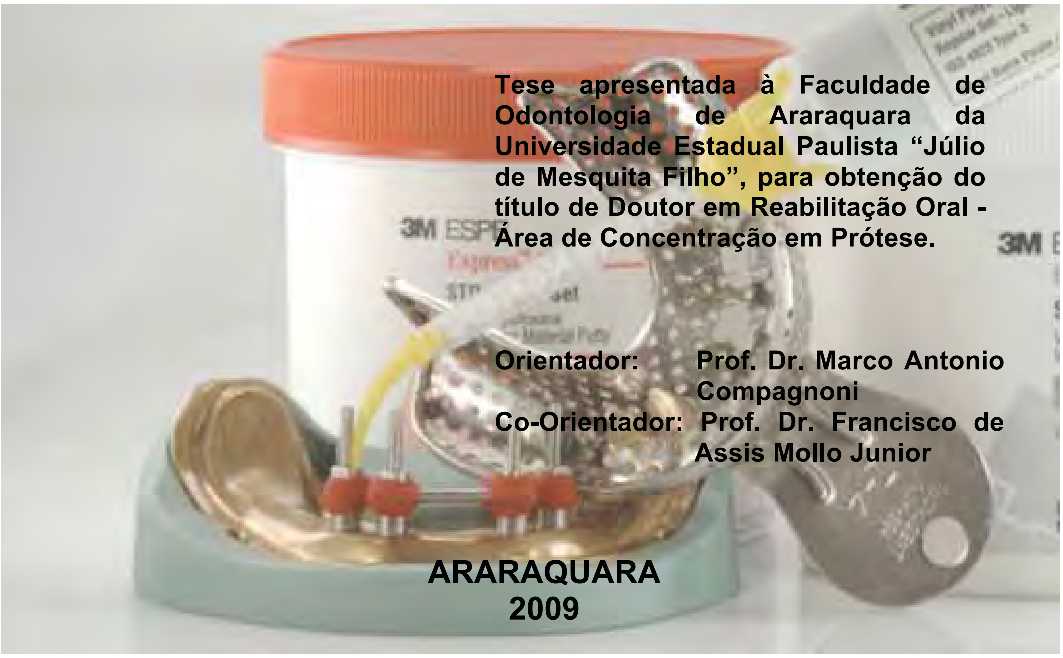

Tese apresentada à Faculdade de Odontologia de Araraquara da Universidade Estadual Paulista “Júlio de Mesquita Filho”, para obtenção do título de Doutor em Reabilitação Oral - Área de Concentração em Prótese.

Orientador: Prof. Dr. Marco Antonio Compagnoni
Co-Orientador: Prof. Dr. Francisco de Assis Mollo Junior

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Araraquara, 08 de julho de 2009.

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Dedicatória

Aos meus pais, **Aerovaldo** e **Maria Zélia**, por terem proporcionado o suporte necessário para que eu pudesse vencer todas as etapas da vida e por acreditarem e permitirem que meus sonhos se realizassem.

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"Para realizar grandes conquistas, devemos não apenas agir, mas também sonhar; não apenas planejar, mas também acreditar." (Anatole France)

Sumário

Sumário

Resumo

Resumo

Del'Acqua MA. Precisão das técnicas de moldagem para próteses implantossuportadas. [Tese de Doutorado]. Araraquara: Faculdade de Odontologia da UNESP; 2009.

Desde que não há consenso em relação a técnica de moldagem mais precisa, foi objetivo deste estudo in vitro avaliar a precisão de 1 técnica de registro (Index de resina composta) e de 5 técnicas de moldagem para próteses implantossuportadas (transferentes quadrados, quadrados jateados, quadrados com extensão lateral, quadrados unidos com Duralay e quadrados unidos com barra de metal) empregando-se 3 materiais de moldagem: silicone de polimerização por adição consistência densa/fluida com moldeira de estoque de inox, poliéter média viscosidade e silicone de polimerização por adição consistência regular com moldeira individual. Foram construídos 1 modelo mestre com 4 análogos de pilares Micro-Unit e 1 estrutura metálica. Obteve-se do modelo mestre um total de 45 modelos, sendo 5 por técnica. A estrutura metálica foi parafusada utilizando-se a técnica de mensuração de fendas por um parafuso. Estas medições foram feitas com o auxílio do programa Leica QWin que recebeu as imagens de uma câmara de vídeo acoplada a uma lupa com um aumento de 100 x. Os resultados obtidos foram analisados estatisticamente utilizando o teste de Kruskal-Wallis seguido pelo método de Dunn, $\propto$=0,05. Dentro das condições experimentais deste estudo, pode-se concluir que não houve diferença estatística entre: modelo mestre (31,63 μm), quadrado Impregum (38,03 μm), quadrado jateado Impregum (46,80 μm), Index (45,25 μm) e quadrado com extensão lateral Express consistência densa/fluida (51,20 μm), sendo esta a eleita. Devido aos piores resultados obtidos com as técnicas quadrado Express regular (151,21 μm) e quadrado jateado Express regular (136,59 μm), o material de moldagem Express consistência regular não deve ser empregado, sendo escolhido então para ser utilizado com moldeiras individuais o Impregum viscosidade média. Caso o cirurgião-dentista pretenda realizar uma técnica com os transferentes unidos (unido com metal = 68,55 μm e unido com Duralay = 165,03 μm), a união deverá ser feita com barras de metal. O procedimento de jateamento e aplicação de adesivo nos transferentes quadrados não apresentou qualquer vantagem e não melhorou a precisão dos moldelos de gesso.

Palavras-Chave: Técnica de moldagem odontológica; implante dentário endoósseo; modelos dentários.

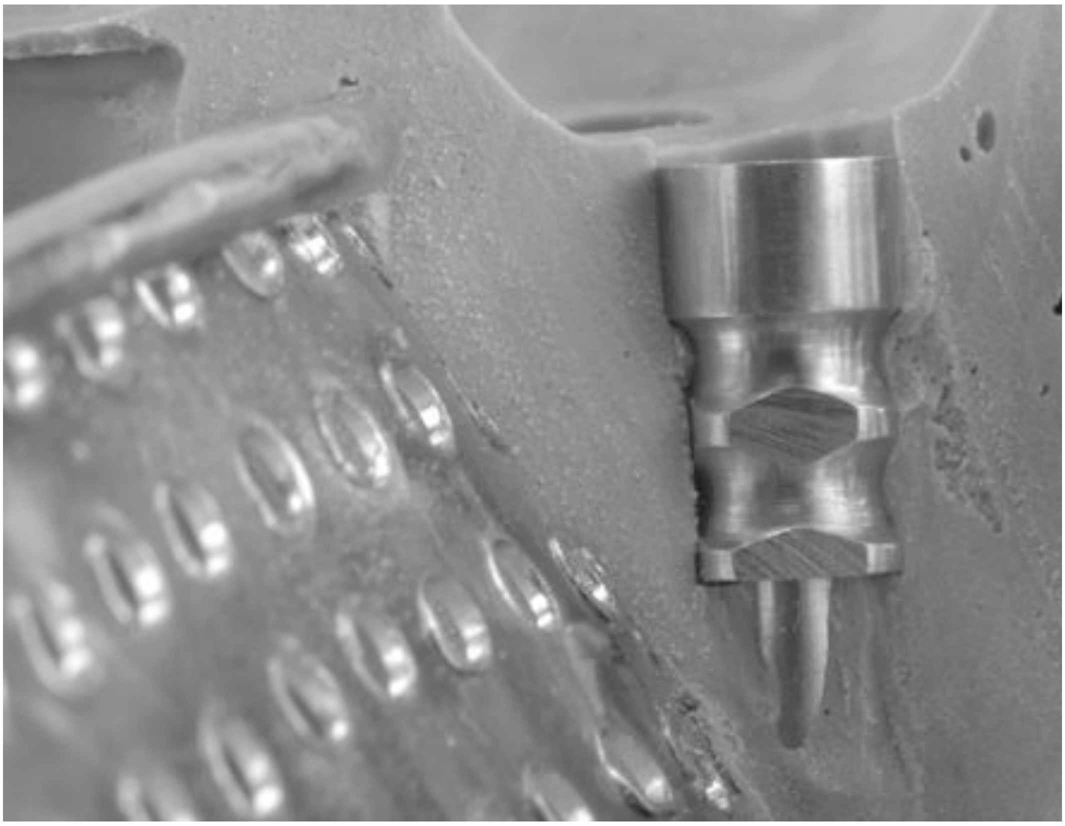
Abstract

Abstract

Del'Acqua MA. Accuracy of impression techniques for an osseointegrated implant-supported prosthesis. [Tese de Doutorado]. Araraquara: Faculdade de Odontologia da UNESP; 2009.

Since there is still no consensus regarding the most accurate impression techniques, it was the purpose of this study compared the dimensional accuracy of stone index and of 5 impression techniques for implant-supported prostheses (squared impression copings, modified squared, squared sandblasted and coated with impression adhesive, modified squared, Duralay splinted and metal splinted) using 3 impression materials: vinyl polysiloxane putty/light body with a metal stock tray and polyether medium consistency and vinyl polysiloxane regular body were used with a custom aluminum tray. A master cast with 4 parallel implant abutment analogs and a framework were fabricated. Nine groups (n=5) were tested. The gap measurement method employed was just one titanium screw tightened to the framework. Group's measurements were analyzed using LeicaQWin software that received the images of a video camera coupled to a stereomicroscope at x100 magnification. The results were statistically analyzed with Kruskal-Wallis One Way ANOVA on Ranks test followed by Dunn's Method, $\propto$=.05. Under the conditions of this study the following conclusions could be drawn: no significant difference was detected among Master Cast (31.63 µm), Squared Impregum (38.03 µm), Sandblasted-Adhesive Squared Impregum (46.80 µm), Index (45.25 µm) and Modified Squared techniques (51.20 µm) (*P*=.05), being the elected. Due to the worst results with the techniques Squared Express Regular (151.21 µm) and Sandblasted-Adhesive Squared Express Regular (136.59 µm), the Express regular body impression material should not be used, and then chosen to be used Impregum Soft medium consistency with custom tray. If the dentist wishes to perform the technique with splinted copings (Metal Splinted = 68.55 µm and Duralay Splinted = 165.03 µm), the splint should be made with bars of metal. The impression technique using sandblasted-adhesive squared impression copings did not present any clinical advantage and did not improve the dimensional accuracy of stone casts.

Keywords: Dental impression technique; dental models; dental implantation, endosseous.



Introdução

Introdução

Os implantes dentais foram inicialmente desenvolvidos com o intuito de melhorar a qualidade de vida dos usuários de prótese total removível, aumentando sua retenção e estabilidade[17].

A partir desse objetivo, para o sucesso do tratamento, o planejamento em prótese sobre implante deve envolver alguns cuidados essenciais, tais como a obtenção de um modelo de trabalho fiel ao posicionamento dos implantes e morfologia dos tecidos moles circunvizinhos[17,51]. Para isso, deve-se considerar que as fases de moldagem e modelagem são diretamente dependentes do material empregado, das técnicas de moldagem e vazamento dos moldes[51].

Técnicas de moldagem têm sido propostas para a obtenção de um modelo de trabalho confiável. De um modo geral, existem 2 técnicas primárias: a indireta com transferentes cônicos (moldeira fechada) e a direta com transferentes quadrados esplintados ou não (moldeira aberta). Quando se utiliza transferentes esplintados, a esplintagem mantém o inter-relacionamento dos pilares e evita o movimento rotacional dos mesmos dentro do material de moldagem durante o parafusamento do análogo[2,3,6,8,35,39,46,48]. Os materiais usados para esplintar os transferentes podem ser: barras de metal[35], gesso para moldagem com baixa expansão de presa[4,14,36,37,53], placa de acetato transparente e resina acrílica[10], resina composta fotopolimerizável[22], resina acrílica fotopolimerizável[4,24,29] ou resina acrílica autopolimerizável[2-4,7,8,12,18,20,21,23,38,44].

