THAIS MARQUES SIMEK VEGA GONÇALVES

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"MASTICATORY FUNCTION IN PARTIALLY EDENTULOUS PATIENTS AFTER REHABILITATION WITH REMOVABLE AND FIXED PROSTHESES OVER OSSEOINTEGRATED IMPLANTS"

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"MASTICATORY FUNCTION IN PARTIALLY EDENTULOUS PATIENTS AFTER REHABILITATION WITH REMOVABLE AND FIXED PROSTHESES OVER OSSEOINTEGRATED IMPLANTS"

Orientadora: Profa. Dra. Renata Cunha Matheus Rodrigues Garcia

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Tese de doutorado apresentada à Faculdade de Odontologia de Piracicaba da Universidade Estadual de Campinas para obtenção do título de Doutora em Clínica Odontológica na área de Prótese Dental.

Doctorate thesis presented to Piracicaba Dental School of the University of Campinas to obtain the Ph.D grade in Dental Clinic, concentration area of Dental Prosthesis.

Este exemplar corresponde à versão final da tese defendida pela aluna Thais Marques Simek Vega Gonçalves e orientada pela Profa. Dra. Renata Cunha Matheus Rodrigues Garcia.

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ABSTRACT

Studies revealed the masticatory improvement after the use of prosthesis over dental implants. However, few are those who evaluated the chewing of partially edentulous patients, comparing the masticatory function after treatment with different partial dentures, which was the aim of this paired clinical trial. Therefore, 12 volunteers (8 females, mean age 62.6 ± 7.8 years) presenting total edentulism in maxilla and partial edentulism in the mandible (Kennedy class I) were selected and received, in a sequential way, a conventional removable partial dentures (RPD), implant-retained partial dentures (IRPD) and implant fixed partial denture (IFPD). All treatment were assembled in the mandible and used for 2 months, while the edentulous maxilla received a new complete denture which was used throughout the study. Mastication was assessed by measuring masticatory performance (MP), food comminution index (FCI), maximum bite force (MBF), masseter and temporal muscle thickness, chewing movements, swallowing threshold (ST), masticatory ability, nutritional status, quality of life (QOL) and patient satisfaction. Data were analyzed and repeated measures analysis of variance was applied followed by Tukey-Kramer multiple for comparisons between treatments. All analyzes were performed using SAS software (release 9.1, 2003, SAS Institute Inc., Cary, USA) ($p \leq 0.05$). MP greatly improved after IRPD and IFPD use with an increase of 85% and 87% respectively. Similar results were observed in respect to FCI and MBF with an increase ($p < 0.0001$) of 91% and 62% in FCI and of 79% and 62% in MBF after the IRPD and IFPD use, respectively. Regardless the prosthesis type, the use of IRPD and IFPD increased the masseter thickness during maximum voluntary clenching ($p < 0.0001$) and altered the chewing movements, reducing the total cycle time, as well as the duration of opening and closing phases ($p < 0.05$). MA improved after IRPD and IFPD use, irrespectively of the food rated. ST was affected by prosthetic treatment, showing a reduction in the number of chewing cycles and in the size of the comminuted particle, with the lowest values observed after IFPD use. There was a

raise in fiber ($p = 0.007$), calcium ($p = 0.001$) and iron ($p = 0.02$) intake after the IFPD use and a reduction in the intake of food with high cholesterol levels ($p = 0.02$). Patients satisfaction also increased ($p < 0.05$) and the impact of oral health on QOL decreased in overall score ($p = 0.04$) and in the physical pain domain ($p = 0.02$) after the IFPD use. The rehabilitation of partially edentulous patients with IRPD and IFPD significantly improved masticatory function and the magnitude of the effect was related to the prosthesis type.

Key words: Mastication, removable partial prosthesis, fixed partial prosthesis, implant-supported dental prosthesis, bite force, quality of life.

RESUMO

Estudos revelam melhora na mastigação após o uso de próteses sobre implantes osseointegrados. Entretanto, poucos são aqueles que avaliam a mastigação de pacientes parcialmente edêntulos, comparando a função mastigatória após a reabilitação por meio de diferentes próteses parciais, o qual foi o objetivo deste ensaio clínico pareado. Para tanto, foram selecionados 12 voluntários (8 gênero feminino, idade média 62.6 ± 7.8 anos), apresentando edentulismo total superior e parcial inferior (classe I de Kennedy), os quais receberam, de forma sequencial, próteses parciais removíveis (PPR), PPR com encaixe implanto-retido (PPRI) e prótese parcial fixa sobre implantes (PPFI). Todos os tratamentos foram realizados na mandíbula e utilizados por 2 meses antes da avaliação mastigatória, enquanto a maxila recebeu uma nova prótese total que foi utilizada durante todo o estudo. A mastigação foi avaliada por meio da mensuração da performance mastigatória (PM), índice de trituração dos alimentos (ITA), força máxima de mordida (FMM), espessura dos músculos masseter e temporal, movimento mastigatório, limiar de deglutição (LD), habilidade mastigatória, estado nutricional, qualidade de vida (QV) e satisfação do paciente. Foi realizada a análise exploratória dos dados e aplicada análise de variância para medidas repetidas seguido de teste de Tukey-Kramer para as comparações múltiplas entre os tratamentos. Todas as análises foram realizadas utilizando SAS software (release 9.1, 2003; SAS Institute Inc., Cary, USA) ($p \leq 0.05$). A PM melhorou consideravelmente após o uso de PPRI e PPFI com aumento de 85% e 87%, respectivamente. Resultados similares foram observados em relação ao ITA e à FMM com aumento ($p < 0.0001$) de 91% e 62% no ITA de 79% e 62% na FMM após o uso de PPRI e PPFI, respectivamente. Independente do tipo de prótese, o uso de PPRI e PPFI aumentou a espessura do masseter durante a contração voluntária máxima ($p < 0.0001$) e alterou o movimento mastigatório, reduzindo o tempo total do ciclo, bem como a duração das fases de abertura e fechamento ($p < 0.05$). A habilidade mastigatória melhorou após o uso da PPRI e PPFI, independente do alimento avaliado. O LD

foi alterado pelo tratamento reabilitador, com redução no número de ciclos e tamanho da partícula triturada, sendo os menores valores observados com o uso da PPFI. Houve aumento no consumo de fibras ($p = 0.007$), cálcio ($p = 0.001$) e ferro ($p = 0.02$) após o uso de PPFI, além da redução no consumo de alimentos com altos níveis de colesterol ($p = 0.02$). A satisfação aumentou ($p < 0.05$) e o impacto da saúde oral na QV reduziu, tanto no score geral ($p = 0.04$) quanto no domínio de dor física ($p = 0.02$) após o uso da PPFI. A reabilitação de pacientes parcialmente edêntulos com PPRI e PPFI melhorou significativamente a função mastigatória e a magnitude do efeito relacionou-se ao tipo de prótese.

Palavras-chave: mastigação, prótese parcial removível, prótese parcial fixa, prótese dentária fixada por implante, força de mordida, qualidade de vida.

SUMÁRIO

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“Talvez não tenha conseguido fazer o melhor, mas lutei para que o melhor fosse feito. Não sou o que deveria ser, mas Graças a Deus, não sou o que era antes.”

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INTRODUÇÃO

A mastigação corresponde à fase inicial do processo digestivo, tendo como objetivo a degradação mecânica dos alimentos, triturando-os em partículas menores, as quais, pela ação umectante e digestiva da saliva, formam o bolo alimentar apto a ser deglutido (van der Bilt *et al.*, 1994). Desta forma, a mastigação adequada favorece a digestão e o aproveitamento dos alimentos ingeridos por permitir maior superfície de contato do alimento com as enzimas digestivas (N'Gom & Woda, 2002).

A manutenção dos elementos dentais permite que o alimento seja adequadamente triturado e facilmente deglutido (van der Bilt *et al.*, 1994). Entretanto, quando há uma diminuição na capacidade mastigatória, as partículas resultantes são maiores, reduzindo a superfície de contato do alimento disponível para a ação enzimática e dificultando a digestão (N'Gom & Woda, 2002) fato que pode gerar carências nutricionais e distúrbios sistêmicos como gastrites e úlceras estomacais (Brodeur *et al.*, 1993). Estudos sugerem que indivíduos com redução no número de dentes apresentam padrões de mastigação adaptativos (N'Gom & Woda, 2002; Liedberg *et al.*, 2004), evitando o consumo de alimentos consistentes e optando por uma dieta com alimentos macios e processados, os quais apresentam altas taxas de gordura saturada e carboidratos refinados, além da baixa disponibilidade de proteínas, fibras, vitaminas e sais minerais, sendo assim considerados menos nutritivos (N'Gom & Woda, 2002; Liedberg *et al.*, 2004). A reabilitação dos elementos dentais ausentes por meio do tratamento protético além de restabelecer a função e a estética dos dentes, resulta em melhora na capacidade de trituração dos alimentos, auxiliando o processo digestivo (Berretin-Felix *et al.*, 2009).

O restabelecimento dos dentes ausentes pode ser realizado por meio de diversos tipos de próteses dentais. O tratamento reabilitador por meio de próteses parciais removíveis (PPRs) é amplamente utilizado na prática clínica e

apresenta vantagens, como a maior conservação de estrutura dental quando comparado ao tratamento por meio de próteses fixas dento-suportadas, menor custo, possibilidade de substituição de um maior número de elementos dentais ausentes e a facilidade de higienização (Budtz-Jorgensen, 1996). Contudo, este tipo de reabilitação pode estar associado a desvantagens biomecânicas, principalmente nos casos de extremidades livres; e estéticas devido à localização de alguns retentores, além de necessitar de desgaste de estrutura dental para a confecção de nichos. Possíveis traumatismos ou sobrecarga aos tecidos de suporte também podem estar relacionados a este tipo de prótese, podendo levar ao aumento da reabsorção óssea sob a extensão distal da base da PPR (Budtz-Jorgensen & Isidor, 1990).

A instalação de próteses implanto-suportadas e/ou implanto-retidas no rebordo desdentado posterior além de prevenir de forma considerável a reabsorção alveolar por meio do constante estímulo do tecido ósseo peri-implantar (Odman *et al.*, 1994), não compromete os elementos dentais adjacentes ao espaço edêntulo (Keltjens *et al.*, 1993). Este tipo de prótese também proporciona maior conforto durante a mastigação, pois apresenta maior estabilidade e fixação (Geertman *et al.*, 1999); manutenção dos contatos oclusais (Jacobs *et al.*, 1992); superioridade estética; e menor tempo de adaptação do paciente ao tratamento (Abt *et al.*, 2012). Adicionalmente, estudos sugerem que após a instalação de próteses fixas sobre implantes os pacientes podem apresentar alguma sensibilidade tátil, conhecida como osteopropriocepção (Jacobs *et al.*, 1992). Essa sensibilidade é decorrente da possível existência de mecanorreceptores dispersos no rebordo ósseo e na mucosa peri-implantar, os quais são estimulados pelos esforços mastigatórios, elevando a percepção tátil e o conforto dos pacientes durante o ato mastigatório (Jacobs *et al.*, 1992). Essa característica tátil pode influenciar de forma positiva a força máxima de mordida, podendo auxiliar a função mastigatória (Budtz-Jorgensen & Isidor, 1990; Mericske-Stern *et al.*, 1995; Budtz-Jorgensen, 1996; Hatch *et al.*, 2001). Ainda segundo Myiaura *et al.* 2000, a força máxima de mordida está fortemente relacionada ao tipo de reabilitação

protética, sendo que indivíduos reabilitados com próteses fixas convencionais apresentam 80% da força de mordida em relação à força de indivíduos totalmente dentados. Quando da reabilitação por meio de próteses parciais removíveis, a força de mordida decresce para 35% em média (Miyaura *et al.*, 2000).

Uma alternativa de reabilitação a ser considerada para os casos de extremidade livre consiste na instalação de apenas um implante na região posterior ao rebordo edêntulo e a colocação de um pilar com encaixe do tipo bola, unindo o implante à base da PPR (Keltjens *et al.*, 1993; Jang *et al.*, 1998; Ohkubo *et al.*, 2008; Bortolini *et al.*, 2011; Senna *et al.*, 2011; Campos *et al.*, 2013). Este procedimento apresenta como vantagens o aumento na retenção e estabilidade da PPR por reduzir possíveis movimentações rotacionais durante a mastigação (Ohkubo *et al.*, 2008; Bortolini *et al.*, 2011); melhora na habilidade mastigatória (Ohkubo *et al.*, 2008); mantem o nível ósseo do rebordo alveolar posterior, uma vez que estimula a neoformação óssea na região (Ericsson *et al.*, 1986); mantem os contatos oclusais posteriores (Budtz-Jorgensen, 1996; Bortolini *et al.*, 2011); reduz o número de retentores necessários para a PPR (Keltjens *et al.*, 1993; Senna *et al.*, 2011); e se constitui em tratamento de menor custo em relação às próteses parciais fixas (Keltjens *et al.*, 1993; Jang *et al.*, 1998).

Na literatura são escassos os estudos que comparam de forma objetiva a mastigação proporcionada por diferentes tratamentos reabilitadores, especialmente quando de próteses parciais fixas sobre implantes (Abt *et al.*, 2012). Segundo Liedberg *et al*. (2004), pacientes reabilitados por meio de próteses fixas sobre dentes apresentam melhor eficiência mastigatória em relação àqueles com PPRs convencionais. Em contraste, quando da comparação da função mastigatória de pacientes usuários de PPR (Classes I e II de Kennedy) com a de portadores de próteses fixas implanto-retidas, Kapur (1991) encontrou valores semelhantes de performance mastigatória entre os grupos. Entretanto, implantes laminados que não apresentam osseointegração, e o maior diâmetro da plataforma oclusal dos dentes artificiais das próteses removíveis são fatores que podem ter influenciado de forma decisiva os resultados do referido estudo (Kapur,

1991), denotando a necessidade da realização de investigações adicionais sobre o tema.

