UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

Conrado Reinoldes Caetano

Movimentação de dentes em próteses totais superior e inferior influenciada por diferentes tipos de muflas metálicas e para micro-ondas

Teeth displacement on upper and lower complete dentures influenced by different metal and microwave flask types

Piracicaba

2017

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Tese apresentada à Faculdade de Odontologia de Piracicaba da Universidade Estadual de Campinas como parte dos requisitos exigidos para a obtenção do título de Doutor em Clínica Odontológica na Área de Prótese Dental.

Thesis presented to the Piracicaba Dental School of the University of Campinas in partial fulfillment of the requirements for the degree of Doctor in Clinical Dentistry, in Dental Prosthesis area.

Orientador: Prof. Dr. Rafael Leonardo Xediek Consani

Este exemplar corresponde à versão final da tese defendida pelo aluno Conrado Reinoldes Caetano, e orientado pelo Prof. Dr. Rafael Leonardo Xediek Consani.

Piracicaba

2017

Agência(s) de fomento e nº(s) de processo(s): CAPES
ORCID: http://orcid.org/http://orcid.org/ht

Ficha catalográfica
Universidade Estadual de Campinas
Biblioteca da Faculdade de Odontologia de Piracicaba
Marilene Girello - CRB 8/6159

	Caetano, Conrado Reinoldes, 1988-
C116m	Movimentação de dentes em próteses totais superior e inferior influenciada por diferentes tipos de muflas metálicas e para micro-ondas / Conrado Reinoldes Caetano. – Piracicaba, SP : [s.n.], 2017.
	Orientador: Rafael Leonardo Xediek Consani.
	Tese (doutorado) – Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba.
	1. Movimentação dentária. 2. Prótese dentária completa. 3. Polimerização. I. Consani, Rafael Leonardo Xediek,1974-. II. Universidade Estadual de Campinas. Faculdade de Odontologia de Piracicaba. III. Título.

Informações para Biblioteca Digital

Título em outro idioma: Teeth displacement on upper and lower complete dentures influenced by different metal and microwave flask types
Palavras-chave em inglês:
Tooth movement
Complete dentures
Polymerization
Área de concentração: Prótese Dental
Titulação: Doutor em Clínica Odontológica
Banca examinadora:
Rafael Leonardo Xediek Consani [Orientador]
Antonio Marcos Montagner
Rafael Pino Vitti
Debora Alves Nunes Leite Lima
Marina Xavier Pisani de Souza
Data de defesa: 23-02-2017
Programa de Pós-Graduação: Clínica Odontológica

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Faculdade de Odontologia de Piracicaba

A Comissão Julgadora dos trabalhos de Defesa de Tese de Doutorado, em sessão pública realizada em 23 de Fevereiro de 2017, considerou o candidato CONRADO REINOLDES CAETANO aprovado.

PROF. DR. RAFAEL LEONARDO XEDIEK CONSANI

PROF. DR. ANTONIO MARCOS MONTAGNER

PROF. DR. RAFAEL PINO VITTI

PROFª. DRª. DEBORA ALVES NUNES LEITE LIMA

PROFª. DRª. MARINA XAVIER PISANI DE SOUZA

A Ata da defesa com as respectivas assinaturas dos membros encontra-se no processo de vida acadêmica do aluno.

Dedico este trabalho

A DEUS, acima de tudo por capacitar-me. Toda Honra e Toda Glória por mais essa Conquista ao Único que É Digno, DEUS, JESUS CRISTO e ESPÍRITO SANTO.

Aos meus Pais José Caetano Filho e Sizalta Aparecida Biajoli Reinoldes Caetano, por todo apoio e carinho não só nesses anos, mas em todos os anos da minha Vida. Agradeço a DEUS, por meus Pais serem Bênçãos em todos os sentidos da minha Vida, ensinando-me por quais caminhos devo andar e o que devo fazer nas situações que enfrentamos durante a Vida. Obrigado pelo Amor Incondicional que os meus Pais têm por mim.

À minha Irmã Larissa Reinoldes Caetano, por estar sempre presente, sendo minha Amiga de todas as horas, apoiando-me em todas as aventuras que planejamos, sendo Bênção de DEUS em todos os momentos da minha Vida, muito obrigado pelo seu Amor por mim.

À minha Tia e Madrinha de Formatura, também Cirurgiã Dentista Viviane Reinoldes Zamberlan, por todo carinho, apoio e incentivo em todos esses anos.

À minha Família, tanto da parte do meu Pai, quanto da minha Mãe, mostrando-me o real sentido do que é viver em Família em todos os sentidos.

À Família da Igreja do Evangelho Quadrangular do Serpa, nas pessoas dos Pastores Nadir Ribeiro Paiva e Deosdete Paiva, por todo o Aprendizado e todos os Ensinamentos e Oração, desde 2006.

A minha tão Amada Família da Igreja Bíblica Evangélica de Piracicaba e aos Pastores Valdir Ávila Sênior e Valdir Ávila, pelos Conselhos, Cuidados, Ensinamentos e Oração, desde 2013.

À Família da Igreja do Evangelho Quadrangular do Areão e ao Pastor Paulinho, que desde 2008, ajudaram-me e me ampararam-me no que precisei com Ensinamentos e Oração.

Amo vocês!

Agradecimentos especiais

Ao meu Orientador Prof. Dr. **Rafael Leonardo Xediek Consani**, por valorizar meu trabalho e esforço, dando o suporte necessário e ensinamentos sobre a Pós-Graduação nesta Instituição de Ensino e Pesquisa. Agradeço por toda atenção e compreensão em todos esses anos trabalhando juntos, concluindo todos os trabalhos idealizados.

Ao meu Amigo **Prof. Dr. Ataís Bacchi**, pela amizade em todos esses anos, e por toda colaboração e disponibilidade na realização deste trabalho.

Ao meu Amigo **Prof. Dr. Mateus Bertolini Fernandes dos Santos**, pela amizade em todos esses anos que convivemos juntos, e por toda colaboração e disponibilidade durante a Pós-Graduação.

Agradecimentos

A **DEUS** acima de tudo, por todo o verdadeiro Amor Incondicional que tem por mim, por me sustentar em momentos difíceis, levando-me e mostrando-me que sou Filho do REI e Herdeiro da Vida Eterna ao Seu lado, com **Cristo Jesus** e o **Espírito Santo**.

À **Faculdade de Odontologia de Piracicaba – UNICAMP**, na pessoa do seu Diretor **Prof. Dr. Guilherme Elias Pessanha Henriques** e do Diretor Associado **Prof. Dr. Francisco Haiter Neto**, pela oportunidade em realizar o Programa de Doutorado.

À **Profa. Dra. Cínthia Pereira Machado Tabchoury**, Coordenadora Geral da Pós-Graduação e a **Profa. Dra. Karina Gonzales Silvério Ruiz**, Coordenadora do Programa de Pós-Graduação em Clínica Odontológica – Área Prótese Dental, pelo apoio institucional**.**

À **Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES,** pela concessão da bolsa de estudos.