Melhores resultados foram observados com a união dos transferentes com resina acrílica autopolimerizável antes da confecção da moldagem[2,3,6,8,35,46,48]. Entretanto, outros estudos demonstraram que este processo de esplintagem é desnecessário[7,13,18,20,21,23,29,38,44]. Porém, deve ser considerado que se este procedimento de esplintagem for realizado com o intuito de se confeccionar um Index, isto é, sem a realização de moldagem, os resultados obtidos apresentam alta precisão[13].

Há também um procedimento alternativo para moldagens no qual os transferentes quadrados são jateados com óxido de alumínio de 50 µm a uma pressão de 2,5 atmosferas e recobertos com o adesivo do material de moldagem[46-49].

Ainda com o intuito de aumentar a precisão dos modelos, em 1995, El Haje[15] propôs uma modificação no formato dos transferentes utilizando resina acrílica autopolimerizável que teoricamente aumentaria a estabilidade do transferente no interior do material de moldagem[16,30].

Outro fator a ser considerado diz respeito ao material de moldagem. O poliéter e polivinilsiloxano são comumente utilizados nas técnicas de moldagem[31,52]. Um material de moldagem elastomérico rígido, como o poliéter, poderia manter os transferentes em posição durante a moldagem[43], além de ser um material que apresenta estabilidade dimensional, alta resistência à deformação permanente e alta resistência ao rasgamento com pequena deformação sobre forças compressivas[9]. Os polivinilsiloxanos, por sua vez, têm sido aceitos extensamente devido à excelente estabilidade dimensional, à superior recuperação elástica, e à precisa reprodução dos detalhes. As adequadas propriedades mecânicas asseguram ao material de moldagem suportar vários esforços durante sua remoção, enquanto mantem a estabilidade dimensional e a integridade[19,33,52].

De acordo com Vigolo et al.[46], em 2004, a precisão dimensional na transferência do posicionamento dos implantes da cavidade oral para os modelos de trabalho é um fator a ser considerado como determinante para o sucesso do tratamento. Tal afirmação enfatiza a necessidade de precisão nos procedimentos que envolvem a adaptação dos componentes protéticos entre si, na etapa de moldagem e vazamento do molde, aos passos laboratoriais de enceramento, inclusão, fundição e soldagem e a própria habilidade do técnico de laboratório[6,38].

A precisão da técnica de moldagem bem como dos procedimentos laboratoriais pode ser verificada quando ocorre um ajuste passivo entre a estrutura metálica e os pilares[11,45]. Dessa forma, considera-se que deverá ocorrer contato circular simultâneo entre os componentes pré-fabricados, e que não deverá induzir tensão nos componentes do implante e no osso circunvizinho. Porém, devido às limitações das propriedades físicas dos materiais de moldagem usados, os procedimentos clínicos e laboratoriais ainda são inadequados para oferecer uma estrutura metálica com ajuste passivo[23,32,41,43], o que é uma característica importante para a manutenção da osseointegração[28,42].

Pelo fato do sistema osso-implante ter menor capacidade que o sistema periodonto-dente em absorver e distribuir forças através do osso alveolar, uma impossibilidade de adaptação passiva produzirá uma sobrecarga aos elementos mecânicos do sistema, que pode resultar em soltura ou fratura dos parafusos[26,40]. Soltura de parafusos pode conduzir a complicações como o acúmulo de tecido de granulação entre o implante e o pilar, resultando possivelmente em fístulas, depósito de placa entre a prótese e pilares e fraturas dos parafusos ou pilares[25,27]. Em casos mais graves pode também afetar os elementos biológicos, causando desde a diminuição da altura do osso marginal peri-implantar até a completa perda da osseointegração[1,34,50].

Como ainda não há consenso definido com relação às técnicas e materiais de moldagem para implantes[31], o propósito desse trabalho foi comparar a precisão das moldagens para próteses sobre implantes, utilizando-se a técnica direta, variando-se os transferentes e o tipo de material de moldagem. A hipótese nula testada foi que a exatidão dos modelos não seria afetada pela técnica e pelo material de moldagem.


3M ESPE
STD Firmer Set
CATALYST
3M ESPE
STD Firmer Set
BASE
3M ESPE
Vinyl Polysiloxane Impression Material

Proposição

Proposição

O propósito desse trabalho foi comparar a precisão das moldagens para próteses sobre implantes, utilizando-se a técnica direta, variando-se os transferentes (transferentes quadrados, transferentes quadrados jateados e recobertos com adesivo, transferentes quadrados com extensão lateral, transferentes quadrados unidos com Duralay, transferentes quadrados unidos com barra de metal e Index) e o tipo de material de moldagem (Impregum Soft média viscosidade, Express consistência regular - 3M ESPE e Express consistência densa/fluida - 3M ESPE).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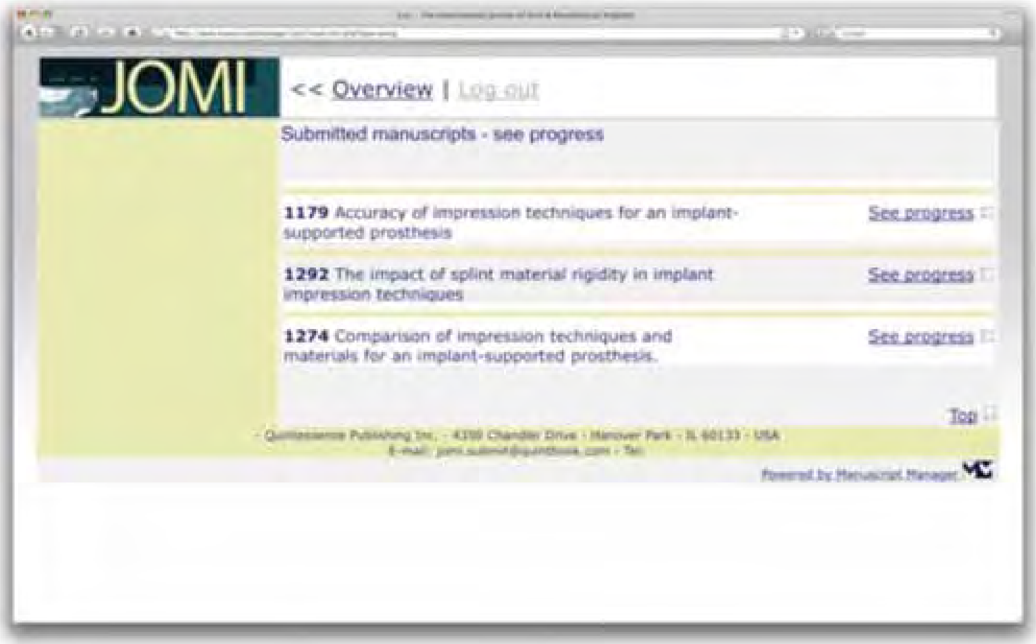
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Decision

Manuscript title: Accuracy of impression techniques for an implant-supported prosthesis
Manuscript type: Original Article
All Authors: Marcelo Antonialli Del'Acqua, Alejandro Muñoz Chávez, Francisco de Assis Mollo-Junior, Marco Antonio Compagnoni,

Decision: **Accept**
Submission number: 4
Decision date: 2009-06-17
Decision letter: Dear Professor Antonialli Del'Acqua

It is a pleasure to inform you that the above article is now acceptable for publication.

The authors will receive a revised manuscript in the galley proof stage. They are asked to carefully evaluate any changes that were made to ensure that the meaning of their article has not been changed. The galley proofs will be provided to the authors electronically shortly before the time that the manuscript goes to final press.

1º Artigo

Accuracy of impression techniques for an implant-supported prosthesis

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Accuracy of impression techniques for an implant-supported prosthesis

ABSTRACT

Purpose: This in vitro study compared the dimensional accuracy of stone index and of 2 impression techniques (squared impression copings and modified squared impression copings) for implant-supported prostheses. **Materials and Methods:** A master cast with 4 parallel implant abutment analogs and a passive framework were fabricated. Vinyl Polysiloxane impression material (Express putty/light body - 3M ESPE) was used for all impressions with a metal stock tray. Three groups (n=5): Index (*I*); Squared (*S*) and Modified Squared (*MS*) were tested. The measurement method employed was just one titanium screw tightened to the framework. Group's measurements (60 gap values) were analyzed using software (LeicaQWin - Leica Imaging Systems Ltd) that received the images of a video camera coupled to a Leica stereomicroscope at x100 magnification. The results were statistically analyzed (ANOVA, Holm-Sidak method, α=.05). **Results:** The mean values of abutment/framework interface gaps were: Master Cast=31.63 µm; Group *I*=45.25 µm; Group *S*=96.14 µm; Group *MS*=51.20 µm. No significant difference was detected among Index and Modified Squared techniques (*P*=.05). **Conclusion:** Under the limitations of this study, the techniques Modified Squared and Index generated more accurate casts than Squared technique.

Key words: dental implantation, dental impression technique, dental models.

INTRODUCTION

Dental implants have become a quite successful method for the restoration of fully and partially edentulous patients. However, due to the precise machine fit of implant components and to the rigid connection of implant to bone,[1-3] the accuracy of master cast is even more critical when compared to conventional fixed prosthodontics.

The accuracy of a master cast depends on the several factors such as type of impression material, impression technique, dimensional change of dental stone during setting, and implant master cast technique.[4] Small discrepancies can lead to stress applied to the implants on screwing down the framework.[3] To provide a passive fit, a framework should induce no strain on the supporting implant components and the surrounding bone in the absence of an applied external load.[2] However, the clinical and laboratory variables intrinsic to restorative treatment make it unattainable to fabricate an absolutely passive framework fit.[2,5]

Vinyl polysiloxane impression materials have been widely accepted due to excellent dimensional stability, superior recovery from deformation, and precise detail reproduction. Adequate mechanical properties ensure the impression material can withstand various stresses upon removal, while maintaining dimensional stability and integrity.[6,7]

Several impression techniques have been proposed to provide a cast that will ensure accurate fit of prostheses on osseointegrated implants. Overall, there are 2 primary techniques, the indirect (closed tray) and direct (open tray) techniques. The direct technique may use splinted or nonsplinted implant impression copings. The materials used to splint impression copings are light-curing composite resin,[8] impression plaster,[9-12] thermoforming material and acrylic resin[13] or autopolymerizing acrylic resin.[9,14-24]

Despite many authors have compared direct and indirect impression techniques,[14,16,19,22,25-28] contradictory results are still available. In addition, several authors advocate connecting the impression copings together intra orally prior to impression making with acrylic resin provide the best result.[20,24,28-30] However, others studies have demonstrated that this splinting process is unnecessary.[14,15,17-19,21,22,26]

Considering the importance to investigate the implants impression techniques, the purpose of this study was to compare the dimensional accuracy of stone index and 2 impression techniques (squared impression copings and squared modified impression copings) using vinyl polysiloxane impression material, metal stock tray, and a master framework for implant-supported prostheses. The null hypothesis tested was that the accuracy of casts would not be affected by the impression technique.

MATERIALS AND METHODS

In this in vitro study, a mandibular edentulous clinical cast with 4 parallel stainless steel abutment analogs (Micro-Unit; Conexão Prothesis Systems, São Paulo, Brazil) was fabricated to serve as a clinically relevant simulation (Fig 1).