Ainda com relação às próteses removíveis, a avaliação objetiva e subjetiva da capacidade mastigatória de pacientes usuários de próteses totais em ambas as arcadas dentárias em comparação ao uso de overdentures implanto-retidas mandibulares, indicam que a maior retenção e estabilidade proporcionada pelo uso de próteses sobre implantes aumentam a capacidade mastigatória, resultando em um menor número de ciclos mastigatórios necessários para triturar o alimento adequadamente. Este fato se torna mais evidente em pacientes que apresentam rebordo alveolar extremamente reabsorvido (Carlsson & Lindquist, 1994; van der Bilt *et al.*, 1994; Geertman *et al.*, 1999; Fontijn-Tekamp *et al.*, 2000; Yi *et al.*, 2001; Pera *et al.*, 2002; Fontijn-Tekamp *et al.*, 2004; van Kampen *et al.*, 2004; Stellingsma *et al.*, 2005; van der Bilt *et al.*, 2006; Fueki *et al.*, 2007). Segundo van Kampen *et al.* (2004) pacientes usuários de próteses sobre implantes também apresentam menores valores de limiar de deglutição, pois trituram melhor os alimentos e consequentemente deglutem partículas de tamanho reduzido, auxiliando o processo digestivo e o aproveitamento nutricional dos alimentos. Por outro lado, Tang *et al.* (1999) e Garrett *et al.* (1999) não encontraram diferenças na performance mastigatória e no padrão do ciclo mastigatório de usuários de próteses totais convencionais ou próteses totais sobre implantes, expondo a presença de controvérsias sobre o tema.

A melhora na capacidade mastigatória obtida após o tratamento protético pode ter reflexos nutricionais e na qualidade de vida do indivíduo (Berretin-Felix *et al.*, 2009). Entretanto, estudos que avaliam o conteúdo nutricional da dieta de pacientes parcialmente edêntulos reabilitados por meio de próteses parciais fixas sobre implantes são escassos na literatura (Abt *et al.*, 2012). Segundo Ellis *et al.* (2008), a reabilitação com overdentures sobre encaixes do tipo bola instalados sobre dois implantes, reduz a dificuldade de mastigação de alimentos com maior consistência como cenoura, maça e nozes, elevando o consumo destes alimentos dentre os pacientes após a reabilitação protética.

Pacientes portadores de overdentures sobre implantes apresentam também maior nível sérico de albumina e vitamina B12, e diminuição da porcentagem de gordura corporal, do tamanho da circunferência abdominal e na proporção cintura/quadril em relação aos pacientes portadores de próteses totais convencionais (Morais *et al.*, 2003). Entretanto, Muller *et al*. (2008), não encontraram diferença nos níveis plasmáticos dos nutrientes analisados, quando o estado nutricional de pacientes reabilitados com próteses totais convencionais foi comparado ao de pacientes usuários de overdentures. Diferenças metodológicas provavelmente estão relacionadas a estes resultados antagônicos.

A qualidade de vida também está relacionada à reabilitação oral, sendo que a satisfação do paciente frente aos diversos tipos de prótese apresenta reflexos na rotina dos mesmos (Allen & McMillan, 2002). Emami *et al.* (2009), verificou que pacientes portadores de próteses sobre implantes se sentem mais satisfeitos em relação àqueles que utilizam próteses totais convencionais. Isto se deve à maior estabilidade e conforto durante a mastigação, quando da utilização de próteses fixas sobre implantes, acarretando na melhora da qualidade de vida em geral (Berretin-Felix *et al.*, 2009). Apesar destes resultados positivos, o efeito do tratamento protético na qualidade de vida de pacientes parcialmente edêntulos ainda precisa ser melhor estudado.

Diante das contradições que ainda persistem, torna-se importante avaliar a mastigação resultante do uso de diferentes próteses em pacientes parcialmente edêntulos, o qual foi o objetivo da presente pesquisa.

CAPÍTULO 1: *Implant support for distal extension removable partial dentures: clinical outcomes and patient satisfaction.*

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Abstract

Statement of problem. Distal extension denture base removable partial dentures are associated with rotational movement that could harm prosthesis retention and stability.

Purpose. This report aimed to describe the use of distal implants to support distal extension denture base removable partial dentures and to evaluate clinical outcomes of this technique on specific features of patient satisfaction.

Material and methods. Twelve participants (62.6 ± 7.8 years) received new conventional mandibular RPD and complete maxillary dentures. After 2 months of conventional prosthesis use, participants completed a questionnaire assessing their satisfaction. Then, implants were inserted bilaterally in the mandibular posterior region and, after 4 months, ball abutments were installed on dentures base. Implants and remaining teeth were followed by clinical and imaging exams. After 2 months, satisfaction was evaluated again and data analyzed by paired Student t test ($P<.05$).

Results. Clinical evaluation revealed stable periodontal conditions around the implants, no intrusions or mobility of teeth, and no radiographic changes in bone level. Participants reported significant improvements ($P<.05$) in retention, comfort, masticatory capacity, and speaking ability after the use of prosthesis with implants.

Conclusion. Implant supported removable prosthesis is a feasible and simple treatment that improves retention and stability, minimizes rotational movements, and significantly increases patient satisfaction.

Clinical implications. Implanted supported removable partial denture improves prosthesis retention and stability, increasing patient satisfaction with reduced cost comparing to fixed implant dentures. Thus, several patients could be benefit with this additional retention by the placement of a single short implant, even those with unfavorable denture-bearing ridge.

Key words: removable partial denture, patient satisfaction, dental implants, implant-supported removable partial denture, case report.

INTRODUCTION

Although total edentulism has decreased,[1] there has been an elevated number of partially edentulous patients[2] probably due to aging of the worldwide population and the oral health-related prevention policies.[1,3] According to Curtis et al[4] 73% of partially edentulous patients show missing molar and premolars, and 40% of these patients are classified as Kennedy Class I.

There are several prosthetic treatment options for partial edentulism, and “removable partial dentures (RPD)” are widely used in clinical practice.[5,6] This prosthetic modality presents advantages compared to tooth supported fixed prosthesis, including better tooth structure maintenance, lower cost, ability to replace a greater number of missing teeth, and ease of cleaning.[5,7] However, distal extension RPD is associated with the some challenges, such as: (1) minimization of biomechanical factors due to resilience differences between alveolar mucosa and the abutment teeth; (2) limited stability and retention due to rotational movement during mastication; (3) discomfort caused by food retention over RPD basis; (4) aesthetic issues due to the clasp appearance and; (5) the need for regular reline to maintain the occlusal contacts and to avoid deleterious force, which may increase alveolar reabsorption or damage the abutment teeth.[8,9]

Partial edentulous patients can also be successfully treated by osseointegrated implant therapy.[10] However, implants in posterior regions are limited by poor bone quantity and quality in the posterior jaw[11-13] and anatomical difficulties related to the position of the inferior alveolar nerve.[10,12-14] Thus, the use of short or small diameter implants or additional surgical procedures, such as bone grafts or mandibular nerve transposition, can be considered as an alternative treatment.[10] However, implants shorter than 10 mm have been associated with high failure rates,[15,16] and some evidence suggests that surgically increasing vertical ridge height is not predictable.[17] In addition, some patients reject or cannot afford multiple surgeries, which further limits the use of fixed prosthetic implants.[15]

The literature provides clinical reports describing the use of a few strategically placed implants as support for distal extension RPD, which increases RPD retention and stability.[18-21] This therapy may provide vertical stabilization for

the removable prosthesis and minimize rotational movements.[17,21-23] Although patient satisfaction after implant-supported RPD insertion,[19,22,24] is merely sited, important features of this satisfaction[25] such as comfort, retention, masticatory capacity, aesthetical appearance, ease of cleaning, and speaking ability have not been analyzed yet. Thus, the current study aimed to describe the use of distal implants for increasing the retention of distal extension RPD and to evaluate the outcomes of this technique on specific features of patient satisfaction.

MATERIAL AND METHODS

Twelve participants (mean age: 62.6 ± 7.8 years) were selected from a partner study approved by Local Ethics Committee (research protocol # 11/2010) and developed at Piracicaba Dental School, University of Campinas, which included a large sample of participants scheduled to receive fixed implant mandible rehabilitation. All patients were completely edentulous on the maxillary arch and partially dentate on mandibular arch, presenting only canines and incisors (Fig. 1). Participants were in good general health, did not have a history or symptoms of temporomandibular disorders, and were free from parafunctional habits and uncontrolled systemic disease, which would have prevented the surgical procedure. In addition, participants presented alveolar bone volume and thickness compatible to the implant installation.

During the first screening, all participants were analyzed including dental and medical anamnesis, intraoral examination of the edentulous ridges and remaining teeth, and periapical and panoramic radiographs (Fig. 2). Radiographs and “computerized tomography (CT)” provided an analysis of the bone tissue amount and confirmed the feasibility of dental implant installation. After, participants who agreed to participate in this study read and signed a consent form.

The proposed oral rehabilitation plan included a conventional mandible RPD, associated with distal implants and ball abutments, which would improve distal extension RPD retention and stability. Since the patients in this study presented low bone height for maxilla implant placement, the treatment goal was to

replace the existing maxillary complete denture.

The conventional maxillary complete denture and mandibular RPD were made according to the conventional technic. A Cobalt-Chromium alloy was used to process mandibular RPD frameworks and the RPD design consisted of a lingual major bar and circumferential or bar clasp retainers, with lingual supports located on the mandible canines cingulum. The prosthesis were installed and adjusted in the participants´ mouth using bilateral balanced scheme of occlusion. Adjustments were made after 7, 14, and 21 days in order to adapt the prosthesis to individual needs. Participants also received verbal and written instructions about dentures insertion, removal, cleaning, and maintenance.

Clinical and images aspects, such as biofilm amount, bleeding on probing, and teeth or implant mobility and/or intrusion were assessed as well as the participants satisfaction was assessed after 2 months of wearing the new conventional prostheses. The satisfaction questionnaire,[26] consisted of 13 questions related to overall satisfaction, retention, comfort, aesthetic appearance, easiness of cleaning, masticatory capacity, and speaking ability.[26] Participants received questionnaire instructions and were left alone to answer the questions. Responses were based on a “visual analog scale (VAS)”,[27] such that the extremes were represented by "complete unsatisfied" and "complete satisfied". Participants were asked to point on the scale a dot, which reflected his or her satisfaction level. Higher scores on the questionnaire corresponded to greater patient satisfaction.

After satisfaction evaluations, all participants were submitted to CT image exams and implants insertion. A surgical guide was performed and used during the CT scan and in the surgical procedure to determine the correct position and inclination of the implants. During the surgery 2 or 3 implants (Titamax; Neodent; Curitiba, Brazil) were installed bilaterally in the premolar and molar region (Fig. 3) with conventional two steps technique. Thus, after implant insertion, participants were instructed to remain without the mandibular prosthesis for one week to allow mucosa healing. Then, RPDs were adjusted and relined with resilient soft lining material (Ufi Gel P; Voco; Cuxhaven, Germany), to be used during four

months periods. This procedure allowed implant osseointegration without damage and restored aesthetics and chewing function.

After osseointegration, all implants were exposed and ball abutments (O´ring; Neodent) were installed in most posterior implants (Fig. 4), (remaining implants were kept in place with the abutment healing caps). The torque used on ball abutments was 32 N in accordance with the manufacturer's instructions. Participants then underwent a periapical image exam (Fig. 5) in order to control and confirm the perfect component fit. Then, the distal extension RPD acrylic resin base was relieved and the ball abutments were captured directly in the mouth in order to improve passive fit.[18,21] Occlusal adjustments were again performed to keep the bilateral balanced occlusion, RPD's acrylic resin bases were polished (Fig. 6), and dentures were inserted in a participants´ mouth. Participants also received cleaning and maintenance instructions and subsequent adjustments after 7, 15, and 21 days, which aimed to facilitate individual adaptation. Clinical and imaging aspects of the implants and teeth, and patient satisfaction were again evaluated after 2 months of implant-supported RPD use.

Statistical analysis

Exploratory analysis using Shapiro Wilk test showed that patient satisfaction data presented normal distribution. Data was evaluated at SAS statistical program, using paired Student t test procedures. Statistical significance was determined at $P<.05$.

RESULTS

The described treatment was performed in 8 women (59.4 ± 6.2 years) and 4 men (69 ± 7.3 years) and the implants used range from 3.75 mm to 6.0 mm in diameter and from 7.0 mm to 13.0 mm in length.

After 2 months of implant supported RPD use, the periodontal conditions around abutment teeth and implants were stable (Fig. 4). Moreover, there were no intrusions or mobility problems of the teeth and no visible bone changes in the natural teeth or implants on the periapical radiographs (Fig. 5).

Specific features of patient satisfaction with the new maxillary and mandibular dentures before and after implant insertion, as represented by mean of VAS scores are shown in Table I. Paired Student t tests showed a significant increase ($P<.05$) in overall patient satisfaction, retention, comfort, speaking ability and masticatory capacity after implant supported RPD use.