Aos **docentes do Departamento de Prótese e Periodontia atuantes no Programa de Pós-Graduação em Clínica Odontológica,** pelos ensinamentos e experiências cotidianas fundamentais para minha formação.

Aos docentes **Prof. Dr. Rafael Leonardo Xediek Consani, Prof. Dr. Marcelo Ferraz Mesquita e Prof. Dr. Valentim Adelino Ricardo Barão** da Área Prótese Total, pela oportunidade de participar das atividades clínicas e teóricas da Graduação. A experiência adquirida com essas atividades foi de grande valia na minha formação.

Aos docentes **Prof. Dr. Guilherme Elias Pessanha Henriques e Prof. Dr. Mauro Antonio de Arruda Nóbilo,** pelo apoio, dedicação, incentivo e companheirismo nesses anos de Pós-Graduação.

Aos docentes **Prof. Dr. Mario Alexandre Coelho Sinhoreti, Prof. Dr. Américo Bortolazzo Correr e Profª. Drª. Vanessa Cavalli Gobbo,** por aceitarem o convite para compor a banca de qualificação, contribuindo com observações e sugestões.

Aos docentes **Prof. Dr. Rafael Leonardo Xediek Consani, Prof. Dr. Rafael Pino Vitti, Profª. Drª. Débora Alves Nunes Leite Lima, Profª. Drª. Marina Xavier Pisani de Souza e Prof. Dr. Antonio Marcos Montagner,** por aceitarem o convite para compor a banca de defesa, contribuindo com observações e sugestões.

Ao Técnico de Laboratório da Área Prótese Dental **Eduardo Pinez Campos,** pela disponibilidade, auxílio, paciência e por ter se tornado muito mais do que um técnico, mas um Pai de Coração.

Ao Técnico de Laboratório da Pré-Clínica **Paulo Alcarde,** por toda paciência e amizade em todos os anos de Graduação e agora na Pós-Graduação.

Aos amigos da Pós-Graduação em Prótese Dental e das demais áreas, pelas Vitórias alcançadas no aprendizado em conjunto.

Ao meu grande amigo e irmão **Gustavo Forjaz Corradini,** por toda amizade, companheirismo, paciência e caminhada rumo ao Alvo Jesus Cristo, nesses anos de FOP.

Ao meu grande amigo e irmão **Paulo Calori,** por toda amizade, companheirismo, paciência, o que acrescentou grande maturidade nesses anos de FOP.

À minha grande amiga **Anna Gabriella Camacho Presotto,** por toda amizade e paciência em me ajudar no desenvolvimento desse trabalho como um todo.

Aos amigos de República e Agregados, **Gustavo Corradini, Paulo Victor, Estêvão Azevedo, Bruno Zen, Tiago Tavares, Maysa Bataglia Tavares, Ricardo Armini Caldas, Marcos Paulo Basso, Cintia Maruki, Mateus Bertolini, Felipe Anacleto, Rafael Vitti, Igor Claes, Paulo Calori, Maria Júlia Vicentin, Pedro Luiz Duarte, Ataís Bacchi, Flávio Azevedo, André Presotto, Paulo Neves, Thomas Barbin, Marcos Passoni, Ederaldo Pietrafesa, Guilherme Martins, João Pedro Marcatto, Pedro Ivo, Pedro Vidotto, Victor Torso, Maria Júlia Valentini, Brenda Bruder, Lucas Granconato, Raphael De Marco, Karol Moraes, Olivia Kiehl, Rodrigo Vasconcelos, Rodrigo Cunha, Renato Tognoli, Marco Carvalho, Moises Nogueira, Thaís Escobar, Regiane Amaral, Roberto Dinelli, Juliana Dinelli, Caio Grohmann, Isabela Grohmann, André Pinho e Eveline Soares,** onde nos tornamos mais do que amigos, nos tornamos irmãos.

A todos os colegas da **Aliança Bíblica Universitária (ABU),** pelo apoio e Oração.

Aos meus amigos de Laboratório, **Anna Gabriella Presotto, Guilherme Machado, Gabriel Meloto, Veber Bomfim, Sales Barbosa, Heloisa Pantaroto, Júlia Campana, Marina Pisani, Adaias Matos, Thamara Belini, Jairo Cordeiro, Wagner Reginato, Giovana Oliveira, Cláudia Bhering e Isabella Marques,** por toda ajuda e companheirismo nesses anos de Pós-Graduação.

A todos que indiretamente contribuíram para a realização deste trabalho.

Epígrafe

"Mas, buscai primeiro o Reino de Deus, e a Sua Justiça, e todas estas coisas vos serão acrescentadas."

Mateus 6:33

Resumo

O objetivo neste estudo foi avaliar a movimentação de dentes artificiais em próteses totais convencionais superiores e inferiores processadas em muflas tradicional e bimaxilar HH metálicas e para micro-ondas. Foram confeccionados modelos padrão em gesso e montagem dos dentes artificiais, obtendo-se 40 pares de próteses enceradas. Pinos metálicos foram colocados nos dentes como referência para as mensurações antes e após o processamento das próteses, sendo: borda incisal dos incisivos centrais superiores e inferiores (I), cúspide vestibular dos primeiros pré-molares superiores e vestibular dos inferiores (P), cúspides mésio-vestibular dos segundos molares superiores e mésio-vestibular dos inferiores (M). As distâncias transversais, incisivo a incisivo (I-I); pré-molar a pré-molar (P-P) e molar a molar (M-M); ântero-posteriores, incisivo esquerdo a molar esquerdo (Ie-Me) e incisivo direito a molar direito (Id-Md), e verticais I-I, P-P, M-M, Ie-Me e Id-Md foram mensuradas com microscópio linear e precisão de 1.0 μm, equipado com câmera digital e unidade analisadora. As próteses foram distribuídas aleatoriamente para polimerização pelas técnicas tradicional, adaptada do ciclo Australiano ou forno de micro-ondas, nos grupos (n=20): G1 - mufla metálica convencional, G2 - mufla metálica bimaxilar HH (dentes em oclusão) e ciclo Australiano; G3 - mufla convencional para micro-ondas, e G4 - mufla bimaxilar HH (dentes em oclusão) para micro-ondas. No ciclo Australiano com muflas metálicas foi utilizado fogão doméstico e recipiente com água à temperatura ambiente (25ºC). A mufla imersa na água foi com temperatura de 65ºC por 30 minutos, e depois a chama foi apagada por 30 minutos. A mufla foi novamente submetida ao aquecimento em 65ºC por 30 minutos, seguida pelo aquecimento da água em 100ºC, com a fervura desta, onde a mufla permaneceu por 1 hora. Em seguida, a mufla esfriada no próprio recipiente de polimerização durante o esfriamento da água. As muflas plásticas foram processadas em forno de micro-ondas com 1400 W de potência (20 minutos a 140 W e 5 minutos a 560 W de potência). Para a avaliação da movimentação dos dentes, foi considerado o valor obtido da diferença das distâncias antes e depois da polimerização da prótese. A diferença entre os valores entre antes e depois da polimerização foi considerada a movimentação dos dentes. Os resultados obtidos foram submetidos à análise de variância (ANOVA 2 fatores), e teste *t* pareado comparando dados do mesmo grupo antes e após polimerização. Diferenças entre fatores foram analisados pelo teste de Tukey (5%). Não houve diferença estatisticamente significante na movimentação dos dentes quando se comparou diferentes tipos de muflas e ciclos de polimerização. Na comparação entre tipos de prótese,