A master framework was made using titanium cylinders (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) and 2-mm-diameter cylindric titanium bars (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) using a laser-welding technique.[26] This framework was the standard for the assessment of all subsequent measurements made to determine the accuracy of casts made from different transfer procedures.[9]

Four windows were created in the metal stock tray to expose coping screws. A box for pouring the impression with dental stone was made with condensation silicone (Zetaplus/Oranwash; Zermack, Badia Polesine, Rovigo, Italy). This matrix was used for all of the impressions, allowing standardization of the format of the casts and of the amount of dental stone employed for the pouring (Fig 2).

All squared impression copings were adapted to the abutment analogs on the master cast using a torque driver (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) with 10Ncm.[31] Fifteen casts were fabricated and divided into three groups (n=5):

• **Group *I*: Index, Squared Splinted Impression Copings**. The splinting process was initiated by placing light-polymerized composite resin (Z100; 3M ESPE) around the squared copings (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil). Preformed composite resin bars with a cross-sectional diameter of approximately 3 mm were fabricated by the injection of composite resin into a drinking straw.[32] Appropriate lengths of the resin bar were sectioned with a cutting disk (Intensiv SA, Grancia, Switzerland) to bridge the spaces between the adjacent impression copings. The ends of the resin bar were luted to the impression copings with composite resin (Fig 3).

• **Group *S*: Squared Impression Copings.** The squared impression copings were adapted to the abutment analogs on the master cast using 10 Ncm torque (Fig 4).

• **Group *MS*: Modified Squared Impression Copings.** A procedure for modifying the sheath of the squared impression coping was accomplished.[33] The body of the impression coping was modified with autopolymerizing acrylic resin (Duralay; Reliance Dental Mfg, Worth, IL) to have an additional 2 mm extension on each side of the retentive feature. (Fig 5)

Vinyl Polysiloxane impression material (Express putty/light body - 3M ESPE) was used according to the manufacturer's instructions for the one-step putty-wash technique. The tray was seated on the master cast with gentle pressure until contacted the base of the master cast. The impression material was allowed to set for 10 minutes from the start of mixing. A standardized pressure of 1.25 kg was exerted over each tray during the impression procedures.

After impression material polymerization, the impression copings were unscrewed and the tray was separated from the master cast. The abutment analogs (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) were then fit to the impression copings using 10 Ncm torque while held with a hemostatic forceps to avoid the possibility for the squared coping to rotate inside the impression (Fig 6). This procedure is not necessary for the modified squared technique. But this procedure was performed to standardize the methodology.

A two-times pouring technique was used to minimize alteration of the setting expansion of the dental stone.[26] Four pieces of latex tube were used, each with a length of 23 mm, an internal diameter of 4 mm, and an external diameter of 8 mm (Auriflex, São Roque, SP, Brazil). The tubes were fitted onto the analogs (Fig 7), and pouring was performed with a die stone (Vel-Mix; Kerr Corporation, Orange, CA) 2 hours after the impressions were made. A ratio of 22 mL of water to 110 g of dental stone was mechanically mixed with a digital vacuum spatulator (Turbomix EDG Equipment, São Carlos, SP, Brazil). After the initial setting (approximately 10 minutes), the latex tubes were removed. A ratio of 6 mL of water to 25 g of stone was mixed under vacuum and syringed (20 mL BD Plastipak syringe; Becton Dickinson, Curitiba, PR, Brazil) around the analogs (Fig 8). All mixes were vibrated into boxed impressions and allowed to set for 2 hour before separation from the impressions.

With the Index Group, the splinted transfers were unscrewed from the master cast and screwed to the abutment analogs with 10 Ncm. A rectangular box for pouring the impression with dental stone was made with condensation silicone and wax. The analogs were seated into the matrix to approximately half their length. When set, the stone index was trimmed and finished (Fig 9).[26,34] All casts (10 casts and 5 index) obtained were stored at room temperature for a minimum of 2 weeks before measurement.[18,21,35]

The 4 implant abutment analogs in the master cast were denoted sequentially A through D from left to right. Four new screws were used for measurements. The standard framework was seated on each cast and a titanium screw was tightened in analog A to 10 Ncm (Fig 10) using a torque driver while measurements of abutment-framework interface gaps were made for analogs C and D. This process was repeated in analog D, and the measurements for analogs A and B were noted.[1,26,34,36-38]

This study have a single calibrated and blinded examiner for examined all definitive casts. These measurements were analyzed using software (Leica Qwin; Leica Imaging Systems, Cambridge, England) that received the images from a video camera (JVC, 0.5 inch CCD, model TK-C1380,Tokyo, Japan) coupled to a Leica stereomicroscope (Leica Microsystems, Wetzlar, Germany) at 100X magnification.

Demarcations were made in the center of each titanium abutment of the framework to standardize the area for image capture. For each obtained picture, lineal readings of the gap were accomplished in 3 areas. The arithmetic mean of these 3 values determined the value of the gap (Fig 11). The mean gap value for the master cast was calculated as the average of 5 consecutive measurements (20 gap values) of the framework.

With the aid of the SigmaStat version 3.11 software (Systat, Evanston, IL), a suitable statistical test was applied. After running statistical adaptation tests (Normality Test and Equal Variance Test), the application of One-way ANOVA parametric test was used. Values of $P<.05$ were judged to be significant. To isolate a group or groups that differed from the others, an all pairwise multiple comparison procedure was used (Holm-Sidak method - $\alpha=.05$).

RESULTS

The mean values and standard deviation (±) of abutment/framework interface gaps were: Master Cast=31.63 µm (±12.35); Group *I*=45.25 µm (±16.79); Group *S*=96.14 µm (±32.55); Group *MS*=51.20 µm (±22.77). No significant difference was detected between Index and Modified Squared techniques ($P=.05$). Significant differences were detected between Index and Squared ($P=.017$) and between Modified Squared and Squared techniques ($P=.025$).

DISCUSSION

The null hypothesis of the present study, stating that the accuracy of casts would not be affected by the impression technique was reject. Significant differences were detected between *I* and *S* and *MS* and *S* groups.

The master cast used in this study was produced using a previously fabricated metal framework. However, a gap of 31.63 µm was still observed between the framework and abutment analogs. This gap can be explained by the measurement method employed. Just one titanium screw was tightened to the framework, leading to amplification of the gap values.[26]

An ideal impression technique would require minimal time, usefulness, inexpensive, comfortable for the patient and, of course, would give the best results[19]. The one-step (simultaneous) putty-wash technique was chosen for this study because of its convenience, common clinical usage and better clinical results.

Unsatisfactory results were obtained with the use of the Squared technique. The gaps observed for the Modified Squared technique (51.20 µm) were smaller than those observed with the Squared technique (96.14 µm). This may be explained by larger area of the modified impression coping being covered by impression material. Therefore, impressions obtained are not as accurate as those in which the impression copings are more embedded within the impression material. It is hypothesized that extension of the modified squared impression coping has a role in providing additional retention and resistance against displacement due to the rectangular form created by this technique. The composition of the material (acrylic resin, composite resin or all-metal made) to modify the impression copings is not important. What is important is the change in the form of the squared impression coping. Modified Squared copings minimized the chance of accidental displacement of the direct impression coping when the abutment analogs were tightened. The Figure 12 illustrates the impression coping locked in the impression.

Another aspect that must be considered when the Modified Squared technique is used is the extra time involved in creating the modified squared coping. The results reinforce the proposal that the surface of the transfers should present a more retentive form and could be used by manufacturers of prosthetic components. It is reasonable to suggest that the results of this technique applied to situations of multiple implant may be extrapolated to clinical situation with single-tooth implant replacement.

The smallest gaps observed in Index Group could be explained by the absence of the impression material for this technique. The pouring procedure can alter the analogs relationship because of the plaster expansion. In order to minimize this factor, a 2-times pouring technique was accomplished. The latex-tube pouring technique used a smaller quantity of dental stone evenly distributed around each analog, thus minimizing the setting expansion. For the Index Group, a small amount of dental stone is already employed in the pouring procedure that minimizes the setting expansion.

Although the results of this study showed similar results between *I* and *MS* groups, the clinical applicability of these procedures must be considered. There seems to be clinical advantage in splinting impression copings with light-polymerized composite resin to minimize problems related to resin polymerization contraction and to avoid this multi-step time-consuming procedure (time required for acrylic resin polymerization and the additional step of sectioning and rejoining the acrylic resin splint). Therefore, there is improved efficiency, a reduction of chair time and greater transfer precision due to the splinting stability.

The results of this study suggested that using the Index technique or the Modified Squared technique, an accurate working cast is more likely to be made. If the final prosthesis fits on one of these casts, then a clinician should be confident that it will most likely fit a patient's mouth.[8] This would be of great advantage, since passive adaptation of the implant abutment to the framework is often difficult to achieve and to interpret in a clinical setting.[37]

Further studies evaluating implants impression techniques in simulated partially edentulous casts are necessary. In addition, a great number of impression materials should be also evaluated. Despite the present study did not simulate all clinical conditions, the techniques evaluated are expected to perform similarly in the oral environment.

CONCLUSIONS

Under the limitations of this study, the techniques Modified Squared and Index produced more accurate casts than Squared technique.

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ILUSTRATIONS

Fig. 1 Metal master cast.

Fig. 2 Metal stock tray and matrix for pouring the impression.

Fig. 3 Splinted squared copings with composite resin.

Fig. 4 Squared Impression Copings.

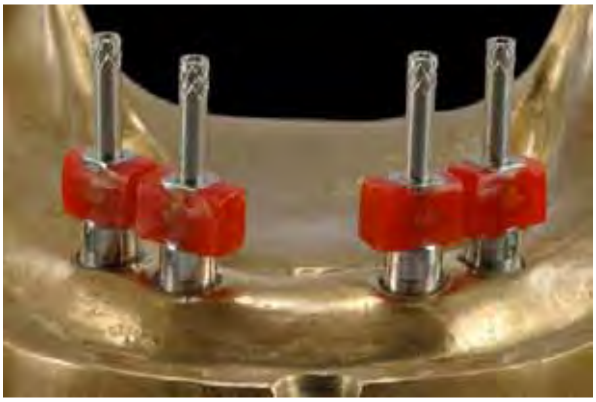


Fig. 5 Modified Squared Impression Copings.

Fig 6 The abutment analogs is torqued while held with a hemostatic forceps.

Fig. 7 Impression with latex tubes fitted onto analogs.

Fig. 8 Syringing dental stone around analogs.

Fig 9 Group Index

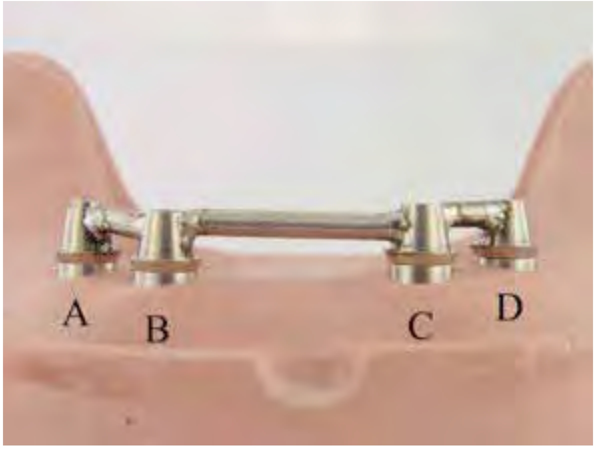


Fig. 10 Framework tightened in analog A to 10 Ncm.