DISCUSSION

There is currently a dilemma in clinical practice regarding maintenance of few natural teeth or the rehabilitation with implant complete dentures.[23] According to Svensson et al[3] periodontal mechanoreceptors in the remaining teeth of partial edentulous patients play a key role in regulating the delicate forces that handle the food prior to biting and chewing. The present study attempted to confirm this statement by using a valuable, simple, and easy treatment that strategically placed implants associated with distal extension RPD in order to maintain residual natural teeth and to improve RPD retention.

Indeed, our results showed great clinical outcomes. Participants showed stable periodontal condition of the abutment teeth and implants without changes in teeth or bone levels after implant supported RPD use. These findings are analogous with clinical trials[19,20,24] and case reports[15,18] outcomes, that have evaluated the same therapy with resembling number of participants.[21,22] In addition, to preserve proprioception by the remaining teeth, Chikunoz et al[9] have described other advantages of implant supported RPD, such as: (1) requirement of a small amount of implants; (2) improvement in load delivery through abutment teeth and implants, minimizing rotational movement, and improving RPD prognosis; (3) low cost and simplified hygiene compared to fixed implant prosthesis; (4) aesthetic advantages by compensating of lack in supporting structures or preventing the clasp appearance; (5) preservation of alveolar bone around the implants and remaining teeth; (6) ability to convert into a complete overdenture; (7) relatively simple clinical and laboratory procedures that improves the acceptance toward the removable treatment.

In regards to patient´s satisfaction outcomes, VAS assessment showed an extremely significant (P<.001) improvement after implant supported RPD use (Table I), with increase in retention, comfort, and masticatory capacity for both, maxillary and mandibular prostheses. Moreover, speaking ability (P=.001) with implant supported RPD was also improved compared to conventional RPD. These remarkable findings support previous studies[19,24] which suggested that the greater comfort and retention of implant-supported RPD could justify the higher satisfaction outcomes.

Despite improved patient satisfaction, cleaning skills (P=.59) and aesthetic quality (P=.08) did not differ before and after implant support. This result may be explained by the fact that both treatments are of removable nature and thereby easy to clean, as reported by the participants. Aesthetic quality may not have improved because a metallic clasp on the lower canines was necessary due to the large extension of the denture base.

It is important to consider the optimal implant length and diameter that is associated with implant supported RPD. Although the literature is not conclusive on this topic, the present clinical report used 7 mm to 13 mm long implants, which are similar to the lengths of implants used in previous studies.[17,21] According to a finite element analysis research[16] the use of longer and wider implants can reduce tension delivered to the alveolar bone. However, it should be noted that the mandibular posterior region has anatomical characteristics that restrict the use of longer implants.[12]

Physiological factors related to bone resorption of the alveolar ridge are also crucial to implant therapy and pose additional challenges. According to Kordatzis et al,[14] posterior mandibular ridge resorption was, on average, 1.63 mm for conventional dentures and 0.69 mm for implant overdentures after 5 years of denture use. Therefore, bone is preserved around osseointegrated implants as a result of the remodeling stimulus.[7] This concept is extremely important for the posterior mandibular area, which usually has reduced bone height. Furthermore, some clinical cases require additional surgical procedures, such as bone grafts or

mandibular nerve transposition to allow longer implant installation.[10] Thus, the use of short implants in the present study may be a simple alternative choice to prevent additional surgical procedures, especially in association with distal extension RPD.

Clinicians should be aware how implants and natural teeth react whenever are involved in a prosthetic connection. Some authors[7,21] do not recommend the rigid union between teeth and implants because their differential resiliency under occlusal force may increase tooth intrusion or jeopardize the osseointegration process. Consequently, the use of resilient attachments on implant-supported RPD is preferred over rigid connections due to more favorable distribution of loads across the mucosa and the bone around implant.[23] Moreover ball abutments are resilient under function, present simply setting and repair, effectiveness, predictability, low maintenance cost, durability, suitable degree of retention, and limited interocclusal distance requirements. Thus, it is important to highlight that teeth and mucosa exerted mostly supportive forces, whereas implants mainly provided retention, which prevented rotational movements.

Although multiple advantages were observed with implant supported RPD, the current report had limitations, such as a small number of subjects and a brief follow up period. Therefore, longitudinal clinical trials with several follow up visits are necessary to determine the long term stability of this type of denture and long term treatment success. Despite these limitations, the findings from this report highlight the effective and viable clinical solution, specially related to the reduced cost of implant supported RPD comparing to fixed implant partial dentures.

CONCLUSION

Implant supported RPD is a feasible and simple treatment that improves overall patient satisfaction, retention, comfort, and masticatory capacity.

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Table I. VAS scores (mean values and standard deviation) (mm) for patient satisfaction features related to conventional and implant-supported RPD.

		Conventional RPD	IRPD	P
Overall Satisfaction		53.3 (± 9.8)	71 (± 8.9)	<.0001*
Retention	Maxilla	67.8 (± 15)	78.2 (± 11.6)	<.0001*
	Mandible	45.3 (± 16.4)	72.2 (± 12.4)	<.0001*
Comfort	Maxilla	70.5 (± 15.8)	81.3 (± 8.1)	.002*
	Mandible	50.9 (± 13.3)	71.6 (± 11.9)	<.0001*
Mastication	Maxilla	62.7 (± 15.9)	78.9 (± 10.8)	<.0001*
	Mandible	42.6 (± 12.9)	69.8 (± 13.9)	<.0001*
Speaking ability	Maxilla	74.1 (± 12.2)	78.8 (± 8.1)	.051
	Mandible	58.4 (± 14.8)	78.2 (± 9)	<.0001*
Ease of Cleaning	Maxilla	84.1 (± 8.9)	84.9 (± 6.9)	.692
	Mandible	74.4 (± 17.4)	77.5 (± 9.6)	.368
Aesthetic	Maxilla	78.4 (± 13.3)	82.4 (± 8.9)	.186
	Mandible	67.2 (± 12.8)	70.1 (± 13.9)	.053

*Significant difference, P≤.05 paired Student t test

Fig. 1. Initial patient clinical condition.

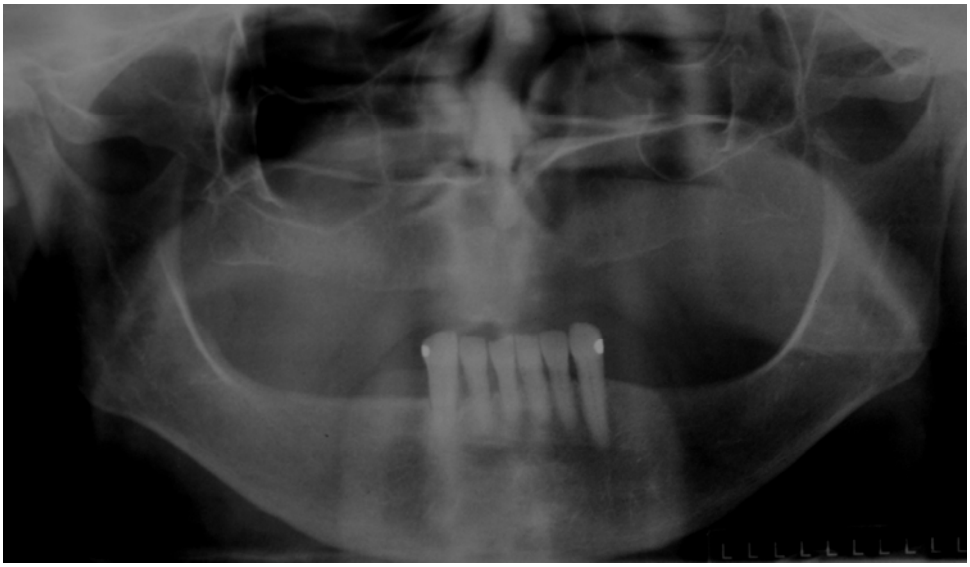

Fig. 2. Diagnostic panoramic radiograph.

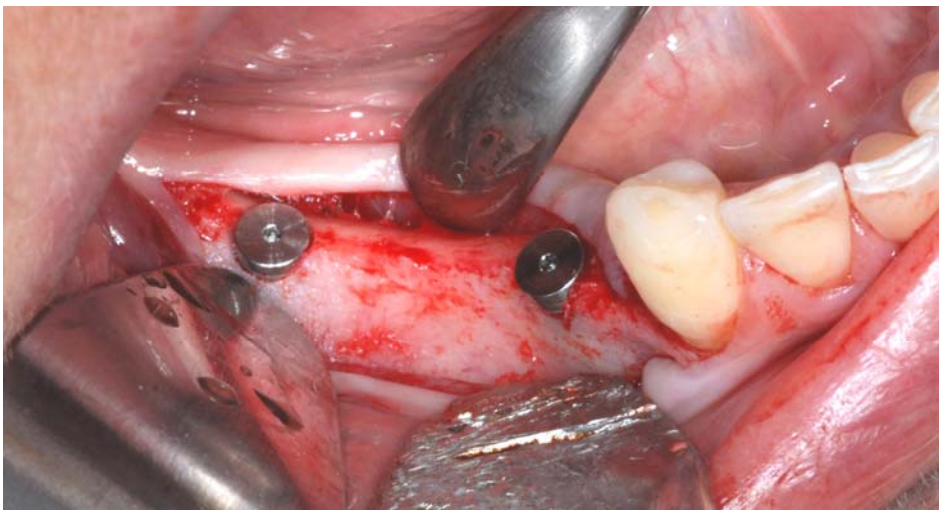

Fig. 3. Intraoperative view of implants placed into the posterior mandible region.

Fig. 4. Occlusal view of implants with heeling caps and ball abutment.

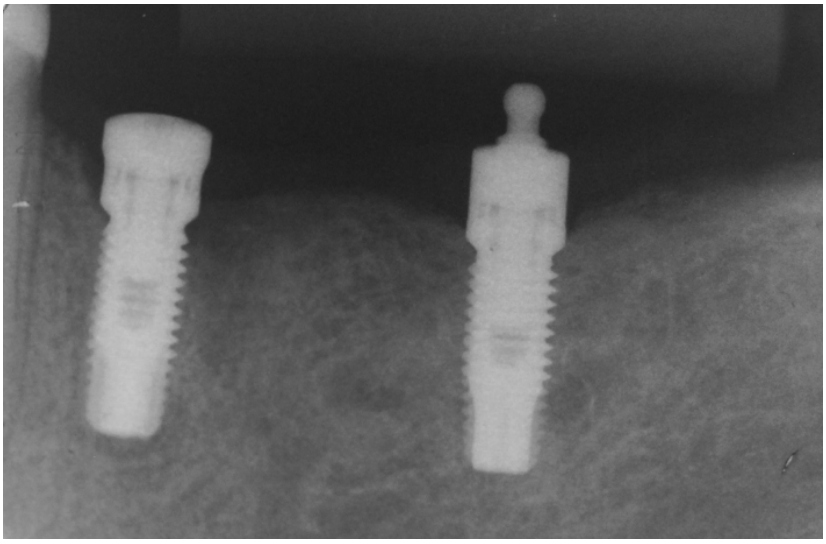

Fig. 5. Follow up periapical radiograph of osseointegrated implants and ball abutments.

Fig. 6. Implant-supported RPD completed after ball abutments capture.

CAPÍTULO 2: *Mastication Improvement After Partial Implant-supported Prosthesis Use.*

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ABSTRACT

Partially edentulous patients may be rehabilitated by the placement of removable dental prostheses (RDP), implant-supported dental prostheses (IRDP) or partial implant fixed dental prostheses (IFDP). However, it is unclear the impact of each prosthesis type over the masticatory aspects, which represents the objective of this paired clinical trial. Twelve patients sequentially received and used each of these three prosthesis types for 2 months, after which maximum bite force (MBF) was assessed by a strain sensor and food comminution index (FCI) was determined using the sieving method. Masseter and temporal muscle thicknesses during rest and maximal clenching were also evaluated by ultrasonography. Each maxillary arch received a new complete denture that was used throughout the study. Data were analyzed by ANOVA for repeated measures, followed by Tukey's test ($p < 0.05$). MBF and FCI increased ($p < 0.0001$) after IRDP and IFDP use with the higher improvement found after IFPD use. Regardless of implant-retained prosthesis type, masseter muscle thickness during maximal clenching also increased ($p < 0.05$) after implant insertion. Partial implant-supported prostheses significantly improved masseter muscle thickness and mastication, and the magnitude of this effect was related to prosthesis type. (*International Clinical Trial Registration* # RBR-9J26XD).

INTRODUCTION

Posterior teeth play important roles in comminuting food and the post-canine teeth loss significantly reduced masticatory performance (van der Bilt *et al.*, 2006). Moreover, loss of a first-molar occlusal pair is also a key factor in prosthetic restoration (Fueki *et al.*, 2011).

Several prosthetic options are available to restore chewing function in patients with missing teeth (Abt *et al.*, 2012; de Freitas *et al.*, 2012). However, few studies (Kapur, 1991; Liedberg *et al.*, 2004) have determined the effects of prosthetic treatment on mastication in partially edentulous patients, and their findings are controversial. Kapur (1991) reported that removable dental prostheses

(RDPs) and partial implant fixed dental prostheses (IFDPs) achieved similar chewing efficiency. In contrast, Liedberg *et al.* (2004) showed higher food comminution in patients with fixed dental prostheses than in RDP wearers. Because masticatory impairment can adversely affect quality of life (Lepley *et al.*, 2010), the effects of different prostheses on mastication is important to determine.