houve diferença significante quando a mandibular mostrou menor movimentação dos dentes quando comparado à maxilar. Em conclusão, os tipos de muflas e ciclos de polimerização proporcionaram movimentação dos dentes com valores similares. Na prótese maxilar ocorreu a maior distância entre dentes.
Palavras–chave: Movimentação de dentes, prótese total, polimerização.

Abstract

This study evaluated the movement of artificial teeth in upper and lower conventional complete dentures, processed with traditional and HH bimaxillary metal and microwave flasks. Forty pairs of dentures were conventionally made, and metal pins were placed on the teeth as reference points for before and after denture processing measurements, as follows: incisal edge of upper and lower central incisors (I), buccal cusp of upper and lower vestibular first premolars (P), mesiobuccal upper and lower cusps of second molars (M). The cross distances incisor to incisor (I-I); premolar to premolar (P-P) and molar to molar (M-M); anteroposterior left incisor to left molar (lI-lM) and right incisor to right molar (rI-rM), and vertical I-I, P-P, M-M, lI-lM and rI-rM were measured with linear microscope with 1.0 μm accuracy equipped with a digital camera and analyzer unit. Dentures were polymerized by traditional, modified Australian cycle or microwave methods, following the groups (n=20): G1 - conventional metallic flask, G2 - HH bimaxillary metal flask (teeth in occlusion) with modified Australian cycle: G3 - conventional microwave oven flask, and G4 - HH bimaxillary microwave flask (teeth in occlusion). For Australian cycle with metal flask was used stove and water at room temperature. The flask immersed in water was heated at 65ºC for 30 minutes, flame quenched for 30 minutes, again submitted to heating at 65ºC for 30 minutes, and followed until boiling water for 1 hour at 100ºC. The flask was cooled in the vessel itself of polymerization during the water-cooling. Denture included in plastic flask was processed in a microwave oven with 1400 W power (20 minutes at 140 W and 5 minutes at 560 W of potency). Teeth movement was considered as the distance between referential points for both before and after denture processing. Data were submitted to 2-way ANOVA, and *p*-paired statistical test compared the data at same group before and after polymerization. Differences between factors and interactions were analyzed by the Tukey's test (5%). There is no statistically significant difference in teeth movement among different types of flasks and polymerization cycles. There was significant difference for the lower denture with smaller teeth movement in relation to upper denture. In conclusion, the flask types and polymerization cycles promoted teeth displacement with similar values. In the upper denture occurred greater value for distance between teeth.

Keywords: Teeth movement, complete denture, polymerization.

Sumário

1 Introdução

De maneira geral, a cada ano os avanços científicos e metodológicos se expandem em todas as áreas, inclusive na saúde. Como consequência positiva, a população tem alcançado maior longevidade, aumentando a expectativa de vida em todo o mundo. Segundo o IBGE (2014), a expectativa de vida do brasileiro é de 75,2 anos, para ambos os gêneros. No entanto, um estudo avaliou que 63,17% de 372 idosos apresentavam edentulismo (Moreira *et al.*, 2009), isto para o Brasil, é um dado de grande importância, pois é um valor alto a ser considerado (Bourgeois *et al.*, 1999; Atchison *et al.*, 2000).

Esses dados confirmam que os padrões de saúde bucal se encontram desfavoráveis, como avaliado pelo programa de saúde bucal do brasileiro (SBBrasil, 2010), onde aproximadamente 3 milhões de pessoas necessitam de reabilitação protética nos dois arcos e 4 milhões de reabilitações parciais (Ministério da Saúde - Brasil, 2011).

Mesmo nos dias atuais, a prótese total convencional tem sido comumente indicada para reabilitação protética, considerando que apresenta excelente custo/benefício (Douglass *et al.*, 2002; Caetano *et al.*, 2013; Caetano *et al.*, 2015). Os avanços provenientes da tecnologia geraram também melhorias na área odontológica, como exemplo, o uso de implantes em pacientes completamente desdentados ou com ausência de um ou mais dentes. Para pacientes completamente desdentados existem próteses sobre implantes que são reabilitações consideradas de excelência, como as *overdentures* ou sobredentaduras, e as próteses totais fixas ou protocolos (Caetano *et al.*, 2013; Caetano *et al.*, 2015).

As *overdentures* são consideradas como primeira opção para reabilitação protética da mandíbula (Feine *et al.*, 2002; Thomason *et al.*, 2010; Caetano *et al.*, 2015), possuindo diferentes sistemas de retenção (Caetano *et al.*, 2015), dentre eles, *o'ring*, barra-clipe e magneto. Entretanto, a inclinação dos implantes pode ser um fator limitante para esse tipo de prótese, considerando que inclinação maior que 10 graus contraindica o uso de retentores tipo bola ou *o'ring* (Walton *et al.*, 2001; Caetano *et al.*, 2015). Com o sistema magneto, a inclinação dos implantes não é considerada fator limitante; todavia, com o uso clínico ocorre desgaste dos componentes, gerando insatisfação dos pacientes (Naert *et al.*, 1991; Petropoulos *et al.*, 1997; Caetano *et al.*, 2015). O sistema barra-clipe permite melhor retenção da prótese devido à rotação e esplintagem do clipe sobre a barra. Outra vantagem é que o enceramento e fundição permitem o correto posicionamento da barra sobre a inclinação dos implantes (Caetano *et al.*, 2015). Contudo, a inclinação inadequada dos implantes prejudica todo o sistema como conjunto, ocasionando tensões que sobrecarregam os componentes protéticos, parafusos, implantes e tecido ósseo peri-implante, por falta de assentamento passivo (Al-Turki *et al*., 2002; Abduo *et al*., 2010; Caetano *et al*., 2015).

Assim, a passividade é um fator significante para o sucesso da prótese sobre implantes, seja *overdenture* ou prótese total fixa, considerando que com inadequado assentamento a prótese fica comprometida (Farina *et al*., 2010; Caetano *et al*., 2013; Caetano *et al*., 2015; Consani *et al*., 2015). A prótese total fixa sobre implantes é também ótima indicação para o restabelecimento protético de desdentados, proporcionando estabilidade, retenção, estética, função e manutenção do rebordo alveolar, devolvendo ao paciente autoestima e satisfação (De Bruyn *et al*., 1997). No entanto, por uma série de fatores o tratamento com *overdenture* ou prótese total fixa não está disponível para todos os pacientes.