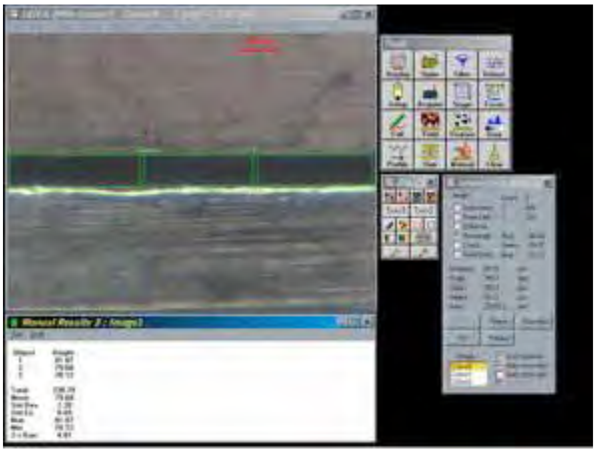
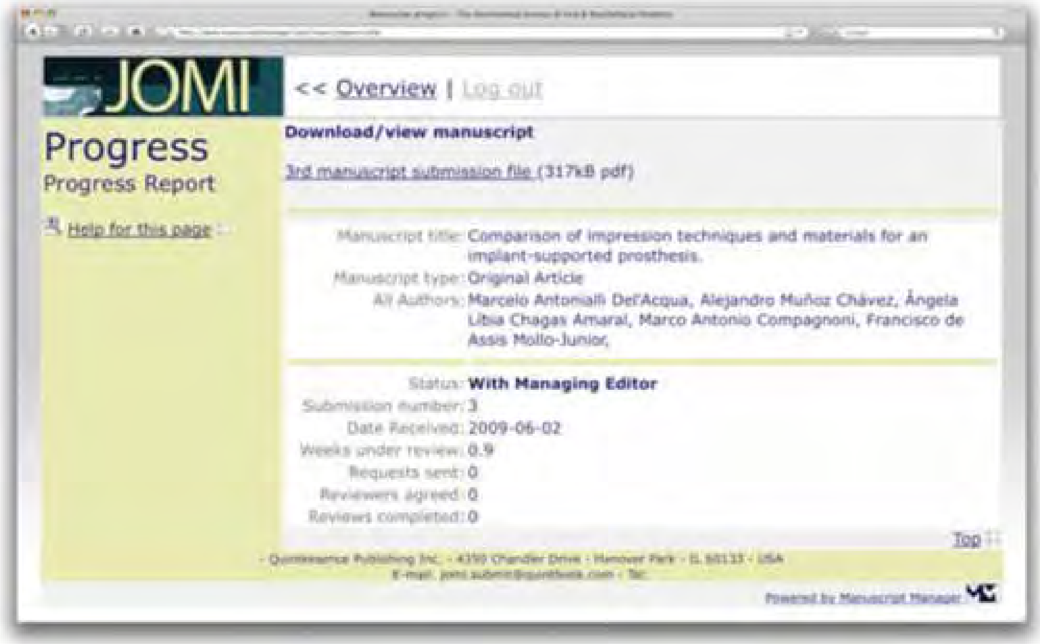


Fig. 11 Leica Qwin Screen .

Fig. 12 Sectional view of modified squared impression copings locked in impression.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2º Artigo

Comparison of impression techniques and materials for an implant-supported prosthesis.

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Comparison of impression techniques and materials for an implant-supported prosthesis.

ABSTRACT

Purpose: To investigate, in vitro, the dimensional accuracy of 2 impression techniques (squared impression copings and squared impression copings sandblasted and coated with impression adhesive) made of vinyl polysiloxane and polyether impression materials. **Materials and Methods:** A master cast (control group) with 4 parallel implant abutment analogs, a passive framework and a custom aluminum tray were fabricated. Four groups (n=5): Squared Impregum (SI), Squared Express (SE), Sandblasted-Adhesive Squared Impregum (ASI) and Sandblasted-Adhesive Squared Express (ASE) were tested. The measurement method employed was just one titanium screw tightened to the framework. A stereomicroscope was used to evaluate the fit of the framework by measuring the size of the gap between the abutment and the framework. The results were statistically analyzed with Kruskal-Wallis One Way ANOVA on Ranks test followed by Dunn's Method, ∝=.05. **Results:** The mean values of abutment/framework interface gaps were: Master Cast=31.63 µm (SD 2.16); SI=38.03 µm (SD 9.29); ASI=46.80 µm (SD 8.47); SE=151.21 µm (SD 22.79); ASE=136.59 µm (SD 29.80). No significant difference was detected among SI or ASI techniques and Master Cast. No significant difference was detected among SE and ASE techniques. **Conclusion:** Within the limits of this study, it can be concluded that Impregum Soft medium consistency was the best impression material and the impression technique did not influence the accuracy of the stone casts.

Key words: dental implant, impression material, implant impression technique.

INTRODUCTION

Dental implants have become a quite successful method for the restoration of fully and partially edentulous patients and one fundamental aspect of achieving success is the passivity of superstructure fit on abutments. However, due to the precise machine fit of implant components and to the rigid connection of implant to bone,[1-3] small discrepancies can lead to stress applied to the implants on screwing down the framework.[3]

Therefore, the accuracy of master cast is critical and depends on the clinical and laboratory variables intrinsic to restorative treatment such as type of impression material, impression technique, dimensional change of dental stone during setting, and implant master cast technique[4] that make it unattainable to fabricate an absolutely passive framework fit.[2,5]

Elastomeric impression materials have been found to be highly accurate without splinting impression copings.[4,6-11] A rigid elastomeric impression material, like polyether, would secure the impression copings accurately, has dimensional stability, high resistance to permanent deformation, high primary shear resistance with little creep under compressive forces that makes it an optimal material to be used for making impressions of the implants.[12] Vinyl polysiloxane impression materials have been widely accepted due to excellent dimensional stability, superior recovery from deformation, and precise detail reproduction.[13,14]

Several impression techniques have been proposed to provide a cast that will ensure accurate fit of prostheses on osseointegrated implants. There are 2 primary techniques, the indirect (closed tray) and direct (open tray) techniques. The direct technique may use splinted or nonsplinted implant impression copings.

Despite many authors have compared direct and indirect impression techniques,[6,10-12,15,16-19] contradictory results are still available.

Several authors advocate connecting the impression copings together intra orally prior to impression making with acrylic resin provide the best result.[18,20-24]

However, others studies had demonstrated that this splinting process is unnecessary.[6-11,16,25]

There is also an alternative procedure in impression making for implant-supported prostheses as the employment of square impression copings that had been sandblasted to roughen their external surfaces at a supragingival level, and then coated with adhesive, in order to avoid the possibility of rotating inside the impression at the moment of analog screwing.[21,23,26]

Therefore, the purpose of the current investigation was to compare implant impression accuracy as a function of impression technique (squared impression copings and squared impression copings sandblasted and coated with impression adhesive) and impression material type (Impregum Soft medium consistency and Express regular body) combinations. The null hypothesis tested was that the impression technique and impression material type would not affect the accuracy of casts.

MATERIALS AND METHODS

A mandibular edentulous clinical cast with 4 parallel abutment analogs (Micro-Unit; Conexão Prothesis Systems, São Paulo, Brazil) was fabricated to serve as a clinically relevant simulation (**Master Cast**). Five fiducial marks (circular depressions 6 mm wide and 3 mm deep) were made on the master cast to standardize tray positioning each time during impression making.[25] The analogues were temporarily secured with acrylic resin Duralay (Reliance Dental Mfg Co, Worth, IL) to make their removal possible after fabrication of the metal framework. A master framework was made using titanium cylinders (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) and 2 mm diameter cylindrical titanium bars (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) using a laser-welding technique.[16] The Duralay resin and the original analogues were removed and discarded. Four new analogues were screwed to the standard framework using a torque wrench (Conexão; Conexão Prothesis Systems Ltd, Sao

Paulo, Brazil) calibrated at 10 Ncm and then embedded into the master cast holes with epoxy resin.[20] The framework was removed from master cast only after the polymerization of the epoxy resin was complete. Thus, the discrepancies due to welding procedure were eliminated almost entirely and a metal master cast with a passively-fitting framework was produced.[15,21,27]

A custom aluminum tray with 2-mm relief for impression material,[28,29] 4 windows to allow access to the coping screws and with 5 stops to standardize tray positioning during impression making was fabricated by casting of a custom acrylic resin tray (Fig 1). This casting procedure was carried out to obtain a single tray to make the 20 impressions. The surfaces of the tray were sandblasted (VH, Araraquara, SP, Brazil) with 125 μm aluminum oxide to increase the bond between the impression material and the tray.[30]

A box for pouring the impression with dental stone was made with condensation silicone (Zetaplus/Oranwash; Zermack, Badia Polesine, Rovigo, Italy). This matrix was used for all of the impressions, allowing standardization of the amount of dental stone employed for the pouring.

All squared impression copings were adapted to the abutment analogs on the master cast at 10 Ncm torque[31] (Fig 2). Four groups with 5 casts each were evaluated:

- **Group SI: Squared Impression Copings / Impregum**.
- **Group SE: Squared Impression Copings / Express**.
- **Group ASI: Sandblasted-Adhesive Squared Impression Copings / Impregum.**
- **Group ASE: Sandblasted-Adhesive Squared Impression Copings / Express.**

The impressions were made with vinyl polysiloxane impression material (Express regular body - 3M ESPE) and polyether (Impregum Soft medium consistency - 3M ESPE). For groups **ASI** and **ASE,** squared impression copings were sandblasted with a microetcher (VH, Araraquara, São Paulo, Brazil) using a 50 μm aluminum oxide abrasive powder at 2.5-atmosphere pressure to roughen their external surfaces (Fig 3). Then, for group **ASI** and **ASE**, squared impression copings were coated with the Polyether adhesive (3M ESPE AG, Seefeld, Germany) (Fig 4) and VPS Tray Adhesive (3M ESPE AG, Seefeld, Germany) respectively.

The manufacturer-recommended impression adhesive was applied over the custom tray and the impression material was loaded inside the tray and syringed around the impression copings. The tray was seated on the master cast with gentle pressure until contacted the 5 location marks. The manufacturer's setting time was doubled to compensate for a delayed polymerization reaction at room temperature rather than at mouth temperature.[25,28,29,32,33] A standardized pressure of 1.25 kg was exerted over each tray during the impression procedures (Fig 5). This was enough to force the excess material to flow out and to maintain constant pressure throughout the working time.[16,22]

After impression material polymerization, the impression copings were unscrewed and the tray was separated from the master cast. Abutment analogs were then fit to the impression copings using 10 Ncm torque (Fig 6) while held with a hemostatic forceps to avoid the possibility for the squared coping to rotate inside the impression.

A two-times pouring technique[16,34-36] was performed by using 4 pieces of latex tube (Auriflex, São Roque, SP, Brazil). The tubes were fitted onto the analogs. Die stone (Vel-Mix; Kerr Corporation, Orange, CA) was mixed with a digital vacuum spatulator (Turbomix EDG Equipment, São Carlos, SP, Brazil) and pouring was performed with a 2 hours after the impressions were made (Fig 7). After the initial setting (approximately 10 minutes), the latex tubes were removed (Fig 8). A ratio of 6 mL of water to 25 g of stone was mixed following the process described previously and syringed (20 mL BD Plastipak syringe; Becton Dickinson, Curitiba, PR, Brazil) around the analogs. All mixes were vibrated into boxed impressions and allowed to set for 2 hour before separation from the impressions.[16] All 20 casts obtained were stored for a minimum of 2 weeks before measurement.[9,25]

The 4 implant abutment analogs in the master cast were sequentially denoted A through D from left to right. The standard framework was seated on each cast and a titanium screw was tightened in analog A to 10 Ncm (Fig 9) using a torque driver while measurements of abutment-framework interface gaps were made for analogs C and D. This process was repeated in analog D, and the measurements for analogs A and B were noted.[1,16,37-40]

These measurements were analyzed using software (Leica Qwin; Leica Imaging Systems, Cambridge, England) that received the images from a video camera (JVC, 0.5 inch CCD, model TK-C1380, Tokyo, Japan) coupled to a Leica stereomicroscope (Leica Microsystems, Wetzlar, Germany) at 100X magnification.