Several methods have been used to evaluate mastication, including occlusal force measurements (Goshima *et al.*, 2010; Muller *et al.*, 2012; Ohara *et al.*, 2013), sieving test (Gotfredsen and Walls, 2007; van der Bilt, 2011), color-changeable gum test (Goshima *et al.*, 2010; Muller *et al.*, 2012), and muscle thickness evaluation (Bhoyar *et al.*, 2012; Muller *et al.*, 2012; Ohara *et al.*, 2013). In addition, correlations between bite force, chewing performance, and masticatory muscle thickness (Raadsheer *et al.*, 1999; Muller *et al.*, 2012) have been established and it is known that masticatory muscle action is influenced by occlusal factors such as partial edentulism (Bhoyar *et al.*, 2012). Thus, masticatory muscle function can be reduced by the severe tooth loss or a soft diet consumption, as typically selected by edentulous patients, leading to muscle atrophy (Tsai *et al.*, 2012).

Dental implants are increasingly used to replace missing teeth (Abt *et al.*, 2012; de Freitas *et al.*, 2012) and studies (Carlsson and Lindquist, 1994; Feine *et al.*, 1994; Geertman *et al.*, 1999; van Kampen *et al.*, 2004) have shown masticatory improvements in implant-supported overdentures wearers. However, implant therapy effecting is unclear in partially edentulous patients chewing which was the aim of this study. The tested hypothesis was that the increased retention and stability provided by implants would be predictive of masticatory improvements and it could affect muscle thickness.

Materials and methods

Experimental design

The Ethics Committee of Piracicaba Dental School, University of Campinas (Piracicaba, Brazil) approved this research (protocol #011/2010). In this longitudinal, single-center clinical trial, subjects served as their own (paired)

controls. Study participation was voluntary, and subjects provided written informed consent prior to enrollment (register # RBR-9J26XD).

Subjects with edentulous maxilla and partial edentulous mandible using old and ill-fitting removable dentures were selected. Each patient received a new complete maxillary denture that was used throughout the study while a sequence of three different mandibular treatments was performed: conventional RDPs, IRDPs, and IFDPs. All treatments were accomplished with no cost to the subjects and each prosthetic treatment was used for 2 months before masticatory evaluation. We measured the maximum bite force (MBF), food comminution index (FCI), and masticatory muscle thickness. The poor conditions of the old prostheses did not allow the masticatory evaluation at baseline.

Subject selection

Eligible subjects had no maxillary teeth and mandibular canines and incisors only, with sufficient bone in the posterior mandible to allow for implant installation. They were in good general health and free of temporomandibular disorder, parafunctional habits or uncontrolled systemic disease that would prevent oral surgery.

Sample size was estimated based on previous study (Miyaura *et al.*, 2000) (bidirectional α of 0.05 and a β of 0.20) and 9.6 subjects were required to detect differences. We added 25% to compensate patient drawback, with a total sample of 12 subjects.

Patients seeking prosthetic treatment at Piracicaba Dental School, University of Campinas were contacted (n = 120), but 12 subjects were excluded due to advanced periodontal disease, 33 due to the retention of lower molars and/or premolars, and 57 were excluded due to insufficient bone height for implant insertion (evaluated by panoramic radiography and/or computed tomography). Three patients refused to participate. Thus, 15 subjects were selected but 1 subject died during the research period and 2 were excluded due to bone resorption complications, yielding a final sample of 12 volunteers (4 men, 8 women) with a

mean age of 62.6 ± 7.8 (range, 48–80) years.

Clinical procedures

Subjects received general dental treatment, including periodontal and dental care for remaining teeth. New complete maxillary dentures and mandibular RDPs were assembled with conventional techniques. RDP frameworks were made of cobalt-chromium alloy, with lingual major bar and circumferential or bar clasp retainers as the RPD design. Lingual rests were located on the lower canine cingulum and also provided indirect retention to rotational movements. Prostheses were installed and adjusted in patients' mouths with bilateral balanced occlusion scheme. After 2 months of prosthesis use, mastication was evaluated.

Subjects received two implants (Titamax; Neodent®, Curitiba, Brazil) per side in mandibular premolar and molar region. The correct implant position and inclination were established using a surgical guide and a conventional two-step technique (Blanes *et al.*, 2007) was used. After 1 week, RDPs were adjusted and relined with resilient soft lining material (Ufi Gel P®; Voco, Cuxhaven, Germany) for use during the 4-month osseointegration period.

The posterior implants were exposed and received ball abutments (O´ring; Neodent®) according to the manufacturer's instructions. Conventional RDP acrylic base was relieved and the capsules were captured directly in the mouth to improve passive fit (de Freitas *et al.*, 2012), transforming the RDP into IRDP. Occlusal adjustments were performed to maintain bilateral balanced occlusion. Masticatory variables were again evaluated after 2 months of IRDP use.

At final step, IRDP was replaced by three-unit metal-ceramic IFDP assembled with conventional techniques (Blanes *et al.*, 2007). All IFDPs were screwed over abutments (Mini Pilar; Neodent®) attached to implants, according to manufacturer's instructions. The screw holes were covered with compound resin and occlusal adjustment was performed. After 2 months of IFDP use, masticatory function was evaluated.

Masticatory function evaluation

MBF was measured with bite force transducer (Spider 8; Hottinger Baldwin Messtechnik GmbH, Darmstadt, Germany) (Fernandes *et al.*, 2003). Sensors (FSR no. 151, 1.2-mm diameter, 5.6-mm thickness; Interlink Electronics Inc., Camarillo, CA, USA) were placed in the bilateral first molar regions and signals were recorded and analyzed by Catman Easy software (ver. 1.0; Hottinger Baldwin Messtechnik GmbH). Subjects were requested to occlude with maximum force for 7 s and the procedure was repeated after 5 min rest. The average of the two measurements was calculated and recorded in Newtons (N).

The reproducibility of MBF method was previously verified in 10 subjects chosen at random. Two separate measurements were performed and high intraclass correlation coefficient was found (r = 0.94).

FCI was evaluated with Optocal artificial test material (Pocztaruk *et al.*, 2008). Subjects were instructed to chew a 3.7g portion, in the habitual manner, for 20 chewing strokes (van der Bilt and Fontijn-Tekamp, 2004), while a single calibrated operator counted the cycles. The comminuted particles were collected, dried and vibrated in a sieving machine (Bertel Indústria Metalúrgica, Caieiras, Brazil) through a stack of sieves ranging from 5.6- to 0.5-mm mesh. Materials retained on sieves were weighed on a 0.001-g analytical balance (Mark; BEL Engineering, Milan, Italy) and the FCI was calculated as the percentage weight of the comminuted material that passed through the 2.8-mm sieve (van der Bilt and Fontijn-Tekamp, 2004).

Real-time imaging of the bilateral masseter and anterior temporalis muscles thicknesses was performed ultrasonographically (SSA-780 A-APLIO Mx, 38 mm/7–18 MHz; Toshiba Medical System Co., Tokyo, Japan). Muscle thickness was measured directly on the instrument's screen (Fig. 1) with an accuracy of 0.01 mm (Castelo *et al.*, 2010).

A pilot study was performed in two different days with 10 subjects, selected at random. The ultrasound measurement error (Se) was calculated by Dahlberg's formula Se = $\sqrt{\sum d^2/2n}$, where *d* is the difference between two measurements and

n is the number of recordings (Dahlberg, 1940). The masseter muscle thickness errors in contracted and relaxed positions were 0.13 and 0.16 mm, respectively, and those for the anterior temporalis were 0.17 and 0.16 mm. These values are considered small, revealing the method accuracy (Georgiakaki *et al.*, 2007). Additionally, Pearson's correlation coefficient performed between the two measurements revealed a strong and significant correlation (r = 0.85 - 0.98) ($p < 0.0001$).

Each trial was conducted in a darkened room with the subject seated in an upright position. All measurements were performed by a single calibrated operator to avoid inter-operator error (Emshoff *et al.*, 2003). A standardized protocol was used to establish the correct location of the muscle site (Emshoff *et al.*, 2003). Initially, the muscles were identified by palpation (masseter: area of greatest lateral distention, ~ 2 cm above the inferior mandibular border; anterior temporalis: anterior to the anterior border of the hairline) (Castelo *et al.*, 2010) and a line was drawn on the subject's skin, showing the specific area where the transducer should be placed. After gel application, the probe was held perpendicular to the muscle, avoiding excessive pressure on the tissue, until the reflection of the bone was depicted as a sharp white line. The thickest part of the muscles was measured perpendicular to the muscle long axis (Figure 1) (Castelo *et al.*, 2010). Three measurements were performed for each muscle at rest and in the maximum voluntary clenching (MVC). Final muscle thickness values were obtained by averaging these values (Castelo *et al.*, 2010).

Statistical analyses

Data distributions were assessed by Shapiro-Wilk tests, which revealed normal distributions. Analysis of variance (ANOVA) for repeated measures was performed with SAS software (release 9.1, 2003; SAS Institute Inc., Cary, NC, USA) and Tukey-Kramer tests were used for comparisons between the prosthetic treatments. Pearson correlations were calculated between masticatory muscle thickness, MBF and FCI. Statistical significance was set to $p < 0.05$.

Results

MBF increased ($p < 0.0001$) after implant insertion (Fig. 2) with gain of 140 N observed between RDP and IRDP use, while an increment of 306 N was detected comparing RDP to IFDP use, growing 79% and 172%, respectively.

Similar trend was observed for FCI with the highest values verified after IFDP use ($p < 0.0001$) (Fig. 3). Multiple comparisons between RDP, IRDP and IFDP use revealed that FCI rose up to 91% when comparing RDP to IRDP, while the improvement found between RDP and IFDP use was 209% on average.

The left and right masseter and anterior temporalis muscles thicknesses during rest and MVC are presented in Table 1. Regardless of side and prosthesis type, masseter muscle thickness during MVC increased after implant insertion ($p \leq 0.05$), raising from 5.9 to 9.3 % in respect to muscle site and prosthesis type. No differences in the masseter or temporalis muscle thickness at rest or the temporalis muscle in MVC were observed (all $p > 0.05$).

Pearson's correlation analysis performed between muscles thickness and masticatory variables revealed weak and no significant correlation ($p > 0.05$).

Discussion

Given the common occurrence of tooth loss, increasing lifespans, and retention of more teeth into advanced age, evidences to inform the clinical management of tooth loss are needed (Abt *et al.*, 2012). Studies comparing different prostheses must eliminate confounding factors (Abt *et al.*, 2012), which can be achieved most reliably by intraindividual comparison of restoration alternatives. This paired study provides sufficient evidences for the effects of prosthetic treatment on masticatory function in partially edentulous patients. Simple, accurately and reliable methods were used to quantify mastication provided by each dental restorative procedure.

As expected, MBF was higher after IFDP and IRDP use than after RDP use. Although no other paired study on this topic has been published, our MBF findings are in accordance with those of Miyaura *et al*. (2000) and Ohara *et al.* (2013).

Nevertheless, greater bite forces are associated with higher masticatory capacity (Lepley *et al.*, 2010), as confirmed by the FCI results of the present study. Previous studies (Carlsson and Lindquist, 1994; Feine *et al.*, 1994; Geertman *et al.*, 1999; van Kampen *et al.*, 2004) with similar methodologies also agree with these results, although they had evaluated completely edentulous patients. In contrast, Kapur (1991) revealed no difference in mastication between RDP and IFDP wearers; however this similarity might be due to the reduced chewing platform. Authors pointed out that this reduction was necessary to prevent damage to the blade implants system (Kapur, 1991). In our case, mandibular prostheses occlusion was based on the non-changed maxillary denture, keeping the chewing platform similar in all prostheses. The increased masticatory function may be related to the drastic reduction in RPD rotational movement after implant insertion, which allowed the development of stronger jaw elevator muscles (Lepley *et al.*, 2010), increasing the ability to comminute test material. It is important to highlight the advantages of IRDP therapy compared to IFDP in relation to the reduced cost and small amount of implants needed (de Freitas *et al.*, 2012). Therefore, IRDP therapy properly restores masticatory function of partially edentulous patients, representing a reliable and more affordable treatment to be offered in the clinical routine.

MBF is considered a key factor of masticatory function (Muller *et al.*, 2012) and masseter muscle thickness was shown to be a major contributing factor of bite force (Raadsheer *et al.*, 1999). Furthermore, periodontal mechanoreceptors play a key role in masticatory force control during food chewing (Trulsson, 2006; Abt *et al.*, 2012), revealing the importance of tooth maintenance. In the present study, the effects of the implant therapy were clearly observed both in MBF and masseter muscle thickness during clenching. Similar muscle changes were observed by a previous study (Bhoyar *et al.*, 2012) after 3-month use of new complete dentures. In addition, Tsai et al. (2012) described that the constant intake of soft food could result in masticatory muscle atrophy (Bhoyar *et al.*, 2012; Muller *et al.*, 2012). Thus, it could be suggested that the enlarged masseter muscle thickness may be related to the higher intake of chewy food which requires a more vigorous action of

the masticatory muscles, explaining the masseter thickness changes. Despite the differences in masseter muscle thickness during MVC, no change in muscle thickness at rest was observed, which was predictable given the short duration of each treatment. Future studies with long-term follow up are needed to evaluate changes in masticatory muscles over time.

Although our data show a dramatic masticatory improvement after implants insertion, special attention must be given to the relative small sample and short follow up period. Based on the statistical estimation, it seems unlikely that increasing sample size would change the results. Nevertheless, a paired experimental design was used avoiding bias, since each subject acts as his own control. The short-term follow up allowed the analysis of different treatments in the same subject without drawbacks. In addition, measurements were performed only after the complete adaptation of subjects to each prosthetic treatment, when no more chewing complaints were reported.