Consequentemente, a prótese total se apresenta como excelente indicação para pacientes totalmente desdentados (Douglass *et al*., 2002; Caetano *et al*., 2013), devido ao menor custo e acessibilidade ao público. A prótese total permite correto recobrimento da área maxilar ou mandibular, melhora o suporte labial, adapta-se aos tecidos gengivais, diminui a velocidade da reabsorção do osso alveolar, reestabelece a estética, função e dimensão vertical fisiológica, restabelecendo o padrão oclusal e permitindo o correto posicionamento dos côndilos na cavidade articular (Bellini *et al*., 2009; Caetano *et al*., 2013).

Entretanto, as próteses totais convencionais, *overdenture* ou implantossuportada são confeccionadas com resina acrílica (Caetano *et al*., 2013; Consani *et al*., 2015). A literatura mostra que a resina acrílica é o material de escolha para a confecção dessas próteses; contudo, apresenta características inerentes negativas como a contração de polimerização, considerada inevitável (Consani *et al*., 2006). Essa contração pode ocasionar alterações dimensionais na oclusão, causando movimentação de dentes e alterando a dimensão vertical. Associados a esse fator que causa desadaptação da prótese total e movimentação de dentes estão os tipos de inclusão das próteses, método de fechamento e esfriamento da mufla, demuflagem, método de polimerização, espessura da base da prótese e composição da resina acrílica (Sadamori *et al*., 1994; Chen *et al*., 1998; Komiyama *et al*., 1998; Consani *et al*., 2002; Consani *et al*., 2006; Consani *et al*., 2009).

As muflas metálicas bimaxilar ou HH e as muflas para micro-ondas bimaxilar ou em oclusão foram desenvolvidas com o mesmo objetivo de polimerizar as próteses superior e inferior simultaneamente (Rizzatti-Barbosa *et al*., 2005). Em especial, a bimaxilar para micro-ondas foi idealizada para diminuir a movimentação de dentes na prótese total convencional (Rizzatti-Barbosa *et al*., 2005). Alega-se também que o método promove economia de 20% de material usado para a polimerização em cada prótese, diminuindo a movimentação de dentes e mantendo a dimensão vertical de oclusão quando comparada à mufla tradicional metálica (Rizzatti-Barbosa *et al*., 2005; Sadan *et al*., 2004). Além disso, não altera as propriedades mecânicas da resina acrílica (Rizzatti-Barbosa *et al*., 2009).

Portanto, torna-se relevante este estudo ao avaliar a movimentação de dentes em prótese total convencional, sujeita ao efeito de diferentes tipos de muflas. Por conseguinte, visando a minimizar o efeito de fatores que comprometem o desempenho da prótese total, este estudo avaliou muflas metálicas e para micro-ondas em relação à movimentação de dentes empregando dois métodos de polimerização.

2 Artigo*

Teeth displacement in upper and lower complete dentures influenced by different metal and microwave flask types

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Supported by Coordination for the Improvement of Higher Education Personnel (CAPES), Brazil.

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Acknowledgements

To Coordination for the Improvement of Higher Education Personnel (CAPES) for the assistance to PhD Program at Piracicaba Dental School, State University of Campinas, SP, Brazil.

* Artigo de acordo com as normas para publicação no periódico *The Journal of Prosthetic Dentistry.*

Abstract

Statement of problem: Artificial teeth displacement is influenced by different factors which compromise the stability of dentures. **Purpose:** This study evaluated the movement of artificial teeth in upper and lower conventional complete dentures processed with traditional or HH bimaxillary metal and microwave flasks. **Material and methods:** Dentures were conventionally made, and metal pins were placed on the teeth as reference points for pre and post denture processing measurements: incisal edge of upper and lower central incisors (I), buccal cusp of upper and lower vestibular first premolars (P), mesiobuccal upper and lower cusps of second molars (M). The cross distances incisor to incisor (I-I); premolar to premolar (P-P) and molar to molar (M-M); anteroposterior left incisor to left molar (lI-lM) and right incisor to right molar (rI-rM), and vertical I-I, P-P, M-M, lI-lM and rI-rM were measured with linear microscope. Dentures were polymerization by the conventional, modified Australian cycle and microwave methods (n=20): G1 - conventional metallic flask, G2 - HH bimaxillary metal flask (teeth in occlusion) with modified Australian cycle: G3 - conventional microwave oven flask, and G4 - HH bimaxillary microwave flask. For Australian cycle with metal flask, the flask immersed in water was heated at 65ºC for 30 minutes, flame quenched for 30 minutes, again submitted to heating at 65ºC for 30 minutes, and followed until boiling water for 1 hour at 100ºC. The flask was cooled in the polymerization water itself during the water-cooling. Denture included in plastic flask was processed in a microwave oven with 1400 W power (20 minutes at 140 W and 5 minutes at 560 W of potency). Teeth movement was considered as the distance between referential points for both pre and post denture processing. Data were submitted to 2-way ANOVA, and *p*-paired statistical test compared the data at same group before and after polymerization. Differences between factors and interactions were analyzed by the Tukey's test (5%). **Results:** There is no statistically significant difference in teeth movement among different flasks and polymerization cycles. When upper and lower dentures were compared, there was significant difference with the upper denture showing greater teeth movement in relation to lower denture. **Conclusion:** Flask types and polymerization cycles promoted teeth displacement with similar values. Greater values for distance between teeth were shown for upper dentures.

Keywords: Teeth movement, complete dentures, flasks, polymerization cycle.

Clinical Implications

The laboratory stage, during the process of inclusion of a prosthesis, may be related to the phenomenon of tooth movement. This is very important because it is directly linked to the clinical success and patient's satisfaction.

Introduction

Despite the advent of new materials, the acrylic resin is still used in large scale and remains the material of choice to produce complete dentures due to its low cost, easiness of handling and acceptable properties, such as color stability and patient's satisfaction. (1,2) However, an acrylic resin inherent problem is the polymerization shrinkage considered as an inevitable occurrence, being also reported by the users as a common clinical fact. (2,3)

As consequence, the complete dentures are subject to same dimensional shrinkage characteristics. (2,4–7) The dental implant method has allowed different prosthetic rehabilitation, (2,8,9) as overdentures, implant-retained prostheses, and implant-supported complete dentures (protocol), this last considered as implant-retained and implant-supported prostheses, all with excellence because has shown good retention, stability, and aesthetics (2,8,10). Nevertheless, notwithstanding the fact that the complete dentures are excellent indications for complete edentulous patients, they present not just adequate stability but also lower cost, favorable aesthetics and function. (2,8)