Demarcations were made in the center of each titanium abutment of the framework to standardize the area for image capture. For each obtained picture, lineal readings of the gap were accomplished in 3 areas. The mean of these 3 values determined the value of the gap (Fig 10). The mean gap value for the master cast was calculated as the average of 5 consecutive measurements (20 gap values), and the framework was screwed in again before each measurement. The same person performed all procedures.

Kruskal-Wallis One Way ANOVA on Ranks test followed by Dunn's Method were used with the aid of the SigmaStat version 3.11 software (Systat, Evanston, IL). Values of $P<.05$ were judged to be significant.

RESULTS

Four groups with 5 casts each were formed. The mean values of abutment/framework interface gaps were: Master Cast=31.63 µm (SD 2.16); SI=38.03 µm (SD 9.29); ASI=46.80 µm (SD 8.47); SE=151.21 µm (SD 22.79); ASE=136.59 µm (SD 29.80) (Fig 11). No significant difference was detected among SI, ASI and Master Cast. No significant difference was detected between SE and ASE. (P>.05). Tables 1 and 2 show the results of all comparisons among the groups.

DISCUSSION

The master cast used in this study was produced using a previously fabricated metal framework. However, a gap of 31.63 µm was still observed between the framework and abutment analogs. This gap can be explained by the measurement method employed. Just one titanium screw was tightened to the framework, leading to amplification of the gap values.[16]

It was accomplished, in this study, a 2-times pouring technique.[16,34-36] The pouring procedure can alter the analogs relationship because of the plaster expansion. In order to minimize this factor, the latex-tube pouring technique used a smaller quantity of dental stone evenly distributed around each analog, thus minimizing the setting expansion.[16]

The null hypothesis that the accuracy of casts would not be affected by the impression technique was accepted. Nevertheless, for the impression material type the hypothesis was rejected.

Polyether and vinyl polysiloxane impression material are common material used to impression techniques. The results of this study suggest Impregum Soft medium consistency as the impression material of choice to achieve a more accurate orientation of the implant analogs in the laboratory master casts. It might be explained because this material is more rigid than regular body Express material, preventing movement of the impression copings inside the impression material.[10] Thus, it appears that the specific composition and viscoelastic properties of the materials are important factors to be considered.

An ideal impression technique would require minimal time, usefulness, inexpensive, comfortable for the patient and, of course, would give the best results. [10] In this study, the results showed no differences between squared impression copings and sandblasted-adhesive squared impression copings. Both the Impregum and Express impression materials verified this finding. Therefore, the extra time involved in the sandblasted-adhesive squared impression copings would be considered unnecessary. The present findings are in contrast to Vigolo et al.[26] (2000) and Vigolo et al.[21] (2003) results, and in accordance with Vigolo et al.[23] (2004). It could be hypothesized that the design of the square impression copings was sufficient to stabilize it, with no need for the additional procedure of sandblasted-adhesive squared impression copings.

In this study, only the impression material was a factor of influence on the accuracy of the master casts. Thus, from the results, it could be suggested that using SI or ASI techniques, an accurate working cast is more likely to be made. Nevertheless, the clinician should choose the less time consuming technique (SI), since it is much easier to used.

Further studies evaluating implants impression techniques in simulated partially edentulous casts are necessary. In addition, a great number of impression materials should be also evaluated. Despite the present study did not simulate all clinical conditions, the techniques evaluated are expected to perform similarly in the oral environment.

CONCLUSIONS

Under the conditions of this study the following conclusions could be drawn:

1. Impregum Soft medium consistency showed better results than Express regular body impression material.
2. The impression technique using sandblasted-adhesive squared impression copings did not present any clinical advantage and did not improve the dimensional accuracy of stone casts.

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ILUSTRATIONS AND TABLES

Fig 1 Custom aluminum tray coated with VPS Tray Adhesive.

Fig 2 Squared impression copings.

Fig 3 Sandblasted squared impression copings.

Fig 4 Squared impression copings sandblasted and coated with polyether adhesive.

Fig 5 Standardized pressure of 1.25 kg.

Fig 6 Abutment analogs fit to the impression copings with 10 Ncm torque.

Fig 7 Latex tubes fitted onto the analogs and pouring with a die stone.

Fig 8 Latex tubes removed after 10 minutes.

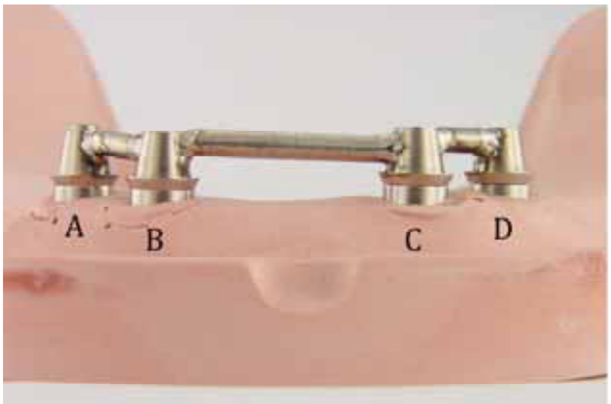

Fig 9 Framework tightened in analog A to 10 Ncm.

Fig 10 Leica Qwin screen.

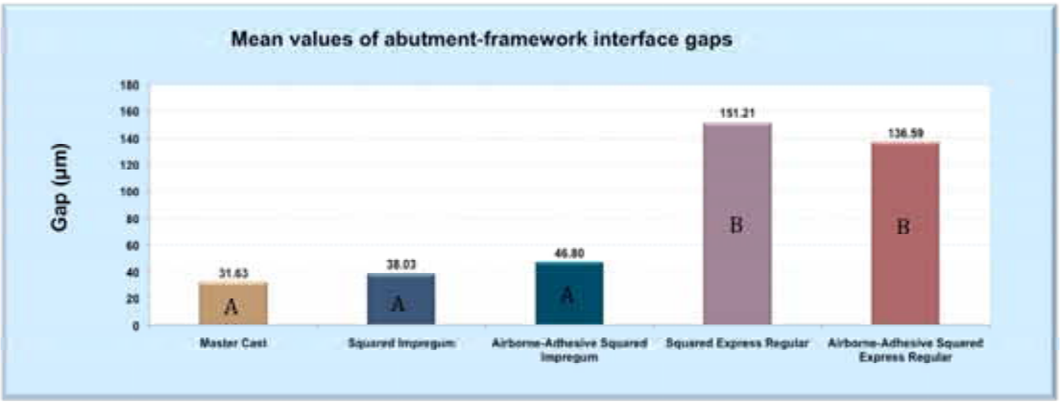

Fig 11 The gap values for groups with the same letter were not significantly different.

Table 1 Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	Mean	Median	25%	75%
Master Cast	31.63	28.865	20.39	42.87
SI	38.03	32.31	23.8	42.875
ASI	46.80	40.425	29.645	53.655
SE	151.21	98.735	34.79	283.465
ASE	136.59	140.875	102.9	157.045

H = 36.645 with 4 degrees of freedom. (P = <0.001)

Table 2 Comparison of All Impression Techniques versus Master Cast (Dunn's Method)

Comparison	Diff of Ranks	Q	P<0.05
ASE vs Master Cast	44.65	4.867	Yes
SE vs Master Cast	36.6	3.989	Yes
ASI vs Master Cast	14.3	1.559	No
SI vs Master Cast	4.95	0.54	Do Not Test


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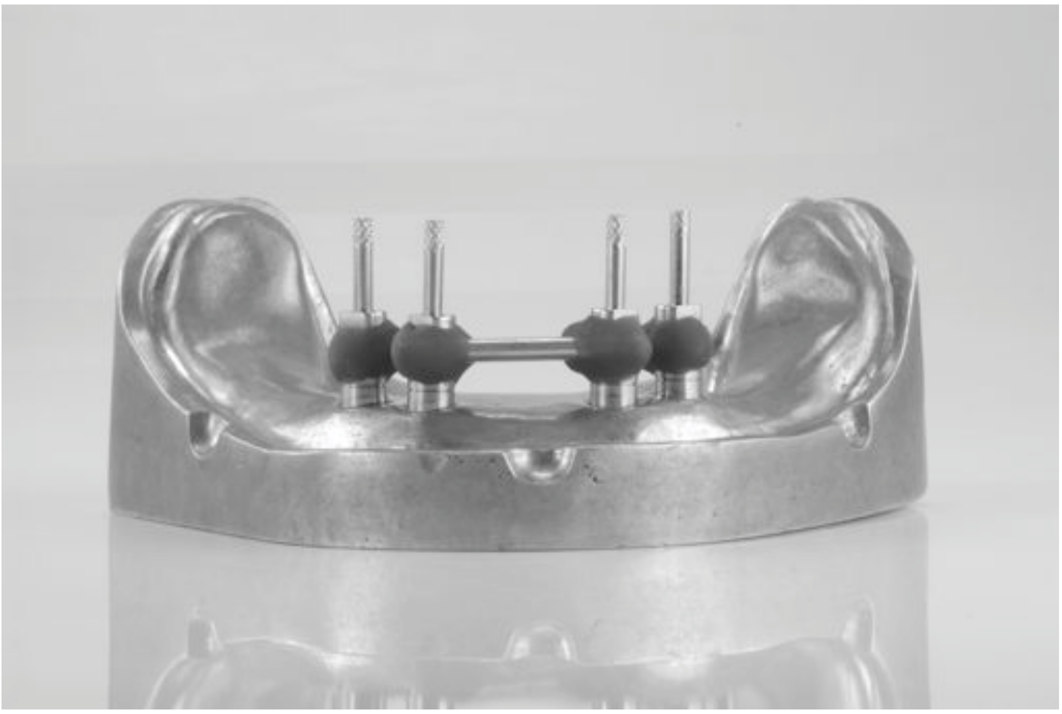

3º Artigo

The impact of splint material rigidity in implant impression techniques

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The impact of splint material rigidity in implant impression techniques

ABSTRACT

Purpose: This in vitro study compared the dimensional accuracy of 2 impression techniques (Duralay Splinted Impression Copings and Metal Splinted Impression Copings) for implant-supported prostheses. **Materials and Methods:** A master cast with 4 parallel implant abutment analogs and a passive framework were fabricated. Vinyl Polysiloxane impression material (Express putty/light body - 3M ESPE) was used for all impressions with a metal stock tray. Two groups (n=5): Duralay Splinted (**D**) and Metal Splinted (**M**) were tested. The measurement method employed was just one titanium screw tightened to the framework. Group's measurements were analyzed using software (LeicaQWin - Leica Imaging Systems Ltd) that received the images of a video camera coupled to a Leica stereomicroscope at x100 magnification. The results were statistically analyzed (t-test, $p<0.05$). **Results:** The mean values of abutment/framework interface gaps were: **D**=165.03 µm; **M**=68.55 µm. There was a statistically significant difference between the groups (P = <0.001). **Conclusion:** Under the conditions of this study, the more accurate impression technique was Squared Metal Splinted Impression Copings technique, proving that the splint material rigidity in implant impression techniques is an important factor to be considered.

Keywords: dental implant, splinting material, implant impression technique.