Mastication can be evaluated by objective and subjective methods (Gotfredsen and Walls, 2007; van der Bilt, 2011). In this study, only objective parameters of mastication were evaluated because subjective chewing assessment is, in general, too optimistic due to the great variability in tooth loss adaptation (Gotfredsen and Walls, 2007; van der Bilt, 2011). Thereby, single sieve method was selected because it is a convenient and reliable method to evaluate the capacity of food comminution (van der Bilt, 2011).

Our data show the real impact of different prosthetic treatments on mastication in partially edentulous patients. However, future investigations should determine the consequences of masticatory improvement on nutritional intake, swallowing threshold, chewing ability, and quality of life.

Conclusions

The IRDPs and IFDPs significantly increased MBF and FCI, being the magnitude of the masticatory improvements closely related to prosthesis type. The use of implants also increased masseter muscle thickness during contraction.

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Table 1. Mean (standard deviation) masseter and anterior temporalis muscle thicknesses according to prosthesis type, jaw position, and side.

Muscle			RPD		IRPD		IFPD	
Masseter	Right	Rest	10.28 ± 1.62	A	10.33 ± 1.67	A	10.62 ± 1.66	A
		MVC	11.81 ± 1.51	A	12.45 ± 1.29	B	12.79 ± 1.36	B
	Left	Rest	10 ± 1.42	A	10.29 ± 1.67	A	10.28 ± 1.85	A
		MVC	11.76 ± 1.92	A	12.47 ± 1.98	B	12.92 ± 2.02	B
Anterior Temporal	Right	Rest	3.17 ± 0.79	A	3.32 ± 0.66	A	3.36 ± 0.69	A
		MVC	4.20 ± 0.89	A	4.30 ± 0.92	A	4.27 ± 1	A
	Left	Rest	3.18 ± 0.68	A	3.23 ± 0.74	A	3.33 ± 0.96	A
		MVC	4.14 ± 0.8	A	4.2 ± 0.73	A	4.22 ± 0.8	A

MVC = Maximum voluntary clenching. Upper letters indicate differences among treatments. Repeated measures ANOVA, Tukey HSD, $p < 0.05$.

Figure 1 Example of an ultrasound image of masseter muscle thickness (mm) during maximum muscle contraction. The intensive white line at the lower part of the image is the echo of the lateral surface of the ramus mandibularis (A) and the narrow white line below at the top represent the outer fascia of the masseter muscle (B). The masseter is seen as a dark area between the fascia (B) and the lateral surface of the ramus (A) measured perpendicular to the ramus.

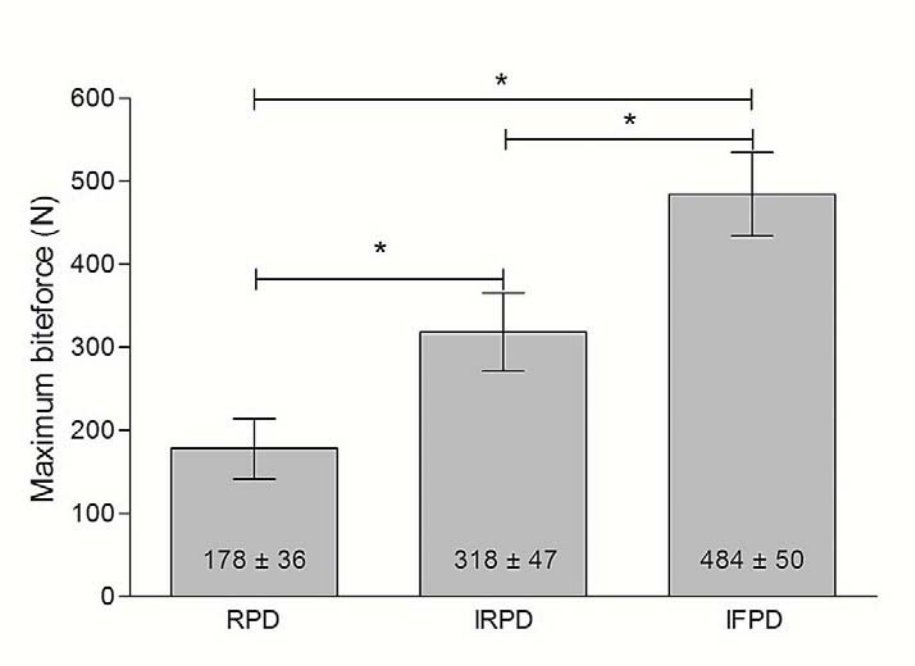

Figure 2 Graph showing mean value of maximum bite force (N) and standard deviations in relation to the prosthetic treatment. Maximum bite force was significantly higher for the implant-supported removable dental prostheses (IRDP) and implant fixed dental prostheses (IFDP) (*$p < 0.0001$).

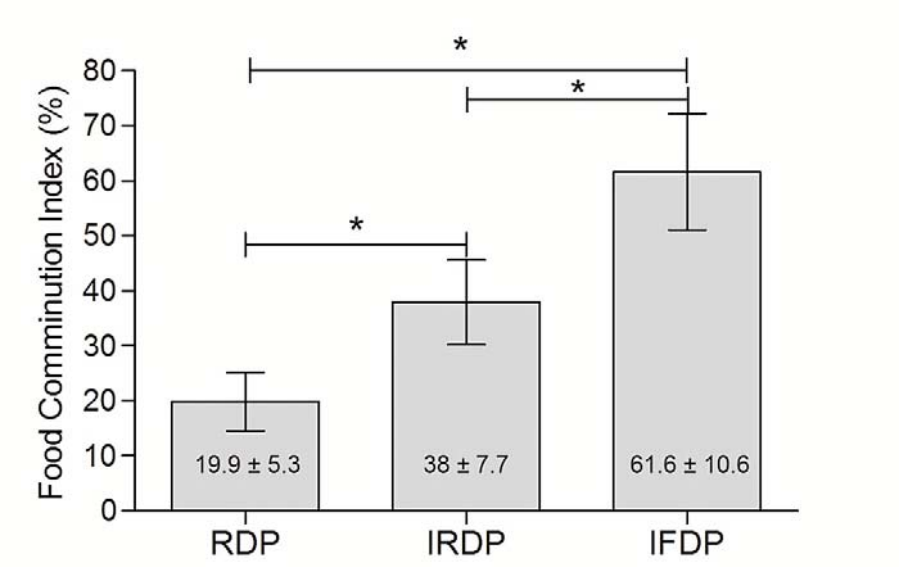

Figure 3 Graph showing mean value of FCI (%) and standard deviation in relation to the prosthetic treatment. The use of implant-supported removable dental prostheses (IRDP) and implant fixed dental prostheses (IFDP) significantly increased the chewing capacity (*$p < 0.0001$).

CAPÍTULO 3: *Improvement in masticatory function and jaw motion after partial implant-supported prosthesis instalation: A paired-controlled clinical trial*

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Abstract

Objective: This paired study evaluated mastication after removable partial dentures (RPDs), implant-supported partial dentures (IRPDs), and implant-fixed partial dentures (IFPDs) use. *Study design:* Mastication was assessed in twelve partially edentulous subjects after they had used RPD, IRPD and IFPD. Masticatory performance (MP) was measured by sieving method and masticatory ability (MA) was evaluated by visual analog scale questionnaire. Mandibular chewing motion was evaluated by kinesiograph. Data were analyzed by repeated-measures ANOVA followed by Tukey-Kramer ($P < .05$). *Results:* MA improved after IRPD and IFPD use ($P < .05$). Similar results were found for MP, which was increased ($P < .0001$) up to 85% and 87% after IRPD and IFPD use, respectively. Opening, closing, and total cycle time duration were reduced after IRPD and IFPD use ($P < .05$), irrespective the implant prosthesis type. *Conclusion:* IFPDs and IRPDs restored masticatory function of partially edentulous patients better than RPDs, favorably affecting MA.

Clinical Relevance

The present research would help clinicians understand the masticatory functions peculiar to each prosthetic treatment and the process by which new chewing patterns are learned when the occlusion is modified through tooth loss and restored by prosthetic treatment. This study encourages the use of implants to improve mastication of partially edentulous patients.

Introduction

The purpose of chewing is to break food into small particles, thus increasing its surface area to produce a homogeneous bolus appropriate for swallowing and facilitating digestive enzyme activity.[1] A severe reduction in the number of occluding teeth leads to chewing impairment.[2] Partially edentulous patients try to compensate for missing teeth by chewing longer,[3] overcooking food (reducing its nutritional value),[4] swallowing larger food particles, or selecting a

softer and less nutritive diet.[5,6] A recent study[7] revealed that changes in eating habits by reducing meat, fruit, and vegetable intake, commonly observed in edentulous patients, may lead to serious health conditions, such as anorexia. Thus, one of the main goals of prosthetic treatment is to restore masticatory function.[8]

Several prosthetic treatments are available to recover the masticatory function and aesthetics of several missing teeth, such as conventional removable partial dentures (RPDs), implant-supported removable partial dentures (IRPDs), and implant-fixed partial dentures (IFPDs).[9] However, there is insufficient evidence to determine the relative chewing effectiveness of each treatment or to recommend one prosthetic intervention over another for patients with partial edentulism.[9] Subjects with extremely deficient dental arches (incisors and canines only) exhibit approximately 49% of the masticatory capacity of subjects with fewer missing teeth (e.g., with molars).[10] Therefore, RPD use by the former improves mastication only slightly. In other words, this type of prosthetic treatment cannot restore the masticatory function of partially edentulous patients on a level comparable to completely dentate individuals.[5]

We previously evaluated the chewing capacity and nutritional intake after RPD and IRPD use.[6] We determined that IRPD treatment is more efficient in restoring mastication, and that its use is associated with improvement in nutritional intake by increasing carbohydrate, protein, fiber, calcium, and iron intake, thus raising energy. Comparisons between RPD and tooth-borne, fixed partial prostheses with respect to food intake revealed a lower consumption of hard foods among RPD patients.[11] Despite these reports,[6,11] there has been no evaluation of masticatory impact after IFPD use. Future studies are necessary to compare the effect on mastication of different prosthetic treatments to establish more efficient therapies for restoration of oral function.

Masticatory function has been assessed objectively by a masticatory performance (MP) test and by recording jaw movements during chewing. It can also be subjectively evaluated by means of masticatory ability (MA) analysis.[8,12]

MP measures the particle size of chewable test materials after a given number of chewing strokes, processed by a sieve system.[5,13] Mandibular movements can be recorded by kinesiograph,[14,15] whereas MA can be evaluated using specific questionnaires.[16] Since MP evaluates the final product of the comminution process and kinesiographic data analyze jaw movements during chewing, both tests are complementary for a masticatory function survey.[17] However, the relationships between MA, MP, and chewing cycle movements, as well as the effects of the various related prosthetic treatments, have yet to be determined.

Comparison of chewing patterns before and after RPD treatment showed increased mandibular velocity during the opening phase of the masticatory cycle after RPD use.[17-19] Lepley et al.[17,18] showed that kinematic measurements of the chewing cycle were related to the occlusal state, being greater and more stable occlusion contacts associated with greater chewing velocity.

Because increased occlusion contact area is related to better MP,[8] we hypothesized that the more stable and better retained the prosthetic treatment is, the more efficient the masticatory function would be.[9,12,20] Therefore, we performed a paired study aiming to monitor the influence on MA, MP, and mandibular movements after each conventional RPD, IRPD, and IFPD prosthetic treatment.

Material and Methods

Experimental Design

This study was a nonrandomized, controlled, single-center clinical trial that evaluated subjects' masticatory function after three different prosthetic treatments were performed on the same subject. Thus, the participants, who were also enrolled in our previous study,[6] functioned as their own controls.

Partially edentulous patients who had sought help at the dental clinic of Piracicaba Dental School, University of Campinas were recruited from February 2010 to January 2012. After selection, each subject was submitted to three sequential, experimental prosthetic treatments in the mandible: conventional free-end RPDs, IRPDs, and IFPDs. The edentulous maxilla was fitted with a

conventional complete denture at the beginning of the study, and this prosthesis was used throughout the study. Masticatory function was evaluated by measuring MA, MP, and mandibular movements, performed after 2 months of each prosthetic treatment.

Ethics Statement

The Ethics Committee at the Piracicaba Dental School, University of Campinas (Piracicaba, Brazil), which is in compliance with the Helsinki Declaration, approved this research (Protocol No. 011/2010). The study was also entered in the Brazilian Registry of Clinical Trials database (No. RBR-9J26XD) and linked to the International Clinical Trials Registration Platform (ICTRP/WHO). Study participation was voluntary, and selected subjects signed a written and formed consent document before enrolling in the research.

Sample Selection

The number of subjects was determined on the basis of previous reports.[5,6] A minimum of 9 subjects was needed to detect a difference with a power of 80% and an error probability of 5%. In view of the withdrawal rate of 25%, the final sample was established at 12 volunteers. We evaluated 120 partially edentulous patients; however, only 15 met the inclusion criteria of presenting no teeth in the maxilla and only canines and incisors in the mandible, to have sufficient compatible, posterior bone for implant installation. All volunteers were in good general health, they had no history or symptoms of temporomandibular disorders, and they were free of parafunctional habits and any uncontrolled systemic disease that could have contraindicated surgical procedures. Figure 1 shows the flowchart of the sample selection. A total of 12 subjects (4 males and 8 females) ranging in age from 55 to 87 years (mean age, 62.6 ± 7.8 years) completed all three experimental prosthetic treatments, having their masticatory function evaluated after the use of RPDs, IRPDs, and IFPDs.