It is important to emphasize that in order to be completely successful in prosthetic rehabilitation, it is necessary to have harmony of the masticatory system.(11) Since that the absence of harmony may lead to misfit, overextension, lack of aesthetics, and failure to reestablish the vertical dimension. As consequence, the dentures would not have good function, presenting occlusal interferences. (12)

Due to the acrylic resin shrinkage related to polymerization, the artificial teeth can displace during the complete denture processing causing occlusal interference, traumatic occlusion, discomfort, and irregular stress distribution on the soft tissue impairing the function of the denture as a whole. (12) There are also other factors that can cause teeth displacement, as commercial acrylic resin type, (13) base thickness, (14) plaster expansion, (15) curing cycle, (16) flask closure, (3,6,17,18) flask cooling method, and deflasking. (19) Nonetheless, some studies have stated that the water absorbed by the acrylic resin could minimize the negative effect of teeth movement. (2,20,21)

In an attempt to reduce the teeth movement, a metal flask for complete denture processing was developed relating upper and lower dentures in occlusion, called bimaxillary or HH bimaxillary flask. [22] After, plastic flask for microwaves irradiation was developed similarly to metal flask; therefore, the dentures are polymerized simultaneously with the teeth in contact. [23] Some studies allege that this method promotes correct occlusal harmony and minimizes the errors in the reestablishment of the vertical dimension of occlusion. [24,25]

Compared to conventional flask, previous studies have shown that the bimaxillary flask promoted reduction of the vertical dimension, [26] lesser teeth movement, [27] and no change in the acrylic resin mechanical properties. [28] During the polymerization, it was reported that the inclusion of two dentures in the same flask promotes 20% of material reduction for each denture. [25]

The literature is still lacking in studies related to acrylic resin polymerization shrinkage. This study evaluated the movement of artificial teeth in upper and lower conventional complete dentures, processed with traditional or HH bimaxillary metal and microwave flasks. The tested hypotheses were: 1- Flask type would not influence the distance between teeth; 2- Different polymerization cycles would not influence the distance between teeth; and 3- Denture types (upper and lower) would not influence the distance between teeth.

Material and methods

This study was developed in vitro and randomized in relation to samples. The conventional upper and lower complete dentures were made with conventional and microwaved acrylic resin (Classico Dental Products, Sao Paulo, SP, Brazil), included in two flask types (conventional or HH bimaxillary), and polymerized by the technique adapted from the Australian cycle or by microwave irradiation.

From upper and lower stone dies (Type III Herodent Soli-Rock; Vigodent, Petropolis, RJ, Brazil), 40 replicas were obtained and the teeth mounting (Trilux EuroVipi O36/L7/M4; VIPI, Pirassununga, SP, Brazil) was carried out in semi-adjustable articulator (BioArt; Sao Carlos, SP, Brazil). From this standard assembly was obtained a matrix of laboratory silicone (Zetalabor; Zhermack, Rovigo, Italy) used in the standardized reproduction of the other dentures. With this procedure, 40 pairs of waxed dentures were made.

Metallic pins were placed on the waxed denture teeth as reference points for measurements before and after denture processing. The pins were fixed with cyanoacrylatebased glue (Super Bonder; Loctite, Sao Paulo, SP, Brazil) placed in six predetermined sites: incisal edge center of the lower central incisors (I), lingual cusp of the lower first premolars (P), and mesiolingual cusp of the lower second molars (M). The I-I, P-P, and M-M transverse distances, and the lI-lM and rI-rM anteroposterior distances were measured before and after denture procedure.

Transverse distances in the X axis: incisor to incisor (I-I); premolar to premolar (P-P) and molar to molar (M-M); left incisor to left molar (lI-lM), right incisor to right molar (rI-rM) and vertical on the Z axis: I-I; P-P, M-M, lI-lM and rI-rM were measured using linear comparator microscope (Walter-UHL-VMM-100-BT, London, UK) with 1 µm accuracy and 120x magnification, equipped with digital camera (KC-512NT, Kodo BR Electronics, Sao Paulo, SP, Brazil) and analytical unit (QC 220-HH Quadra-Check 200; Metronics, Bedford, USA).

The dentures were randomly divided into 4 groups, according to flask type (n = 20): G1 - Conventional metal flask; G2 - HH bimaxillary metallic flask, with teeth in occlusion; G3 - Conventional microwave flask; G4 - HH bimaxillary flask for microwave, with teeth in occlusion. The denture inclusion procedure for conventional and HH bimaxillary metallic, and microwave flasks was according to traditional technique. [21,25,29]

Materials were proportioned and manipulated according to manufacturers' instructions. The acrylic resin (Conventional; Classico) in the plastic stage was inserted into the metal flasks, and processed according to the adapted Australian cycle by using a stove and container with water at room temperature. The flask immersed in the water was heated at 65ºC for 30 minutes, flame quenched for 30 minutes, again submitted to heating at 65ºC for 30 min, and followed until boiling water for 1 hour at 100ºC. The flask was cooled in the polymerization water itself during the water-cooling.

Microwaved acrylic resin (Onda Cryl; Classico) was processed in oven (BSH Continental AW-42; Manaus, AM, Brazil) in the cycle recommended by the manufacturer (20 minutes at 140 W and 5 minutes at 560 W of potency). After processing, the flasks were removed from the microwave oven, and bench cooled at room temperature. Afterwards, the dentures were deflasked and the distances between teeth evaluated in the same way as described for after denture processing. For the assessment of teeth movement, it was considered the changes occurred in the distances between the teeth before and after the denture processing. The difference between these values was considered as teeth displacement.

Data were submitted to 2-way ANOVA, and *p*-paired statistical test compared the data at same group before and after polymerization. Differences between factors and interactions were analyzed by the Tukey's test (5%).

Results

Table 1 shows the means and standard deviation for teeth movement before and after polymerization according to flask and denture types, and teeth distances.

Table 1. Means and standard deviation for teeth movement before and after polymerization according to flask and denture types.

	Flask type							
	Conventional metal		HH metal		Conventional microwave		HH microwave	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
I-I	0.094 (±0.163)	0.007 (±0.360)	-0.019 (±0.261)	0.034 (±0.146)	0.154 (±0.139)	-0.002 (±0.083)	0.125 (±0.221)	0.068 (±0.319)
P-P	0.275 (±0.206)	0.141 (±0,171)	0.283 (±0.172)	0.108 (±0.160)	0.449 (±0.227)	0.138 (±0.183)	0.372 (±0.372)	0.118 (±0.312)
M-M	0.439 (±0.205)	0.168 (±0.162)	0.456 (±0.223)	0.077 (±0.294)	0.438 (±0.200)	0.169 (±0.256)	0.518 (±0.160)	0.234 (±0.180)
Id-Md	-0.212 (±0.676)	0.46 (±0.559)	-0.565 (±0.829)	0.348 (±0.503)	-0.279 (±1.050)	0.384 (±0.425)	0.277 (±0.904)	0.303 (±0.503)
Ie-Me	0.661 (±0.539)	-0.087 (±0.53)	1.128 (±0.607)	-0.088 (±0.711)	0.936 (±1.145)	0.017 (±0.869)	0.048 (±1.055)	0.137 (±0.472)

Table 2 shows the influence of the denture type on the teeth movement. The upper denture showed tooth displacement bigger when compared with the lower denture (p=0.081, 2-way ANOVA). The flask type and interaction with denture type (upper or lower) did not affect the teeth movement before and after polymerization ($p>0.05$, 2-way ANOVA).