INTRODUCTION

Dental implants have given dentistry the successful method to provide effective rehabilitation and to improve the quality of life of fully and partially edentulous patients. However, due to the precise machine fit of implant components and to the rigid connection of implant to bone,[1-3] the accuracy of master cast is even more critical when compared to conventional fixed prosthodontics, depending upon the type of impression material, impression technique, dimensional change of dental stone during setting, and implant master cast technique.[4]

To provide a passive fit, a framework should induce no strain on the supporting implant components and the surrounding bone in the absence of an applied external load.[2] However, the clinical and laboratory variables intrinsic to restorative treatment make it unattainable to fabricate an absolutely passive framework fit. [2,5] Small gaps can lead to stress applied to the implants on screwing down the framework.[3]

Vinyl polysiloxane impression materials have been widely accepted due to excellent dimensional stability, superior recovery from deformation, and precise detail reproduction. Adequate mechanical properties ensure the impression material can withstand various stresses upon removal, while maintaining dimensional stability and integrity.[6-8]

There are indirect and direct impression techniques for implant-supported prosthesis. The direct technique may use splinted or nonsplinted implant impression copings. The splinting of the transfer copings avoids the rotational movement of impression copings in the impression material under the applied torque force during analog fastening and control of the transfer coping relationships in the impression material. The materials used to splint impression copings are light-curing composite resin,[9] impression plaster,[10-13] thermoforming material and acrylic resin[14] or autopolymerizing acrylic resin.[10,15-25]

Humphries et al.[15] concluded that the indirect technique is better than the direct technique. In contrast, some authors reported better results with the direct technique.[17,20,26,27] Others concluded that both techniques are equally accurate.[23,28-30]

Several authors advocate that splinting the transfer coping with acrylic resin delivers better results than not splinting. [17,21,25,29,31-33] However, others studies had demonstrated that this splinting process is unnecessary.[15,16,18-20,22,23,27]

Although several impression techniques have been proposed to provide a cast that will ensure accurate fit of prostheses on osseointegrated implants, there is no article in the literature specifically regarding the material rigidity used to splint impression copings. The accuracy of a splinted impression technique will depend on if the splint does not deform under the forces of impression material. Thus, theoretically, a technique that used a more rigid splint material, produce a more accurate master cast. Therefore, it was the purpose of this study test the effect of the splint rigidity on the dimensional accuracy of 2 splinted impression techniques (Duralay Splinted Impression Copings and Metal Splinted Impression Copings) using vinyl polysiloxane impression material, metal stock tray, and a master framework for implant-supported prostheses.

MATERIALS AND METHODS

A mandibular edentulous clinical cast with 4 parallel abutment analogs was fabricated to serve as a clinically relevant simulation (Master Cast). The analogues were secured temporally with Duralay resin (to make their removal possible after making of the framework). A framework was made using titanium cylinders and 2 mm diameter titanium bars (Conexão; Conexão Prosthesis Systems, São Paulo, Brazil) using a laser-welding technique. The Duralay resin and the original analogues were removed and discarded. Four new analogues were screwed to the framework with the aid of a calibrated torque wrench (Conexão; Conexão Prothesis Systems Ltd., São Paulo, Brazil) limited to 10 Ncm and then embedded into the master cast holes with epoxy resin.[21,24,27,29] The framework was removed from master cast only after the polymerization of the epoxy resin was complete. Thus, the discrepancies due to welding procedure were eliminated almost entirely and a metal master cast with a passively-fitting framework was produced.[17,27,31]

Usually stock metal trays are used for indirect impression technique, however, metal stock trays were used instead of individual trays to facilitate and make more simple and rapid the direct impression technique. Four windows were created in the metal stock tray to expose coping screws. A box for pouring the impression with dental stone was made with condensation silicone (Zetaplus/Oranwash; Zermack, Badia Polesine, Rovigo, Italy). This matrix was used for all of the impressions, allowing reproduce tray position and standardization of the format of the casts and of the amount of dental stone employed for the pouring (Fig 1).

The fitting surfaces of all components were cleaned with isopropyl alcohol before each impression.[22] All squared impression copings were adapted to the abutment analogs on the master cast using 10 Ncm torque[34] (Fig 2). Correct seating of the impression copings was verified throughout the impression and pouring procedures both visually and with a probe (nº 5 Duflex - SS White, Rio de Janeiro, Brazil).

Two groups with 5 casts each were evaluated:

• **Group M: Metal Splinted Impression Copings.** The shanks of right angle burs (2.35 mm diameter) were fixed with cyanoacrylate adhesive (Loctite Super Bonder; Henkel Ltda, Itapevi, São Paulo, Brazil) in squared impression copings at the level of their circumferential groove to serve as a rigid splinting material (Fig 3). Small increments of Duralay acrylic resin (Duralay; Reliance Dental Mfg, Worth, IL) were added to the shanks of right angle burs and impression copings using a bead brush technique (Fig 4).

• **Group D: Duralay Splinted Impression Copings**. The splinting process was initiated by placing Duralay acrylic resin around the copings. Preformed acrylic resin bars with a cross-sectional diameter of approximately 3 mm were fabricated at least 24 hours before by the injection of acrylic resin into a drinking straw.[35] Appropriate lengths of the resin bar were sectioned with a cutting disk (Intensiv SA,Grancia,Switzerland) to bridge the spaces between the adjacent transfer copings. Using a bead brush technique, the ends of the resin bar were luted to the transfer copings with acrylic resin.[35,36] An additional step of sectioning (diamond-coated disk 150 μm thick; Intensiv SA) and rejoining the acrylic resin was performed to reduce the effects of polymerization shrinkage[19,24,37] (Fig 5).

The acrylic resin was allowed to set for 17 minutes before the impression was made.[36] The impressions were made in a controlled-temperature environment (23 ± 2°C) with a relative humidity of 50% ± 10%. Vinyl Polysiloxane impression material (Express putty/light body - 3M ESPE) was used according to the manufacturer's instructions. Each impression was produced with equal quantities of impression material. The putty impression material was mixed for 30 seconds by hand and loaded inside the tray and, at the same time, the light body was syringed around the impression copings and splint, followed by immediate placement of the tray loaded with putty impression material. The tray was seated on the master cast with gentle pressure until contacted the base of the master cast. The impression material was allowed to set for 10 minutes from the start of mixing. The manufacturer's setting time was doubled to compensate for a delayed polymerization reaction at room temperature rather than at mouth temperature.[22,38-40] A standardized pressure of 1.25 kg was exerted over each tray during the impression procedures. This was enough to force the excess material to flow out and to maintain constant pressure throughout the working time.[27,32]

After impression material polymerization, the impression copings were unscrewed and the tray was separated from the master cast. The abutment analogs were then fit to the impression copings using 10 Ncm torque.

A two-times pouring technique was used to minimize alteration of the setting expansion of the dental stone.[27,41-43] Four pieces of latex tube were used, each with a length of 23 mm, an internal diameter of 4 mm, and an external diameter of 8 mm (Auriflex, São Roque, SP, Brazil). The tubes were fitted onto the analogs (Fig 6), and pouring was performed with a die stone (Vel-Mix; Kerr Corporation, Orange, CA) 2 hours after the impressions were made. A ratio of 22 mL of water to 110 g of stone was used, and the stone was mixed by hand for 15 seconds to incorporate the water and then mechanically mixed under vacuum for 30 seconds with a digital vacuum spatulator (Turbomix EDG Equipment, São Carlos, SP, Brazil). After the initial setting (approximately 10 minutes), the latex tubes were removed. A ratio of 6 mL of water to 25 g of stone was mixed following the process described previously and syringed (20 mL BD Plastipak syringe; Becton Dickinson, Curitiba, PR, Brazil) around the analogs (Fig 7). All mixes were vibrated into boxed impressions and allowed to set for 2 hour before separation from the impressions.[27] All 10 casts obtained were stored at room temperature for a minimum of 2 weeks before measurement.[19,22,39]

The 4 implant abutment analogs in the master cast were denoted sequentially A through D from left to right. The standard framework was seated on each cast and a titanium screw was tightened in analog A to 10 Ncm (Fig 8) using a torque driver while measurements of abutment-framework interface gaps were made for analogs C and D. This process was repeated in analog D, and the measurements for analogs A and B were noted.[1,27,44-47]

These measurements were analyzed using software (Leica Qwin; Leica Imaging Systems, Cambridge, England) that received the images from a video camera (JVC, 0.5 inch CCD, model TK-C1380, Tokyo, Japan) coupled to a Leica stereomicroscope (Leica Microsystems, Wetzlar, Germany) at 100X magnification (Fig 9).

Demarcations were made in the center of each titanium abutment of the framework to standardize the area for image capture. For each obtained picture, lineal readings of the gap were accomplished in 3 areas. The arithmetic mean of these 3 values determined the value of the gap. The mean gap value for the master cast was calculated as the average of 5 consecutive measurements (20 gap values), and the framework was screwed before each measurement. The same person performed all procedures.

With the aid of the SigmaStat version 3.11 software (Systat, Evanston, IL), a suitable statistical test was applied. After running statistical adaptation tests (Normality Test and Equal Variance Test), the t-test was used. Values of $P<.05$ were judged to be significant.

RESULTS

Two groups with 5 casts each were formed for a total of 10 casts. Forty gap values were calculated. The mean gap value for master cast was of 31.63 μm (SD 2.16). The mean and standard deviation of abutment-framework interface gaps are summarized in Table I. There was a statistically significant difference between **D** and **M** groups ($P = <0.001$).

DISCUSSION

The master cast on which the restoration superstructure is fabricated must reproduce the intraoral position of the abutments and surrounding hard and soft tissues as accurately as possible, to allow for the fabrication of passively-fitting prostheses and, consequently, the elimination of strain on the supporting implant components and the surrounding bone.[2,40] If a clinically passive fit is not achieved and the metal supporting structure is unstable intraorally, the metal framework is usually sectioned, repositioned, and soldered. But this involves more time and produces a weaker and metallurgically more complex prosthetic framework.

A perfect fit occurs when all the matching surfaces of the implant and prosthesis are in alignment and contact without the application of force.[5] In order to identify a passive fit, the master cast used in this study was produced using a previously completed metal framework. However, a gap of 31.63 μm was still observed between the framework and abutment analogs. This gap can be explained by the measurement method employed. Just 1 titanium screw was tightened to the framework, leading to amplification of the gap values.[27]

A torque of 10Ncm was used for tightening the gold screws. With a higher torque, there would have been a risk of screw fracture, the vertical discrepancy would have been reduced, and there inevitably would have been transfer of stresses to the implants and screws.[5]

An ideal impression technique would require minimal time, usefulness, inexpensive, comfortable for the patient and, of course, would give the best results.[20] The 1-step putty-wash technique was chosen for this study because of its convenience, common clinical usage and better clinical results.[8]

In order to minimize the plaster expansion factor, a 2-times pouring technique was accomplished,[27,41-43] in spite of the pouring technique did not influence the accuracy of the stone casts when splinted squared impression copings are used.[27]

Splinting procedure is recommended before making the impression of implant-supported prosthesis, in order to decrease the amount of distortion and to improve impression accuracy and implant stability.[17,21,25,29,31-33]

Unsatisfactory results were obtained with the use of the Duralay Splinted Impression Copings technique. The gaps observed when the Metal Splinted Impression Copings technique (M= 68.55µm) was used were smaller than those observed with the Duralay Splinted Impression Copings technique (D=165.03µm). The increased splint rigidity by metal burs has a role in preventing permanent deformation of splint by stress that is exposed from recovery of the impression to fabrication of the working cast. Splint the impression copings with metal burs to withstand forces of distortion and to avoid the time required for acrylic resin polymerization and the additional step of sectioning and rejoining the acrylic resin splint is a clinical advantage.

CONCLUSIONS

Under the conditions of this study, the more accurate impression technique was Squared Metal Splinted Impression Copings technique, proving that the splint material rigidity in implant impression techniques is an important factor to be considered.

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ILUSTRATIONS AND TABLES

Fig. 1 Master cast, metal stock tray, matrix for pouring the impression and impression material.

Fig. 2 Squared impression copings adapted to the abutment analogs on the master cast.

Fig. 3 Shanks of right angle burs fixed with Super Bonder in squared impression copings.

Fig. 4 Squared Metal Splinted Impression Copings.