Clinical Procedures

Initially, all subjects were fitted with complete maxillary dentures and conventional, mandibular free-end RPDs that were produced according to

traditional techniques[21] by a single dental technician. RPD frameworks were made from cobalt-chromium alloy, designed with a major lingual bar and circumferential or bar-clasp retainers', having rests on the mandibular canine cingulum. Both prostheses were installed and adjusted in the patient's mouth with a bilaterally balanced scheme of occlusion. After 2 months of complete maxillary and mandibular free-end RPD use, masticatory function was evaluated.

Two or three implants (Titamax, Neodent, Curitiba, Brazil) were bilaterally installed in the mandibular premolar and molar regions. The correct planning of the implant setting was established by assistance of surgical guide, and the conventional two-step technique[22] was chosen. Subjects remained without the free-end RPDs for 1 week after the surgical procedure. Then, the RPDs were adjusted and relined with resilient, soft lining material (Ufi Gel P, Voco, Cuxhaven, Germany), to be used during the osseointegration period (4 months).

Ball abutments (O-ring, Neodent) were installed in the most-posterior implants, according to the manufacturer's instructions. The free-end RPD acrylic base was relieved, and the ball abutments were captured directly in the mouth.[23] Occlusal adjustments were performed to keep the occlusion bilaterally balanced. Masticatory variables were evaluated after 2 months of IRPD use.

As the final step of the research, all subjects had their IRPDs replaced by bilateral, three-unit IFDPs. The IFPDs were fabricated in metal-ceramic with conventional techniques[22] and screwed onto the implant abutments (Mini pilar, Neodent) according to the manufacturer's instructions. Screw holes were covered by compound resin and occlusal adjustments were performed. After 2 months of IFPD use, subjects had their masticatory function evaluated again.

Masticatory Ability

Subjective evaluation of masticatory function was assessed by MA.[8,24] A routine questionnaire[16] based on a visual analog scale (VAS) was used to measure the subjective ability to chew food of different textures and consistencies.[16] In this evaluation, subjects were asked to rate their ability to chew bread, Parmesan cheese, sausage, lettuce, peanuts, apples, and raw carrots[16] by placing a dot on a

scale ranging from “very easy” to “very difficult”. Lower scores represented greater MA.[16]

Masticatory Performance

The sieving method was used to evaluate MP. Subjects were instructed to chew 17 cubes of chewable artificial material Optocal,[25,26] based on the silicon material Optosil (Heraus Kulzer, Sao Paulo, Brazil). They were instructed to chew the test material in their habitual way for 20 chewing strokes, which were counted by a single calibrated researcher.[13] All chewed particles were collected and, after being washed and dried, they were shaken at 2 Hz for 20 min in a sieving machine (Bertel Industria Metalurgica, Caieiras, Brazil) through a 10-sieve stack, with mesh sizes gradually decreasing from 5.6 to 0.5 mm, and a bottom plate.[25]

Particles retained on each sieve and on the bottom plate were weighed on an analytical balance (sensitivity to 0.001 g; Model 2060, Bel Engineering, Monza, Italy). MP was calculated as the median particle size (X_{50}).[25] The X_{50} value corresponds to the aperture of a theoretical sieve through which 50% of the weight of comminuted food can pass.[5,25] The Rosin-Rammler equation (nonlinear regression analysis) mathematically describes the cumulative distribution of particle size by weight: $Qw^{-}(X) = 1 - ((2-X/X_{50})^{b})$, where Qw is the weight fraction of particles smaller than X, and b represents the spread of the distribution (broadness variable).[5] Thus, the lower the X_{50} value, the better the MP.

Mandibular Movements

Mandibular movements were evaluated by a jaw-tracking kinesiograph (JT-3D, BioResearch, Milwaukee, WI, USA)[14] in two distinct situations: (1) the range of mandibular movements, and (2) the jaw motion during chewing. Subjects were seated comfortably in a dental chair with the Frankfurt plane parallel to the ground. A small magnet was temporarily attached to the mandibular incisors, and the magnetic sensor device was adjusted to the subject’s head, following the manufacturer’s instructions. Tracked jaw movements were displayed on a computer screen in 3-D spatial coordinates on vertical, anteroposterior, and lateral axes.

Mandibular movements were evaluated by first asking the subject to keep the teeth in maximum intercuspal position. Then, the subjects were requested to perform the maximum range of motion, which consisted of maximum opening and closing, maximum lateral movements (right and left), and maximum protrusion. Chewing movements were evaluated by masticating 3.7 g of Optocal (17 cubes). Subjects were instructed to place the test material on their tongue and keep their teeth together in the maximum intercuspal position. Then, a single calibrated researcher instructed subjects to start chewing in their habitual way. The chewing cycles were counted by the researcher and, after 20 strokes, the subjects were asked to stop.

Chewing movement parameters analyzed were the duration of opening, closing, and occlusal phase(s), length of the masticatory cycle, opening and closing angles measured on the frontal plane, and maximum velocity (opening and closing).[14] The range of mandibular movements and jaw motion during chewing were analyzed by a custom computer program (BioPack, BioResearch). The first masticatory cycle of each chewing test was discarded because it involved the initial positioning of the test material over the teeth.[18]

Statistical Analyses

Normal distribution of data was found after exploratory analysis. ANOVA for repeated measures (SAS Institute, Cary, NC, USA, Release 9.1, 2003) was used for data analysis, and the Tukey-Kramer tests were used to compare prosthetic treatments. Statistical significance was determined at $P < .05$.

Results

Regardless of the type of food, MA generally improved after IRPD and IFPD use, with lower VAS values attributed to IFPD use ($P < .05$) (Table I). Comparisons between IRPD and RPD showed lower VAS values when the subject used the first prosthesis ($P < .05$) for all food types.

MP values measured after each prosthesis use are shown in Figure 2. Significant MP improvement was found after implant-based prosthesis use ($P <$

.001), with smaller particle size found after IFPD use ($P < .001$). MP increased to 85% with IRPD use and to 87% with IFPD use (Figure 2).

Range of motion was not altered by different prosthetic treatments ($P > .05$) (Table II). However, independent of the implant prosthesis type, the times of opening, closing, and total cycle during Optocal chewing were reduced ($P < .05$) (Table III).

Discussion

Treatment involving a complete maxillary denture and a removable mandibular partial denture is one of the most common prosthetic procedures in the daily routine.[27] Nevertheless, evidence is needed to inform the best clinical management of extensive tooth loss.[9] In addition, there is a lack of well-designed studies concerning masticatory function after implant insertion for support of RPDs in mandibular Kennedy Class I arches.[23] The present study evaluated the MA, MP, and mandibular movements during chewing cycles to verify masticatory capacity after three different prostheses were used by the same subject. Because their use avoids, to a great extent, intra-individual confounding factors, paired studies are indicated when different types of prostheses are compared.[11] Moreover, simultaneous recordings of MP and jaw movement might improve understanding of which chewing patterns yield the best masticatory capability after prosthetic treatment.[28]

MA was improved after IRPD and IFPD use, with smaller VAS values being found after IFPD use. Several food textures and harnesses' were investigated.[16] The MA results, as expected, revealed that hard foods, such as Parmesan cheese, apples, and raw carrots, were the most difficult to chew. Softer foods were found to be less so, irrespective of the prosthetic treatment. These findings corroborate those of Kogawa et al.,[29] who elucidated the relationship between poor MA and low intake of hard foods, such as fruits and vegetables. After IRPD and IFPD use, subjects from the present study had almost no complaints about chewing, even for hard food. Similar results were obtained in studies[16,30]

performed with completely edentulous patients who had their conventional dentures replaced by implant-supported overdentures, rating their MA for most foods as equally easy to chew.

VAS-based MA questionnaires are commonly used by both experimental and clinical researchers. Such instruments offer the advantages of a parametric statistical approach to the results.[31] The test-retest reliability of the MA questionnaire used in the present study was previously found to have a low random variation and high reliability (r = 0.96, intraclass correlation).[16] With this instrument, we were able to detect potentially important clinical differences with respect to the MA among the various prosthetic treatments we used.

A correlation between MA and MP has been established.[8] Thus, as improvement in MA was found, similar advances were expected in MP. This assumption was confirmed in the present study, in which MP was significantly improved after 2 months' use of the IRPD or IFPD ($P < 0.05$) as opposed to the RPD, with the best results found after IFPD use. These findings are consistent with those of Liedberg et al.,[11] who compared mastication of RPD wearers against those with fixed, tooth-supported partial-dentures, by means of a gum-chewing, color-mixing test and swallowing threshold measurement. Their results indicated a higher masticatory capacity in the fixed prosthesis group, suggesting that the more retentive and stable the prosthesis, the more effective the chewing process is.

In the present study, we also showed that use of the more retentive prosthesis (IFPD) was intimately associated with a higher chewing capacity. However, some studies[2,32,33] based on the short dental arch concept showed no differences in masticatory function between subjects using and not using RPDs. A possible explanation for these contrasting results is the maintenance of at least two remaining occluding tooth units in patients with short dental arches, which preserve the MP of partially edentulous patients.[33] In our case, severe tooth loss was restored, explaining the substantial effect of prosthetic treatment on masticatory function.

The marked improvement in MP after IRPD and IFPD use might be

related to the way masticatory forces are delivered to the supporting structures. In a conventional RPD, the functional load is transmitted to the abutment teeth and soft tissues,[27] such that RPD wearers usually complain of masticatory impairment and food retention under the RPD resin base when chewing high-consistency food.[6,11,16] In IRPD wearers, on the other hand, masticatory loads are distributed over the abutment teeth and the resilient attachments installed on distal implants. Thus, the stress concentration over the soft tissues is reduced, and the integrity of the vertical dimension is maintained, reducing the risk of mucosal overload. IRPDs also reduce denture-base movement during chewing, allowing patients to bite strongly before displacing the denture.[23] These characteristics might be responsible for the higher MA and MP found among IRPD wearers, compared with those using RPDs.

IRPD and IFPD treatment significantly reduced the total cycle time as well as the opening and closing time ($P < 0.05$). These results are consistent with previous reports[28,34] which examined the relationship between poor chewing capacity and longer masticatory cycles. Thus, the faster the chewing rate, the more efficient the chewing process, which supports the findings of the present study.[28] On the other hand, Ohkubo et al.[14] showed no differences in chewing cycle duration when partially edentulous patients were rehabilitated by RPDs or IRPDs. Only healing abutments were used as implant support for IRPDs in the Ohkubo et al.[14] study. The fact that healing abutments provide the only support that does not improve prosthesis retention might explain this discrepancy. In addition, these authors analyzed chewing patterns at the same appointment by inserting and removing the healing abutments, not allowing the patient to adapt to the new prosthetic treatment.[14] In summary, the use of stable and highly retentive prostheses, such as the IRPD and IFPD, for longer periods might be responsible for the improved chewing movement found in the present study.

Changes in chewing motion could also be related to the influence of the prosthesis type on the neural control of jaw movements.[19,35] The brain, receiving sensory information from several mechanoreceptors in and around the mouth,[35]

modulating the jaw motion by sensorimotor regulation.[36] The periodontal mechanoreceptors play a central role in encoding the patterns of masticatory forces, regulating food manipulation, biting, and chewing.[36] When natural teeth are replaced by implant prostheses, the periodontal ligament disappears, and the periodontal mechanoreceptors no longer given the brain about mechanical events.[35] Nevertheless, previous studies[19,20] on completely edentulous patients showed significant improvement in chewing movements, reduction in chewing-cycle duration, and a wider range of jaw movement after implant-supported denture use, all of which agree with our findings. These changes in chewing patterns might be related more to the increase in retention and stability of the implant-based prosthesis and less to the peripheral mechanoreceptors' input.

The clinician should be aware that implant therapy is versatile and that, in the future, patients might elect to restore their partially edentulous ridges with fixed, implant-supported restorations.[23] Thus, the present research would help clinicians understand the masticatory functions peculiar to each prosthetic treatment and the process by which new chewing patterns are learned when the occlusion is modified through tooth loss and restored by prosthetic treatment.

Conclusion

The increased retention of IFPDs and IRPDs fostered improvement in MA and MP and significantly reduced chewing cycle time. Therefore, the prosthesis type was related to more efficient masticatory movements.

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Table I. Mean values (standard deviation) for the VAS score (mm) evaluating masticatory ability according to the prosthetic treatment.

Food type	RPD		IRPD		IFPD	
Bread	70.17 (± 13.9)	A	47.08 (± 11.8)	B	17.90 (± 12.2)	C
Parmesan cheese	75.25 (± 17.4)	A	55.17 (± 14.2)	B	25.30 (± 14.1)	C
Sausage	15.67 (± 11.7)	A	7.58 (± 3.8)	B	2.70 (± 1.4)	C
Lettuce	31.75 (± 25)	A	20.83 (± 18.6)	B	8.20 (± 6.7)	C
Peanut	68.67 (± 23.7)	A	46.75 (± 11.9)	B	11.30 (± 7.8)	C
Apple	74.17 (± 12.4)	A	50 (± 8.6)	B	15.7 (± 13.4)	C
Carrot	81.67 (± 12.8)	A	58.75 (± 9.9)	B	24.8 (± 14.6)	C

Distinct letters indicate differences among treatments. ANOVA for repeated measures, Tukey HSD, $P < .05$.

Table II. Mean values (standard deviation) for range of mandibular motion (mm) in the frontal and horizontal plane according to the prosthetic treatment.