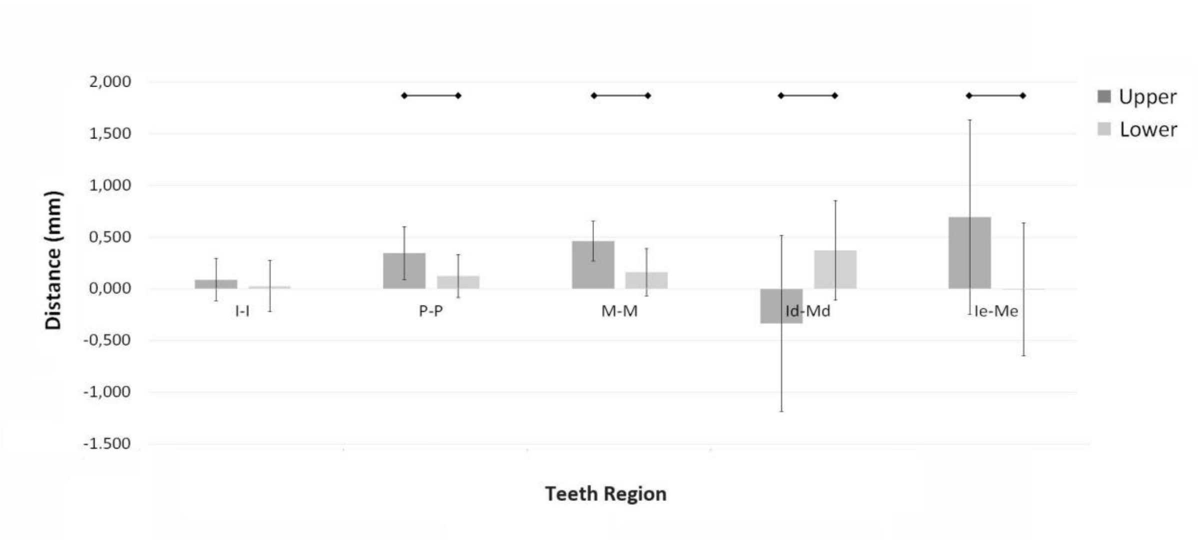
Table 2. Two-way ANOVA for teeth movement before and after polymerization according to flask, denture, and their interaction.

	Dependent Variable	**Sum of Squares**	***df***	**Mean Squares**	**F value**	***P****
Flask	I-I	0.693	3	0.231	1.027	0.386
	P-P	0.230	3	0.077	0.474	0.701
	M-M	0.225	3	0.075	0.617	0.606
	Id-Md	1.582	3	0.527	0.940	0.426
	Ie-Me	1.672	3	0.557	0.901	0.445
Denture	I-I	0.165	1	0.165	0.734	0.395
	P-P	1.176	1	1.176	7.293	0.009
	M-M	2.927	1	2.927	24.042	0.000
	Id-Md	12.704	1	12.704	22.629	0.000
	Ie-Me	6.634	1	6.634	10.725	0.002
Flask × denture	I-I	0.805	3	0.268	1.194	0.318
	P-P	0.099	3	0.033	0.205	0.893
	M-M	0.130	3	0.043	0.357	0.784
	Id-Md	0.234	3	0.078	0.139	0.936
	Ie-Me	3.505	3	1.168	1.889	0.139
Total	I-I	21.741	80	-	-	-
	P-P	32.179	80	-	-	-
	M-M	37.211	80	-	-	-
	Id-Md	55.098	80	-	-	-
	Ie-Me	61.739	80	-	-	-

*Significant at $p<0.05$.

Figure 1 shows the means and standard deviation for teeth movement before and after polymerization according to distance and denture type (upper or lower). There was statistically significant difference between denture types for each distance, except for I-I.

Figure 1. Teeth movement (mm) before and after polymerization for denture type (upper or lower). Groups connected by horizontal line show statistical difference between dentures in each region.



Discussion

This study analyzed the teeth movement in upper and lower complete dentures influenced by different flask and denture types, and polymerization cycles. Despite the claim that the flask type influences the teeth movement,(30) the results of the current study did not show any effect on the teeth distance (Table 2). The first hypothesis tested that the flask type would not influence the teeth movement was accepted. This result is in agreement with others studies showing that the flask type is not a factor that influences the tooth displacement.(2,3,20,21)

Therefore, the difference between the horizontal and anteroposterior distances related to teeth movement were not statistically significant, as much for metal as microwave flasks. Thus, the second hypothesis tested that different polymerization cycles would not influence the distance between teeth was also accepted. This result is in agreement with previous studies.(2,21,31–33) This finding is probably due to different variables occurred in the denture procedure, as flask inclusion, sample standardization, material inclusion, flask cooling, and denture deflasking.(2,3,14,30,31,34) However, discrepancies were shown in the teeth movement level for upper dentures when different metal flasks were used,(30) fact that would explain the effect of different denture inclusion methods on the teeth displacement.

The current study has shown that whatever the polymerization cycle or flask type, there was statistically significant difference between the upper and lower dentures in relation to teeth distance values; thus, the third hypothesis that denture types (upper and lower) would not influence the distance between teeth was rejected. The supposition alleged for this result would be the fact that upper or lower dentures differently influence the stability of the tooth after denture procedure due to different thermal shrinkage occurred in both flask cooling and denture deflasking.[2,30]

The thickness of denture bases is a significant factor for the magnitude of the shrinkage that occurs during denture processing,[35-37] and changes in the linear dimension occur according to the thickness of acrylic resin submitted to the polymerization cycle, while the location within the flask is another significant factor.[38]

It has been claimed that the molar inclination in maxillary denture was greater for thinner base (1.25 mm) when compared to thicker base (3.75 mm),[39] and there were significant variations in tooth movement between thick and thin denture bases while an increase in the molar-to-molar distance was found in both the thin and thick dentures; however, the magnitude of tooth movement was larger in thick dentures.[40] In the current study, the denture base thickness (2 mm) should not have influenced the movement of the teeth because previous study has shown that two layers of base plate wax (1 mm each) are sufficient to standardize thickness across the groups.[41]

In addition, both denture types show greater distance involving posterior teeth, especially for molars when the anteroposterior and horizontal distances were considered (Figure 1). Despite the shape of the maxillary alveolar arch to promote better stress distribution when compared to the mandibular alveolar arch, the palate anatomy favors a greater resin shrinkage mainly in the posterior palate border, making marginal sealing difficult in this region.[17] On the contrary, the small movement for the I-I distance is due to the smaller interproximal contact showed for incisors.[34] In addition, this fact can be associated to smaller acrylic resin amount in the anterior region, and consequent lesser polymerization shrinkage when compared to palatal region of the upper denture or free ends of the lower denture.[42]

For P-P, M-M, rI-rM, and lI-lM distances, different denture regions promoted greater distance between teeth (Figure 1). Despite the differences between before and after denture polymerization in relation to teeth movement, the lower denture showed result more satisfactory than the upper one. The supposition for this fact would be that the lower denture has smaller distortion than that showed by the upper denture; however, the retention and stability levels have been considered better for upper dentures. In addition, a previous study has shown that the dimensionally stable areas in maxillary dentures were the canines and the most unstable was the posterior palate.[43]

Therefore, the current study became important when evidenced the influence of flask and denture types, and polymerization methods on the distance between teeth. In addition, the work showed that the posterior region of the maxillary and mandibular alveolar arches is an important factor for teeth movement in both denture types.