Fig. 5 Resin bar was rejoined with a bead brush technique.

Fig. 6 Latex tubes being fitted onto analogs.

Fig. 7 Syringing dental stone around analogs.

Fig. 8 Framework tightened in analog A to 10 Ncm (4º cast of Group Duralay Splinted).

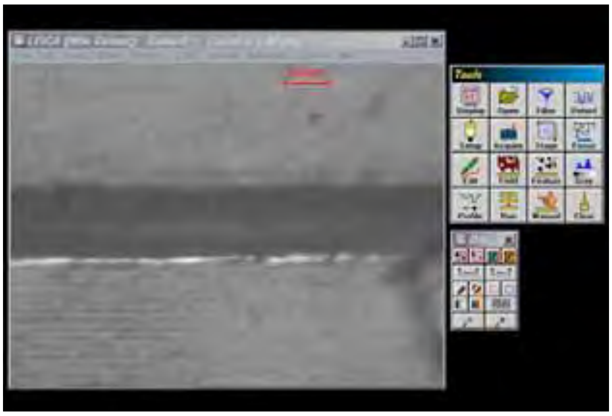


Fig. 9 Image at 100X magnification of abutment D/framework interface gap (143.57 μm gap).

Table I. Comparison between techniques using the t-test

Group	*N*	*Mean*	*SD*	*SEM*
Metal Splinted	20	68.55	36.11	8.07
Duralay Splinted	20	165.03	59.64	13.34

Difference = -96.48

t = -6.19 with 38 degrees of freedom.

There is a statistically significant difference between the groups (P = <0.001)

Power of performed test with alpha = 0.050: 1.000

Discussão

Discussão

A hipótese testada no presente estudo, de que a exatidão dos modelos de gesso não seria afetada pela técnica de moldagem e pelo material de moldagem foi rejeitada, uma vez que os resultados demonstraram diferenças significativas entre essas variáveis (Tabelas do Apêndice).

As técnicas com transferentes quadrados, jateados ou não, moldados com Impregum e moldeira individual, bem como as técnicas Index e transferentes quadrados com extensão lateral moldados com moldeira de estoque de inox e Express consistência densa/fluida foram altamente precisas, obtendo os melhores resultados, sendo estes estatisticamente semelhantes ao modelo mestre.

A técnica com transferentes quadrados modificados com extensão lateral proporciona uma segurança maior devido à redução da possibilidade do transferente girar no interior do molde no momento do parafusamento do análogo. A extensão lateral fornece uma maior estabilização, pela retenção adicional e resistência contra o deslocamento oferecida pela maior área de superfície de contato entre o transferente e o material de moldagem[15,16,30]. Essa extensão lateral pode ser feita com resina acrílica, resina composta ou inteiramente em metal. Devido aos resultados superiores observados a partir dessa técnica, deixa-se como sugestão aos fabricantes de componentes protéticos, a criação de um componente com um formato retangular, simulando essas extensões laterais. Pode-se também sugerir que os resultados dessa técnica aplicada para múltiplos implantes possam ser extrapolados para a situação clínica com implantes unitários.

Dentre as técnicas avaliadas no presente estudo, foi também considerada a precisão dos modelos obtidos a partir de moldagens utilizando transferentes quadrados jateados com óxido de alumínio seguidos por aplicação de adesivo[46,48,49]. A partir desta técnica, cria-se uma melhor conexão entre o transferente e o material de moldagem, o que implicaria que o grau de micromovimentos deveria diminuir durante todos os passos desde a realização da moldagem até o vazamento e resultar em um modelo mestre mais preciso[46,48,49]. Entretanto, esta teoria não foi observada a partir dos resultados apresentados neste estudo. Ao se realizar as moldagens com Impregum ou Express regular e moldeira individual observou-se que o procedimento de jateamento e aplicação de adesivo foi desnecessário, uma vez que os resultados foram estatisticamente semelhantes aos grupos com transferentes quadrados não jateados, concordando com os resultados de Vigolo et al.[46], em 2004. Além disso, esse procedimento apresenta como desvantagem um maior tempo para a sua realização.

Em relação a técnica do Index avaliada neste estudo, observou-se que a transferência do posicionamento dos implantes ocorreu de maneira precisa. Esse resultado poderia ser explicado pela ausência de material de moldagem, que gera tensões e micromovimentações na esplintagem, e pela pequena quantidade de gesso empregada no vazamento, minimizando as possíveis alterações advindas da expansão de presa[12]. Porém, como a técnica do Index não copia tecidos moles, só pode ser utilizada como confirmação da precisão de um outro modelo de gesso obtido através de uma outra técnica de moldagem ou então para a realização das soldas da estrutura metálica.

O material empregado para a esplintagem na técnica do Index foi resina composta fotopolimerizável devido ao fato de possuir uma contração de polimerização menor que a da resina acrílica autopolimerizável e evitar o tempo requerido para a polimerização, seccionamento e re-união do esplinte[12,22,23].

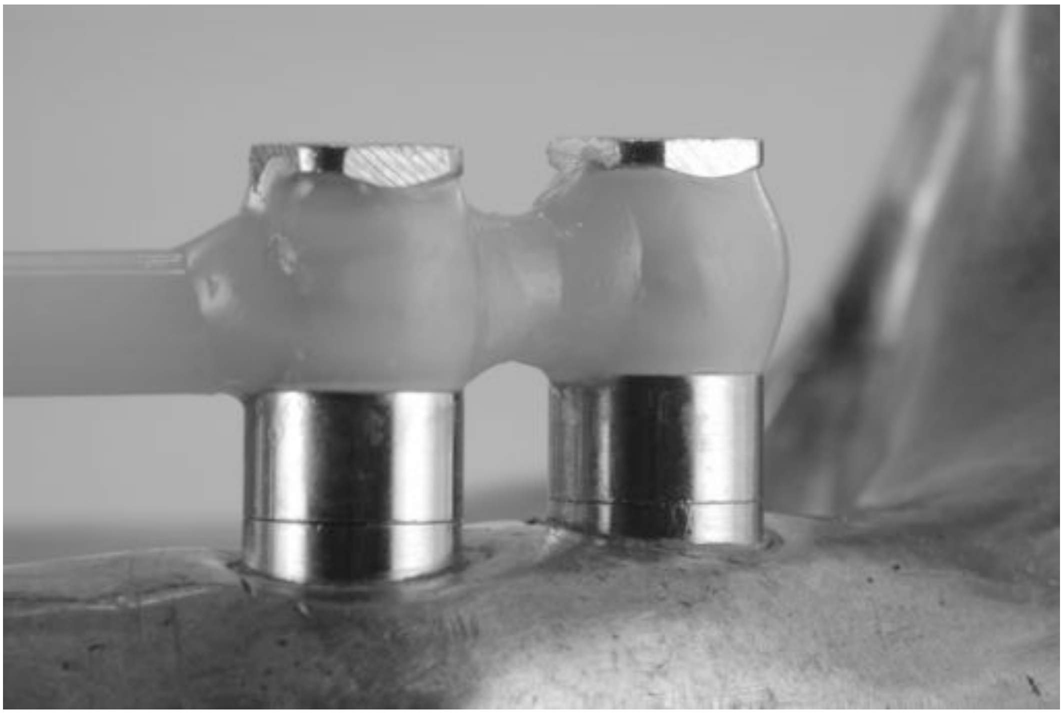
Em relação às técnicas com os transferentes esplintados, foi constatado que não houve nenhuma vantagem em se utilizar a técnica unida com Duralay, a não ser que esta união seja realizada com a intenção de se confeccionar um Index[13]. Os resultados do presente estudo mostraram que a união dos transferentes com barra de metal obteve maior precisão do que a técnica com transferentes unidos com Duralay. Este resultado poderia ser explicado uma vez que o aumento da rigidez do conjunto esplinte/transferente tem um papel importante na prevenção da sua deformação pelo estresse ao qual é exposto, desde a moldagem até a fabricação do modelo de trabalho[29,46]. Além disso, esplintar os transferentes quadrados com barras de metal pode ser considerado vantajoso, uma vez que elimina a fase laboratorial para a confecção das barras de resina acrílica e o tempo clínico requerido para o seccionamento e re-união do esplinte de resina acrílica.

Em relação aos material de moldagem com consistência regular, as fendas observadas quando se utilizou o Impregum foram muito menores que aquelas observadas para o Express, o que indica que o poliéter seria o material de escolha a ser utilizado em moldeira individual. Isto se deveria ao fato de este material possuir rigidez suficiente para estabilizar o transferente quadrado no interior do molde, prevenindo seu deslocamento acidental durante todos os procedimentos relacionados com a fabricação do modelo de trabalho[38]. Os resultados deste estudo portanto indicaram que a composição e a viscosidade do material de moldagem são fatores a serem considerados[51].

Assim, o objetivo de nossos trabalhos foi avaliar como produzir modelos de gesso mais precisos, pois é sabido que ajuste passivo é um fator relevante para a manutenção da osseointegração e sucesso dos implantes[28,39,42,50]. Apesar da estrutura metálica de nossos trabalhos possuir um ajuste o mais passivo possível no modelo mestre, foi observada ainda uma fenda de 31,63 µm que pode ser explicada pelo método de mensuração das fendas pelo aperto de um só parafuso da estrutura metálica resultar na amplificação dos seus valores[11,13,22,25,28,40,45,53].

Para o vazamento dos modelos de gesso avaliados neste estudo foi utilizada a técnica de vazamento com tubos de látex (técnica de vazamento em 2 tempos), pois requer uma menor quantidade de gesso uniformemente distribuída ao redor de cada análogo. Esta técnica foi utilizada com o objetivo de minimizar os efeitos da expansão de presa do gesso[5,13].

Considerando as limitações deste estudo serão necessários futuros trabalhos com o objetivo de avaliar técnicas de moldagem em próteses sobre implante utilizando modelos parcialmente desdentados. Porém, devido a enorme variedade de materiais de moldagem disponíveis atualmente, outros materiais devem ser avaliados. Apesar do presente estudo ter sido realizado in vitro, é esperado que as técnicas avaliadas tenham um desempenho semelhante em condições clínicas.



Considerações Finais

Considerações Finais

Dentro das condições experimentais deste estudo, pode-se concluir que as técnicas que tiveram resultados estatisticamente semelhantes ao modelo mestre foram: transferente quadrado utilizando-se Impregum e moldeira individual, transferente quadrado jateado utilizando-se Impregum e moldeira individual, Index e transferente quadrado com extensão lateral utilizando-se Express consistência densa/fluida e moldeira de estoque de inox. Porém, pelos motivos descritos, fica como indicação para a obtenção de modelos de trabalhos precisos a técnica com transferente quadrado com extensão lateral utilizando-se Express consistência densa/fluida e moldeira de estoque de inox.