Range of Motion		RPD		IRPD		IFPP	
Frontal Plane	Vertical	33.33 (± 3.6)	A	34.62 (± 3.5)	A	35.56 (± 2.9)	A
	A-P	32.18 (± 6.1)	A	32.74 (±4.9)	A	32.83 (± 4.9)	A
	Lateral Deviation	3.54 (± 1.7)	A	3.45 (± 1.6)	A	3.61 (± 1.7)	A
Horizontal Plane	Right	10.36 (± 2.7)	A	10.49 (± 2.8)	A	11.05 (± 3)	A
	Left	10.76 (± 2.8)	A	10.75 (± 2.8)	A	10.50 (± 2.7)	A

Distinct letters indicate differences among treatments. ANOVA for repeated measures, Tukey HSD, $P < .05$.

Table III. Mean values (standard deviation) of mandibular movements during chewing of Optocal test material according to the prosthetic treatment.

Chewing motion	RPD		IRPD		IFPD	
Opening Time (s)	220.18 (± 26.9)	A	195.82 (± 28.4)	B	192.83 (± 28.4)	B
Closing Time (s)	270.33 (± 40.4)	A	237.12 (± 27)	B	222.33 (± 30.9)	B
Occlusal Time (s)	132.72 (± 23.1)	A	122.94 (± 25.6)	A	117.37 (± 30.1)	A
Cycle Time (s)	623.73 (± 75.5)	A	576.97 (± 62.2)	B	510.39 (± 52.8)	B
Opening Angle	88.54 (± 14.1)	A	91.63 (± 11.3)	A	90.02 (± 9.4)	A
Closing Angle	76.64 (± 24)	A	83.62 (± 15.4)	A	82.48 (± 20.5)	A
Max Open Velocity (mm/s)	176.96 (± 44.6)	A	158.46 (± 22.4)	A	183.94 (± 44.9)	A
Max Close Velocity (mm/s)	147.31 (± 37)	A	134.17 (± 15.5)	A	146.85 (± 44.1)	A

Distinct letters indicate differences among treatments. ANOVA for repeated measures, Tukey HSD, $P < .05$.

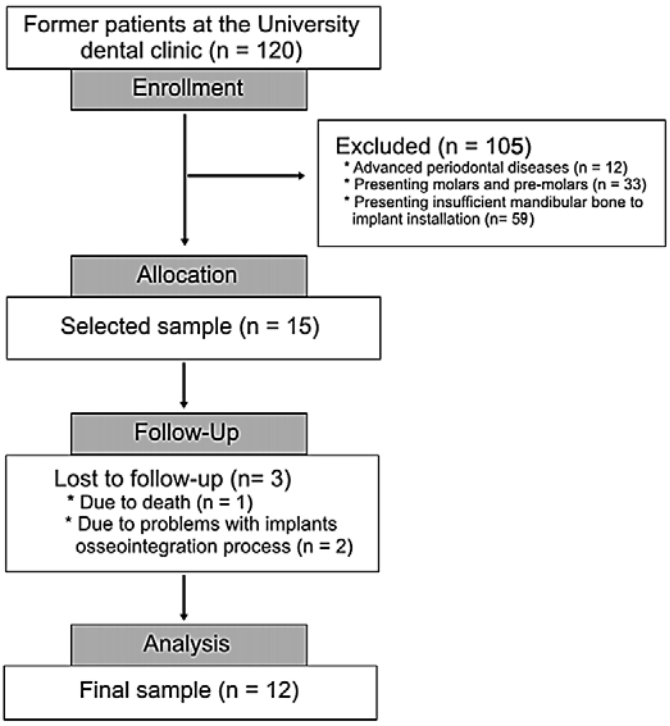

Fig. 1. Flowchart of subject recruitment.

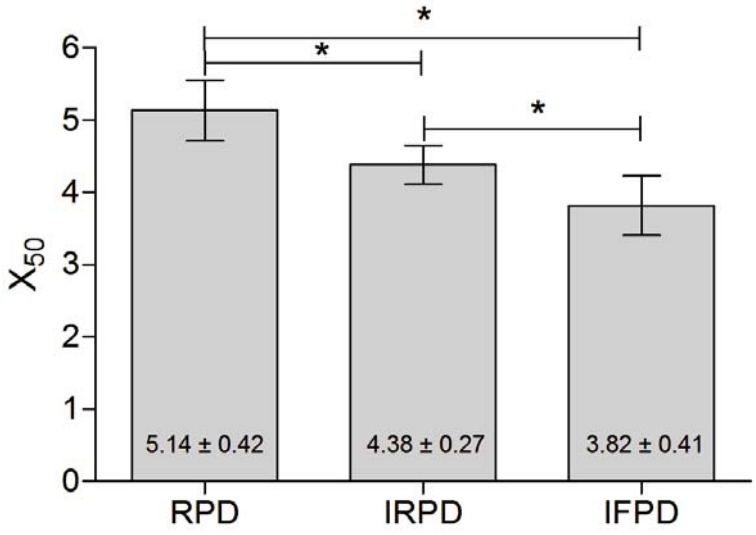

Fig. 2. Comparisons of MP (X_{50} values) according to the prosthetic treatment. *P < .0001

CAPÍTULO 4: *Effect of implant support for partially edentulous patients on swallow threshold, nutritional intake, and oral health-related quality of life*

Manuscript submitted to the *Clinical Implant Dentistry and Related Research*.

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ABSTRACT

Background: Implant can improve oral function of partially edentulous patients. *Purpose:* We evaluated the effects of implant-supported removable partial denture (IRPD) and implant-fixed partial denture (IFPD) on mastication, diet intake, and oral health-related quality of life (OHRQoL).

Materials and methods: This paired clinical trial evaluated swallow threshold, nutrition, patient satisfaction, and OHRQoL of 12 partially edentulous subjects (mean age 62.6 ± 7.8 years) after IRPD and IFPD use. Swallow threshold was assessed by masticatory cycles and medium particle size (X_{50}). Nutritional intake was verified by a 3-day food record. Visual analogue scale-based questionnaire assessed patient satisfaction. OHRQoL was verified with oral health impact profile (OHIP-49). Repeated-measures analysis of variance evaluated data, followed by Tukey ($p \leq .05$).

Results: IFPD treatment reduced X_{50} ($p = .002$) and chewing cycles ($p = .006$). Higher fiber ($p = .007$), calcium ($p = .001$), and iron ($p = .02$) and lower cholesterol consumption ($p = .02$) were observed after IFPD use. OHIP-49 summary score ($p = .04$) and physical pain ($p = .02$) were lower with IFPD than with IRPD use. Subjects were more satisfied with IFPD therapy.

Conclusion: IFPD use leads to higher masticatory capacity, healthier diet, and OHRQoL and patient satisfaction improvements.

INTRODUCTION

The number of partially edentate individuals is expected to increase considerably in the future, due to increasing lifespan and the retention of more teeth into advanced age.[1,2] In the United States, the number of partial dentures is estimated to exceed 60 million by 2020.[2] Dental rehabilitation options for partially edentulous patients include removable partial dentures (RPDs), fixed partial dentures, and implant-based prostheses.[3] Implant prostheses overcome some of the functional limitations of RPDs, especially in patients with extensive tooth loss.

Studies[4-6] have shown better results of masticatory capacity after using implant-retained or supported prostheses compared to conventional treatment. Partial edentulism is associated with chewing impairment.[3] Recovery of masticatory function is a key factor that can affect the patient's preference for a particular prosthetic treatment.[1,7] Thus, reliable data about the impact of implant-supported rehabilitations on chewing capacity are needed, to guide dentists in the clinical management of tooth loss.

In addition to effects on eating, the loss of molars or premolars elicits important cosmetic, communicational, and social impacts.[8] A direct linear relationship has been reported between the loss of occlusal units and oral health-related quality of life (OHRQoL),[9] showing that missing teeth may affect the psychosocial life of the individual. Assessment of the OHRQoL is crucial for oral health care planning and should be used to advocate better treatment.[10] Efforts should be made to determine which types of prosthetic treatment afford better functional ability and satisfaction for partially edentulous patients. Partial edentulism can contribute to serious morbidity and mortality in older patients.[11] A Japanese study[12] revealed that people with no teeth have poorer general health and higher mortality rates than those with teeth, showing the relevance of the topic. Such associations may be explained by the effects of oral diseases, tooth loss, and poor masticatory function on diet and nutritional status.[7,13,14] Poor oral health and poor chewing function have been implicated as risk indicators for a poor diet.[7]

People who have lost teeth can become handicapped by their dentition, suffering impaired intakes of nutrient-rich foods, including vegetables, fruits, meat, and whole grains.[13,15,16] The comminution impairments of partially edentulous patients are closely related to the number of missing teeth; as the number of occlusal pairs decreases, the chewing capacity becomes more impaired.[17] Patients may alter their behaviors to overcome their chewing handicaps.[18] Some adaptations commonly used by RPD wearers include increasing the number of masticatory cycles, chewing for longer periods, swallowing larger-sized food particles, consuming softer and easier-to-eat foods, and overcooking fibrous food

to make consumption practical.[7,13,15,16] Swallowing larger particles can influence the gastric process, with potential detrimental consequences for the gastric mucosa.[19] Previous studies[13,19,20] revealed that subjects with impaired masticatory performance present higher risk of digestive problems, such as non-ulcerative functional dyspepsia, gastritis, and ulcers. Recovering masticatory function and improving nutritional intake through prosthetic treatment represent important steps towards improving the health of partially edentulous patients.

Despite of the clinical importance of the theme, few studies have evaluated the impact of prosthetic treatment on the nutritional intake of partially edentulous patients. Garret and colleagues[21] revealed reduced caloric intake and increased protein, fat, carbohydrate, and cholesterol consumption by fixed partial denture compared to RPD wearers. We previously evaluated the nutritional intake and swallow threshold after RPD and implant-supported RPD (IRPD) use by the same volunteer,[4] finding that IRPD use significantly improved the masticatory capacity and the carbohydrate, protein, calcium, fiber, and iron intakes compared to RPD use. These findings could suggest that the IRPD better restored mastication, enabling subjects to improve their nutritional intake.[4] Studies[3,22,23] evaluating prosthesis use by partially edentulous patients have revealed that implant-fixed partial dentures (IFPDs) promote better comfort during chewing and increased patient satisfaction. However, to the best of our knowledge, no report has evaluated the impact of IFPD use on nutritional intake. Studies[14,24,25] performed with totally edentulous patients showed no significant differences in the food intake of implant-fixed complete denture compared to conventional denture wearers.

These contradictory results encouraged us to evaluate the impact of IFPD use on mastication, nutritional intake, and OHRQoL. We hypothesized that the retention and comfort level provided by different prosthetic treatments would affect the masticatory capacity, represented by the swallow threshold, and that a higher chewing capacity could improve the nutritional intake and enrich the patient's quality of life (QoL). Thus, the aim of this study was to evaluate the effects

of IRPD and IFPD use on the swallow threshold, nutritional intake, patient satisfaction, and OHRQoL, represented by the oral health impact profile (OHIP) measurements. In addition, we investigated the relationship between the variables to identify the contribution of each in the prosthetic treatments.

MATERIALS AND METHODS

Study Design

This was a prospective and unblinded clinical trial, with a paired and controlled design. Swallow threshold, nutritional intake, patient satisfaction, and OHIP were measured after 2 months of consecutive use of IRPD and IFPD. Study participation was completely voluntary, and selected subjects signed an informed consent document prior to enrolling in this research. The local Ethics Committee at Piracicaba Dental School, University of Campinas (Piracicaba, Brazil) approved this research (protocol # 011/2010). This clinical trial was also registered in the Brazilian Registry of Clinical Trials database (# RBR-9J26XD), which is linked to the International Clinical Trials Registration Platform (ICTRP / WHO).

Subject Selection

The present study is based on data collected in a larger study about the oral health status and masticatory function, with an emphasis on the type of dental prosthesis used, nutritional status, QoL, and anthropometric measurements of partially edentulous patients. Previous data from studies[4,7] about nutritional intake performed with similar samples were used to calculate the sample size. The calculation was performed using a bidirectional α of 0.05 and a β of 0.20, with 9.6 participants required to detect differences. We added 25% to that number to compensate for refusals, obtaining a total sample of 12 participants.

To be selected as volunteer, subjects must present no teeth in the maxilla and only canines and incisors in the mandible, with good bone anchorage and no advanced periodontal issues. Additional inclusion criteria were: *(1)* sufficient bone compatible for implant installation (> 12 mm from the bone crest to the inferior alveolar canal, and > 5 mm wide crest of mandible without undercuts),

(2) no history of radiation in head or neck region, *(3)* no uncontrolled systemic disease, which would have prevented the surgical procedure, *(4)* no periodontal issues, *(5)* no history or symptoms of temporomandibular disorders, and *(6)* no parafunctional habits.

A total of 120 people were evaluated to obtain the final sample. Most of the excluded individuals did not meet the inclusion criteria or had problems during the osseointegration process. Twelve subjects (4 males) ranging in age from 55 to 87 years (mean age 62.6 ± 7.8 years) completed the clinical trial. They received a new maxillary conventional complete denture at the beginning of the study, which was used throughout the study, while the mandible received IRPD and IFPD, sequentially used.