Conclusion

It was possible to conclude that the flask types and polymerization cycles promoted teeth displacement with similar values. Greater values for distance between teeth were shown for upper dentures.

Acknowledgements

To Coordination for the Improvement of Higher Education Personnel (CAPES) for the assistance to PhD Program at Piracicaba Dental School, State University of Campinas, Brazil.

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3 Conclusão

De acordo com a metodologia, resultados obtidos e discutidos,pode-se concluir que:

1. Os tipos de mufla promoveram valores similares de deslocamento dos dentes.
2. Independetemente do ciclo de polimerização, correspondente à cada tipo de mufla, promoveram valores similares de deslocamento dos dentes.
3. Prótese superior apresentou maiores valores de distância entre os dentes.

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[*] De acordo com as normas da UNICAMP/FOP, baseadas na padronização do International Committee of Medical Journal Editors - Vancouver Group. Abreviatura dos periódicos em conformidade com o PubMed.

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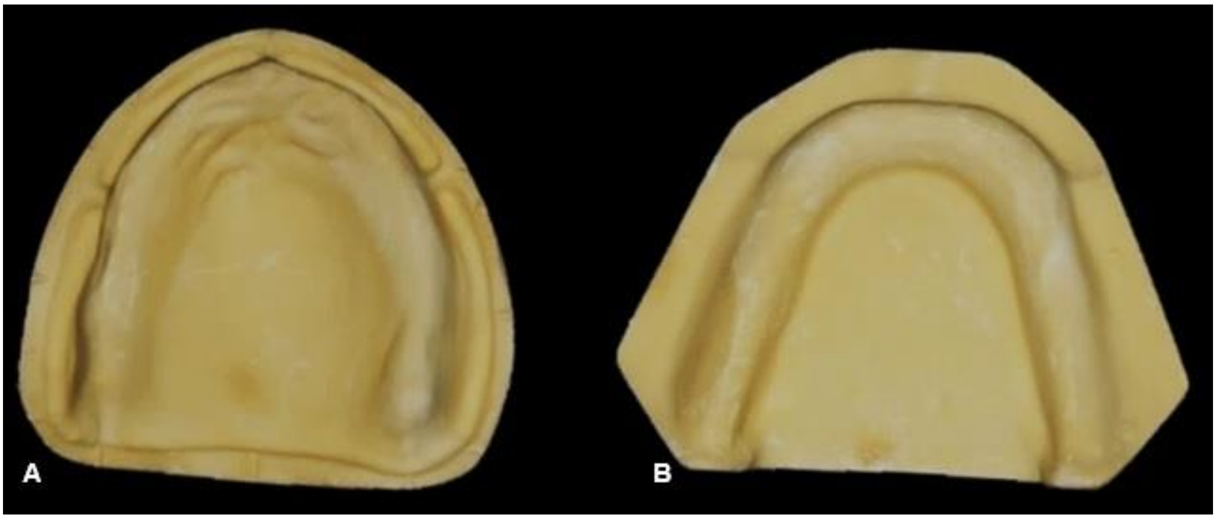
Apêndice 1

Metodologia Ilustrada

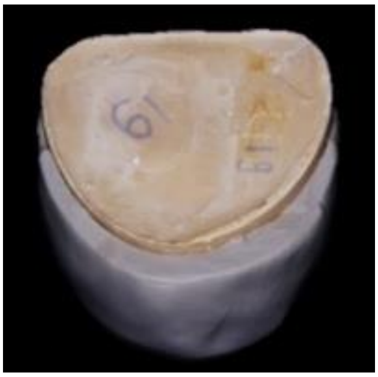
1. Confecção das próteses.

Figura 1. Moldelos em Gesso Pedra Tipo III: (A) Superior; (B) Inferior.



Fonte: Caetano et al., 2016.

Figura 2. Adaptação dos dentes no molde (A); adaptação do molde com dentes ao modelo de gesso (B; C).



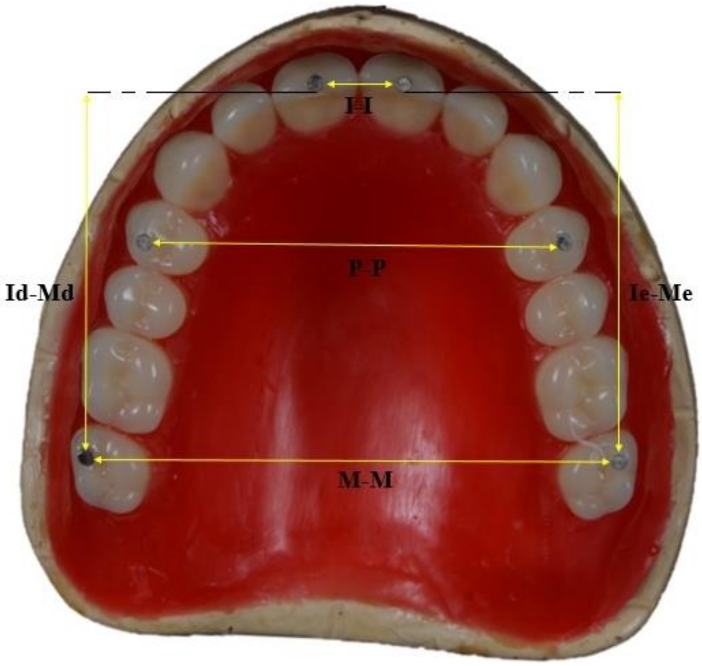
Fonte: Caetano et al., 2016.

Figura 3. Montagem de dentes para posterior duplicação: (A) Superior; (B) Inferior.

Fonte: Caetano et al., 2016.