Accuracy of Impression and Pouring Techniques for an Implant-Supported Prosthesis

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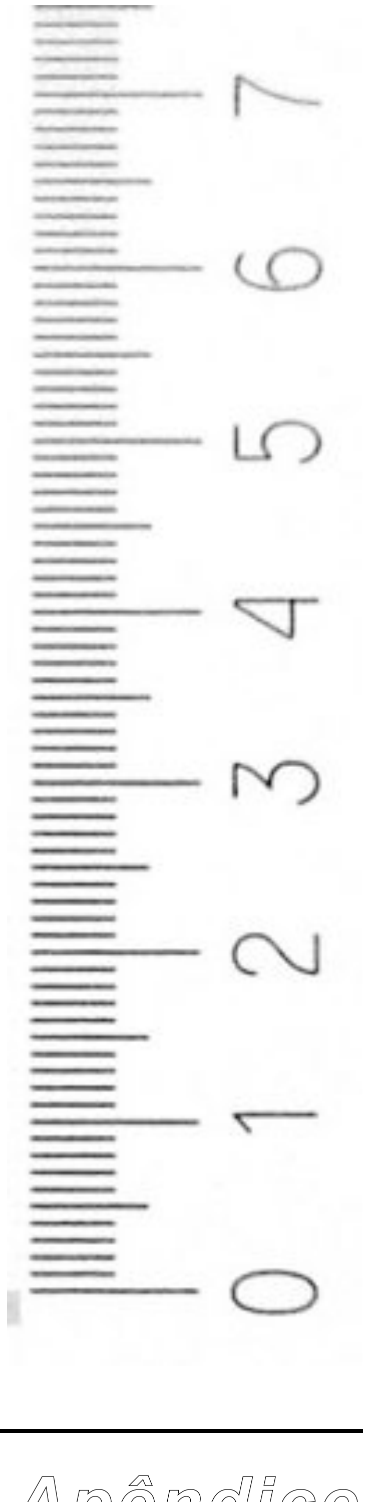

Apêndice

Apêndice

A Tabela 1 contém todos os valores das 5 mensurações feitas para o Modelo Mestre.

Tabela 1 – Modelo Mestre (31,63 µm)

ANÁLOGO	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
A	46,19	49,13	52,82	37,59	44,47
B	42,99	42,75	41,76	33,90	38,08
C	21,37	20,64	17,93	19,16	17,69
D	23,34	18,18	20,64	23,83	20,14
MÉDIA	**33,47**	**32,68**	**33,29**	**28,62**	**30,10**

Nas tabelas seguintes estão os resultados das mensurações das fendas para as técnicas de moldagem e as comparações feitas após a análise estatística. (Tabelas 1.1 a 1.5 referentes ao 1º Artigo; Tabelas 2.1 a 2.6 referentes ao 2º Artigo, Tabelas 3.1 e 3.3 referentes ao 3º Artigo e Tabelas 4.1 e 4.2 referentes a todas as técnicas descritas nos 3 artigos).

A análise estatística foi feita com o auxílio do programa SigmaStat versão 3.11 (Systat, Evanston, IL). O teste estatístico indicado para cada comparação feita foi aplicado após serem testadas a normalidade (teste de Kolmogorov-Smirnov) e a homogeneidade das variâncias (teste de Levene).

Tabela 1.1 – Index de Resina Composta Z100 (45,25 µm)

ANÁLOGO	1° Index	2° Index	3° Index	4° Index	5° Index
A	30,87	20,58	55,37	36,26	41,65
B	61,74	66,15	74,48	62,72	76,44
C	35,77	52,43	38,71	30,38	52,43
D	44,59	27,93	25,48	44,59	26,46
MÉDIA	**43,24**	**41,77**	**48,51**	**43,49**	**49,25**

Tabela 1.2 – Quadrado Extensão Lateral Express Densa/Fluida Moldeira Inox (51,20 µm)

ANÁLOGO	1° Modelo	2° Modelo	3° Modelo	4° Modelo	5° Modelo
A	47,04	43,61	27,93	54,39	94,08
B	72,03	38,22	19,11	65,17	61,25
C	35,77	91,14	72,52	70,07	50,96
D	20,58	26,95	28,42	72,03	32,83
MÉDIA	**43,86**	**49,98**	**37,00**	**65,41**	**59,78**

Tabela 1.3 – Quadrado Express Densa/Fluida Moldeira Inox (96,14 µm)

ANÁLOGO	1° Modelo	2° Modelo	3° Modelo	4° Modelo	5° Modelo
A	62,23	143,08	88,69	116,62	103,39
B	70,56	85,26	56,84	78,40	98,98
C	90,65	105,84	119,07	147,98	160,72
D	36,26	100,45	48,02	101,43	108,29
MÉDIA	**64,93**	**108,66**	**78,16**	**111,11**	**117,85**

Teste de normalidade: Passaram (P = 0,738)

Teste de semelhança das variâncias: Passaram (P = 0,083)

Tabela 1.4 – Análise de Variância a um critério de classificação (One Way ANOVA)

Grupo	Média	Desvio Padrão	Erro Padrão da Média
Index Resina Composta	45,252	16,787	3,754
Quadrado Express	96,138	32,545	7,277
Quadrado Extensão Lateral Express	51,205	22,773	5,092

Fonte de Variação	Graus de Liberdade	Soma dos Quadrados	Média Quadrática	F	P
Entre Grupos	2	30959,03	15479,515	24,973	<0,001
Dentro dos Grupos	57	35331,855	619,857		
Total	59	66290,886			

As diferenças entre os valores das médias foram maiores do que seria esperado ao acaso, havendo diferença estatisticamente significativa entre os grupos de tratamento (P = <0,001).

Tabela 1.5 – Método de comparações múltiplas de Holm-Sidak

Comparações	Diferença das Médias	t	Valor de p não ajustado	Nível Crítico	Significante
Quadrado Express x Index Resina	50,887	6,463	2,48E-08	0,017	Sim
Quadrado Express x Hélice Express	44,933	5,707	0,000000432	0,025	Sim
Hélice Express x Index Resina Composta	5,953	0,756	0,453	0,05	Não

Tabela 2.1 – Quadrado Impregum Moldeira Individual (38,03 µm)

ANÁLOGO	1° Modelo	2° Modelo	3° Modelo	4° Modelo	5° Modelo
A	5,15	31,36	32,92	59,21	40,79
B	42,63	14,95	34,64	41,03	29,24
C	26,22	69,34	31,70	69,04	134,64
D	43,12	29,65	21,38	2,70	0,98
MÉDIA	**29,28**	**36,33**	**30,16**	**43,00**	**51,41**

Tabela 2.2 – Quadrado Jateado Impregum Moldeira Individual (46,80 µm)

ANÁLOGO	1° Modelo	2° Modelo	3° Modelo	4° Modelo	5° Modelo
A	21,56	45,08	43,61	21,07	32,83
B	25,48	45,57	37,24	67,13	51,45
C	136,71	92,12	64,68	29,40	55,86
D	43,61	34,79	27,44	29,89	30,38
MÉDIA	**56,84**	**54,39**	**43,24**	**36,87**	**42,63**

Tabela 2.3 – Quadrado Jateado Express Regular Moldeira Individual (136,59 µm)

ANÁLOGO	1° Modelo	2° Modelo	3° Modelo	4° Modelo	5° Modelo
A	130,83	143,57	97,51	162,19	142,59
B	151,9	204,33	104,37	282,73	101,43
C	139,16	175,91	137,69	145,53	191,59
D	146,51	20,58	20,09	100,94	132,3
MÉDIA	**142,10**	**136,10**	**89,92**	**172,85**	**141,98**

Tabela 2.4 – Quadrado Express Regular Moldeira Individual (151,21 µm)

ANÁLOGO	1° Modelo	2° Modelo	3° Modelo	4° Modelo	5° Modelo
A	33,81	56,35	22,54	64,68	24,99
B	327,32	343,98	94,57	300,86	187,18
C	348,39	221,97	347,41	147,98	266,07
D	35,77	23,52	102,9	25,48	48,51
MÉDIA	**186,32**	**161,46**	**141,86**	**134,75**	**131,69**

Tabela 2.5 – Teste de Kruskal-Wallis

Grupo	Mediana	25%	75%
Modelo Mestre	28,865	20,39	42,87
Quadrado Impregum	32,31	23,8	42,875
Quadrado Jateado Impregum	40,425	29,645	53,655
Quadrado Expres Regular	98,735	34,79	283,465
Quadrado Jateado Express Regular	140,875	102,9	157,045

H = 36,645 com 4 graus de liberdade. (P = <0,001)

As diferenças entre os valores das medianas foram maiores do que seria esperado ao acaso, havendo diferença estatisticamente significativa entre os grupos de tratamento. (P = <0,001)

Para isolar o grupo ou grupos que diferem dos outros foi utilizado um procedimento de comparação múltipla.

Tabela 2.6 **–** Comparações múltiplas contra o Modelo Mestre (Teste de Dunn)

Comparação (contra Modelo Mestre)	Diferença de Postos	Q	P<0,05
Quadrado Jateado Express	44,65	4,867	Sim
Quadrado Express Regular	36,6	3,989	Sim
Quadrado Jateado Impregum	14,3	1,559	Não
Quadrado Impregum	4,95	0,54	Não

Tabela 3.1 – Quadrado Unido Barra Metal Express Densa/Fluida Moldeira Inox (68,55 µm)

ANÁLOGO	1º Modelo	2º Modelo	3º Modelo	4º Modelo	5º Modelo
A	80,36	56,84	61,74	47,04	137,20
B	107,80	71,54	110,74	75,46	124,46
C	18,62	37,73	33,32	54,88	85,26
D	53,90	35,77	16,17	40,67	121,52
MÉDIA	**65,17**	**50,47**	**55,49**	**54,51**	**117,11**

Tabela 3.2 – Quadrado Unido Duralay Express Densa/Fluida Moldeira Inox (165,03 µm)

ANÁLOGO	1º Modelo	2º Modelo	3º Modelo	4º Modelo	5º Modelo
A	186,20	156,31	249,90	116,62	137,20
B	186,20	130,34	176,40	109,27	103,39
C	293,51	93,10	194,53	132,79	136,71
D	298,90	108,78	204,82	143,57	142,10
MÉDIA	**241,20**	**122,13**	**206,41**	**125,56**	**129,85**

Teste de normalidade: Passaram (P = 0,087)

Teste de semelhança das variâncias: Passaram (P = 0,193)

Tabela 3.3 – Teste t

Grupo	Média	Desvio Padrão	Erro Padrão da Média
Unido com Metal	68,551	36,105	8,073
Unido com Duralay	165,032	59,64	13,336

Diferença = -96,481

t = -6,189 com 38 graus de liberdade. (P = <0,001)

95% de intervalo de confiança para diferença das médias: -128,040 até -64,922

A diferença nos valores médios dos 2 grupos é maior do que seria esperado pelo acaso, existe uma diferença estatisticamente significativa entre os grupos (P = <0,001).

Tabela 4.1 – Teste de Kruskal-Wallis

Grupo	Mediana	25%	75%
Modelo Mestre	28,865	20,39	42,87
Index Z100	43,12	30,625	58,555
Quadrado Impregum	32,31	23,8	42,875
Jateado Impregum	40,425	29,645	53,655
Quadrado Express regular	98,735	34,79	283,465
Jateado Express regular	140,875	102,9	157,045
Quadrado Express densa/fluida	99,715	74,48	112,455
Hélice Express densa/fluida	49	30,625	71,05
Metal Express densa/fluida	59,29	39,2	96,53
Duralay Express densa/fluida	142,835	123,48	190,365

H = 97,368 with 9 degrees of freedom. (P = <0,001)

As diferenças entre os valores das medianas foram maiores do que seria esperado ao acaso, havendo diferença estatisticamente significativa entre os grupos de tratamento. (P = <0,001)

Para isolar o grupo ou grupos que diferem dos outros foi utilizado um procedimento de comparação múltipla.

Tabela 4.2 – Comparações múltiplas contra o Modelo Mestre (Teste de Dunn)

Comparação (contra Modelo Mestre)	Diferença de Postos	Q	P<0,05
Unido com Duralay – Express densa/fluida	125,125	6,836	Sim
Quadrado Jateado - Express Regular	106,9	5,841	Sim
Quadrado - Express densa/fluida	88,775	4,85	Sim
Quadrado - Express regular	81,325	4,443	Sim
Unido com Metal - Express densa/fluida	55,55	3,035	Sim
Quadrado Hélice - Expres densa/fluida	35,6	1,945	Não
Index resina composta Z100	28,675	1,567	Não
Quadrado Jateado Impregum	26,15	1,429	Não
Quadrado Impregum	10,9	0,596	Não