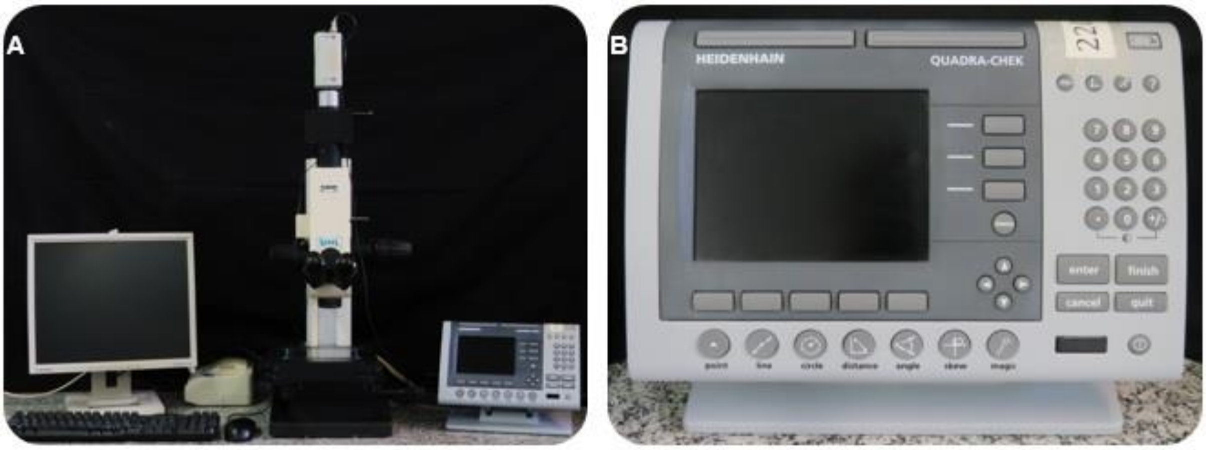
2. Mensuração

Figura 4. Mensuração das distâncias entre dentes.



Fonte: Caetano et al., 2016.

Figura 5. Microscópio linear comparador (A) e precisão de 1.0 µm, equipado com câmera digital e unidade analisadora (B).



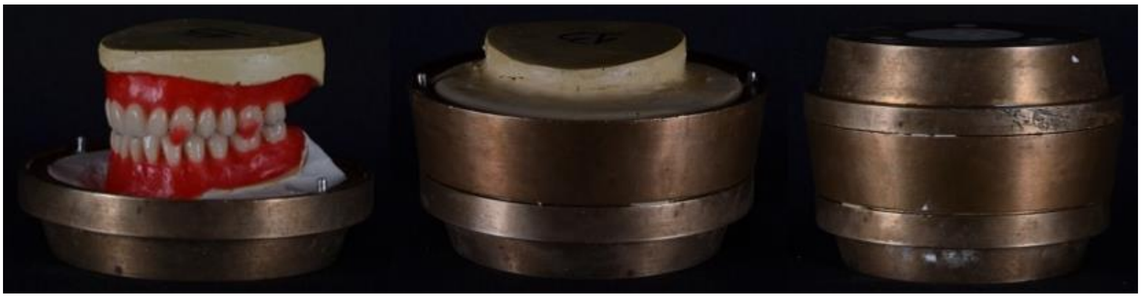
Fonte: Caetano et al., 2016.

3. Inclusão das próteses

Figura 6. Etapas da inclusão na mufla convencional metálica.

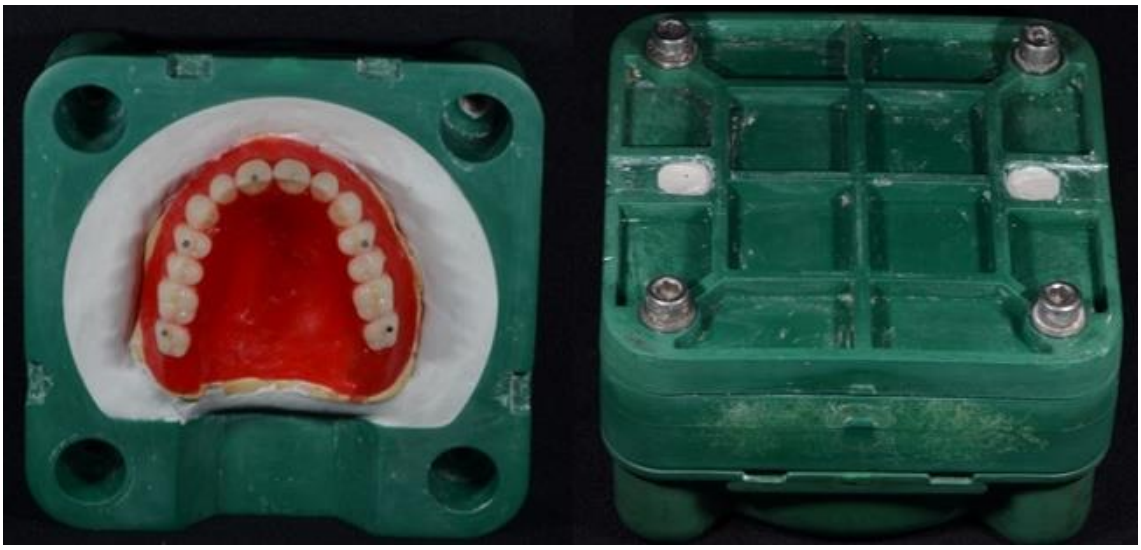
Fonte: Caetano et al., 2016.

Figura 7. Etapas da inclusão na mufla HH metálica.



Fonte: Caetano et al., 2016.

Figura 8. Etapas da inclusão na mufla convencional para micro-ondas.



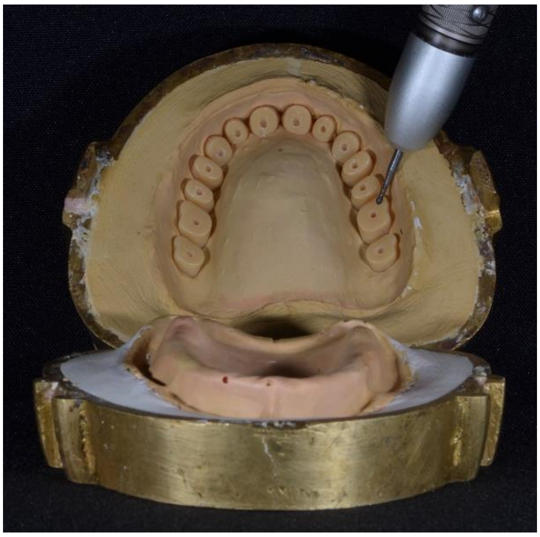
Fonte: Caetano et al., 2016.

Figura 9. Etapas da inclusão na mufla HH para micro-ondas.

Fonte: Caetano et al., 2016.

4. Polimerização

Figura 10. Preparo dos dentes para prensagem da resina acrílica e posterior polimerização.



Fonte: Caetano et al., 2016.

Figura 11. Próteses superior e inferior terminadas.

Fonte: Caetano et al., 2016.

Anexo 1

Comprovante da Submissão do Artigo – 2 Artigo

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