Clinical Procedures

We previously performed a study in which subjects received complete maxillary dentures and conventional mandibular RPDs.[4] The RPDs were transformed into IRPDs by the installation of implants and ball abutments in the posterior mandible region (molar and pre-molar). These procedures were detailed in our previous publication.[4] In the present study, subjects using IRPDs were evaluated with respect to the swallow threshold, nutritional intake, patient satisfaction, and OHRQoL. Then, bilateral three-unit IFDPs were assembled and used to replace the IRPDs. The IFPDs were constructed in metal ceramic with conventional techniques and screwed over abutments (mini pilar, Neodent®, Curitiba, Brazil) attached to implants according to the manufacturer's instructions. The screw holes were covered by compound resin, and occlusal adjustments were performed. After 2 months of IFPD use, the swallow threshold, nutrient intake, OHRQoL, and patient satisfaction measurements were again measured.

Measurements

Swallow threshold

The swallow threshold was determined by the sieving of Optocal test material,[26] based upon a silicone impression material (Optosil Comfort, Heraeus Kulzer GmbH & Co KG, Hanau, Alemanha). First, a 3.7-g portion of non-salted

peanuts was used to establish the number of masticatory cycles used until the patient swallowed. Subjects were instructed to chew the peanuts, in their habitual way, until they felt the urge to swallow, while a calibrated researcher recorded the number of completed masticatory cycles.[4] Mouth rinses were performed several times to cleanse the oral cavity completely. Second, the subjects chewed, in their habitual way, a 3.7-g portion of Optocal (17 cubes measuring 5.6 mm on each edge and 3 cm^3 in volume) for the same number of masticatory cycles used to chew peanuts, counted by the same researcher.[4]

The Optocal particles were collected after chewing and air-dried for at least 1 week. A sieving machine (Bertel Industria Metalurgica, Caieiras, SP, Brazil) was used for 20 minutes to sieve the particles through a stack of up to 10 sieves, with mesh sizes gradually decreasing from 5.6 to 0.5 mm, and a bottom plate. Particles remaining in each sieve were weighed (Mark, Bel Engineering, Monza, Milano, Italy). The median particle size (X_{50}), representing the aperture of a theoretic sieve through which 50% of the weight of the comminuted food could pass,[17] was calculated. Each subject performed this procedure three times across different days, and averaged outcomes were recorded.

Nutritional intake

Nutritional intake was evaluated from the dietary intake and the body mass index (BMI, kg/m^2).[4,24] The dietary analysis is a comprehensive and reliable method.[24,27] Subjects kept a written detailed record of all food and drink consumed for a period of 3 days.[4,27] After completing their diaries, subjects were interviewed for additional clarification about food portions and cooking methods. Nutrient intake was calculated and analyzed with computerized food tables. The daily intake of energy (kcal), fat (g/day), carbohydrate (g/day), protein (g/day), calcium (mg/day), fiber (g/day), and iron (mg/day) were calculated (NEPA-Unicamp 2006).[4]

OHRQoL evaluation

The OHIP-49 was used to assess the OHRQoL. This instrument is a questionnaire developed by Slade and Spencer[10] that describes the impact of oral health conditions on aspects of function, daily living, and social interactions in

seven domains, including functional limitations, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.[10] For each OHIP-49 item, subjects were asked how frequently they had experienced the impact of that item in the last month. Responses were made on a scale of never = 0, hardly ever = 1, occasionally = 2, fairly often = 3, and very often = 4.[10] Scores for each domain were summed. Overall higher OHIP-49 summary scores and subscales for the domains indicate greater OHRQoL impairment.[10] A previous study[28] evaluated the reproducibility of OHIP-49 in a Brazilian population, revealing significant values, with Kendall-tau correlation coefficients ranging from 0.72 to 0.74 between dimensions of three interviews. In the same study,[28] the Cronbach α coefficient was used to verify the internal consistency, with a range of 0.96 and 0.90 for the dimensions of the interviews and for total items, respectively.

Patient satisfaction

Patient satisfaction was assessed by a questionnaire based on a visual analog scale (VAS), with the extremes represented by "complete unsatisfied" and "complete satisfied".[8] This questionnaire consisted of 13 questions related to overall satisfaction, retention, comfort, masticatory capacity, speaking ability, easiness of cleaning, and aesthetic appearance.[29,30] Subjects were asked to point to a dot on the scale that best represented his or her satisfaction level for each item. Higher scores on the questionnaire corresponded to greater patient satisfaction.

Statistical Analyses

All measured variables were compared between the use of IRPD and IFPD. Normality of the data distributions was assessed by Shapiro-Wilk tests, which revealed normal distributions. Consequently, analysis of variance (ANOVA) for repeated measures was applied, and comparisons between IRPD and IFPD were conducted using the Tukey-Kramer test. Relationships among the variables were derived using Pearson's correlation coefficient and step-wise regression. All tests were performed with SAS software (release 9.1, 2003; SAS Institute Inc., Cary, NC, USA), with significance level of $p < .05$.

RESULTS

Swallow threshold

Mean X_{50} values and chewing cycles after IRPD and IFPD use are shown in Table 1. Repeated-measures ANOVA showed reductions for particle size (p = .002) and number of chewing cycles (p = .006) after IFPD treatment. Figure 1 shows the changes in the swallow threshold due to prosthetic treatment for each subject. For all subjects, IFPD use corresponded to fewer chewing cycles and smaller particle size.

Dietary Intake

Table 2 shows the nutritional intake during the use of each prosthesis type. Use of IFPDs increased calcium, fiber, and iron intakes (p < .05) and decreased cholesterol consumption (p = .02). No differences were found between the IRPD and IFPD use with respect to BMI, calories, protein, fat, and carbohydrate intake (p > .05).

OHRQoL Evaluation

The average OHIP-49 summary score (p = .04) and physical pain domain score (p = .02) were lower for IFPD treatment compared to IRPD treatment. No significant differences between treatments were found for the other OHIP-49 domains (Table 3).

Patient Satisfaction

Mean VAS values related to patient satisfaction after IRPD and IFPD use are shown in Table 4. Use of IFPD significantly increased patient satisfaction for all evaluated aspects, except easiness of cleaning.

Pearson's Correlation

Table 5 reports the results of Pearson's correlation analysis performed between variables. Decreased median particle size at the moment of swallowing was moderately correlated to an increased number of masticatory cycles (p < .01). Strong and positive correlations were found between calorie and protein (p < .001), calorie and carbohydrate (p < .001), protein and fiber (p < .01), protein and calcium

($p < .01$), and calcium and iron consumptions ($p < .01$). Moderate and positive correlations were observed between calorie and fat ($p < .05$), calorie and fiber ($p < .05$), calorie and calcium ($p < .01$), protein and carbohydrate ($p < .01$), protein and cholesterol ($p < .05$), fiber and carbohydrates ($p < .05$), fiber and calcium ($p < .05$), and fiber and cholesterol consumptions ($p < .05$). No other significant correlation was found.

DISCUSSION

The use of fixed implant prosthesis may overcome some of the functional limitations of a removable prosthesis. We attempted to elucidate the effects of IRPD and IFPD use on mastication, and the possible implications of chewing on the nutritional intake and OHRQoL. We found significant improvements of the swallow threshold after IFPD use. The size of the swallowed particle was reduced and fewer masticatory cycles were needed to reach this particle size (Figure 1). Studies[5,6] performed with implant-supported overdentures have revealed similar results. Consequently, it may be suggested that the use of prostheses offering higher retention and stability leads to more efficient mastication, and that this better chewing could allow subjects to improve their food selection.

There are limited data on the effects of prosthetic rehabilitation on nutrient intake, especially in partially edentulous patients. Our results are in disagreement with those obtained by Moynihan and colleagues,[27] who evaluated changes in dietary selection and nutrient intake after RPD or resin-bonded bridge use. Those authors found no differences between the two treatments. The discrepancy between our study and that of Moynihan and colleagues[27] could be related to the type of prosthesis used. In the previous study, patients in the resin-bonded bridge group were restored by the short dental arch concept, whereas the teeth were fully restored in the RPD group. Thus, the patients could have faced different chewing issues, which might have masked changes in nutritional intake, contributing to explain the contrasting results.

According to Kagawa and colleagues,[31] subjects with good masticatory function select healthier food, improving their fruit and vegetable intake. This theory was verified in our previous study,[4] where the higher chewing capacity of IRPD compared to conventional RPD use resulted in higher intake of energy, carbohydrate, protein, fiber, calcium, and iron. In the present study, we evaluated the impact of the IRPD replacement of IFPD on the nutritional intake, revealing significant improvements in fiber, calcium, and iron intake when the fixed prosthesis was used. These results corroborate with the concept that improved masticatory capacity is associated with a greater possibility of healthier food choices by partially edentulous patients.[7,25,32] Positive correlations were found between protein and fiber, calorie and protein, carbohydrate and calorie, protein and calcium, and fiber and calorie intakes, revealing significant improvements in diet quality.

Whole grain products and the skins of raw vegetables and fruits are important sources of fiber, which facilitates the digestive transit, decreases plasma cholesterol levels, reduces the glycemic response to carbohydrate-containing meals, and reduces the prevalence of colorectal cancer.[13,32] The recommended level of fiber intake is 20 to 35 g/day.[32,33] Tooth loss reduces the intake of highly consistent food;[25] thus, the gain of 9.4 g/day in fiber intake after IFPD use (Table 2) could be considered relevant. Improvements in calcium intake after IFPD use could play an important role in bone health, structure, and function, and the prevention of osteoporosis and osteoporosis-related fractures.[34] Increases in albumin and iron levels may be linked to the higher consumption of meat.[24]

A possible consequence of the increased meat intake could be an increase in the cholesterol level.[35] However, a significant reduction in cholesterol levels was observed after IFPD use, indicating that the iron intake improvements may have come from healthier foods, such as vegetables and/or low-fat meat. Literature reports have shown close relationships between fatty diet and obesity, hypertension, atherosclerosis, and non-insulin-dependent diabetes.[13] A randomized clinical trial[35] described that lower cholesterol levels and smoking

cessation are key factors for reducing risks of myocardial infarction, stroke, and sudden death.[35] The observed reduced cholesterol levels after IFPD use could indicate the improved health of the partially edentulous patients.

After receiving IFPD treatment, subjects reported better OHRQoL on the OHIP-49 summary score compared to when they were using IRPDs. The OHIP-49 is one of the most sophisticated and comprehensive instruments designed to assess OHRQoL.[23] This questionnaire has been translated and validated in various languages, including Portuguese,[28] and is used globally.[23] The original OHIP-49 version was chosen because it is more sensitive to minor changes among prosthetic treatments undetectable by simplified OHIP versions and also includes specific questions related to missing teeth.[28]

Because the present study was the first OHRQoL evaluation focused only on implant-based prostheses, it was difficult to compare the outcomes with the literature. Nevertheless, findings from previous studies[1, 23] seem to support our results. Gates et al.[1] evaluated the OHRQoL in partially edentulous patients before and after the conversion of a conventional RPD into an IRPD. This paired design study revealed a positive and significant improvement in OHIP-49 scores and an 11.8-unit reduction of the average OHIP-49 summary score after IRPD use. Similar OHIP-49 scores were found in the present study for IRPD use, revealing that the incorporation of implants into RPDs has a positive effect on the OHRQoL of partially edentulous patients. Another recent study[23] compared the OHRQoL of partially edentulous patients with IFPDs to patients with RPDs. They also reported higher OHIP-49 scores in IFPD wearers. Thus, it could be suggested that the higher the prosthesis retention, the lower the impact on the OHRQoL is, supporting the differences found in the present study between IRPD and IFPD use.

A previous report[36] established the clinical meaning for the OHIP summary score differences between prosthetic treatments, indicating what patients perceive as relevant when treated with each option. According to their data, a 6-unit reduction in the OHIP-49 score between treatments represents a “little improvement”, while differences higher than 10 units are related to “a lot better”

global transition response.[36] Studies[1,23] comparing RPDs with implant-based prostheses revealed significant reductions in OHIP-49 summary scores (17.4 and 23.4 units) after IRPD and IFPD use. We observed a 6.9-unit reduction in the OHIP-49 score after IFPD use. Smaller OHIP-49 scores for all domains were found compared to previous reports. These smaller results were expected, because both prosthetic treatments were implant-supported or retained. Nevertheless, IFPD use improved the impact of oral health on the patient's QoL.

An association has been found between the use of implant prostheses and improvements in the prosthetic biomechanics, with subsequently greater patient satisfaction.[1,22] Our results are consistent with this theory, confirming that patients were more satisfied when the prosthesis retention was higher. Patients reported significant improvements in satisfaction concerning retention, comfort, masticatory capacity, speech, and appearance after IFPD use ($p < .05$). A previous report[22] revealed similar findings after IFPD use compared to a complete dentate control. Taken together, these results suggest that the IFPD treatment permits successful rehabilitation for partially edentulous patients.

It is important to recognize the limitations of this study, particularly related to the analyzed sample size. OHRQoL and patient satisfaction with respect to specific prosthetic treatments are commonly assessed in epidemiologic studies.[9,10,28] However, the use of a small sample size and a paired study design offered the advantage of controlling several confounding factors that could influence the final results.[3] In addition, several studies[1,8,22,29] with similar or even smaller sample sizes and assessing OHRQoL or patient satisfaction were found. High significant differences with strong statistical power were found in the data analysis, supporting the proper estimation of the sample size. Although it is clear that the IFPD offers substantial benefits, this treatment is not feasible for all patients, due to anatomical, medical, financial, or personal reasons.[22] In these situations, a limited number of strategically placed implants in association with well-constructed RPDs can be a simple and low-cost treatment alternative.

CONCLUSION

The use of IFPD improved the masticatory capacity and induced health changes in terms of the nutritional intake. The higher patient satisfaction and masticatory improvement after IFPD use resulted in OHRQoL improvements.

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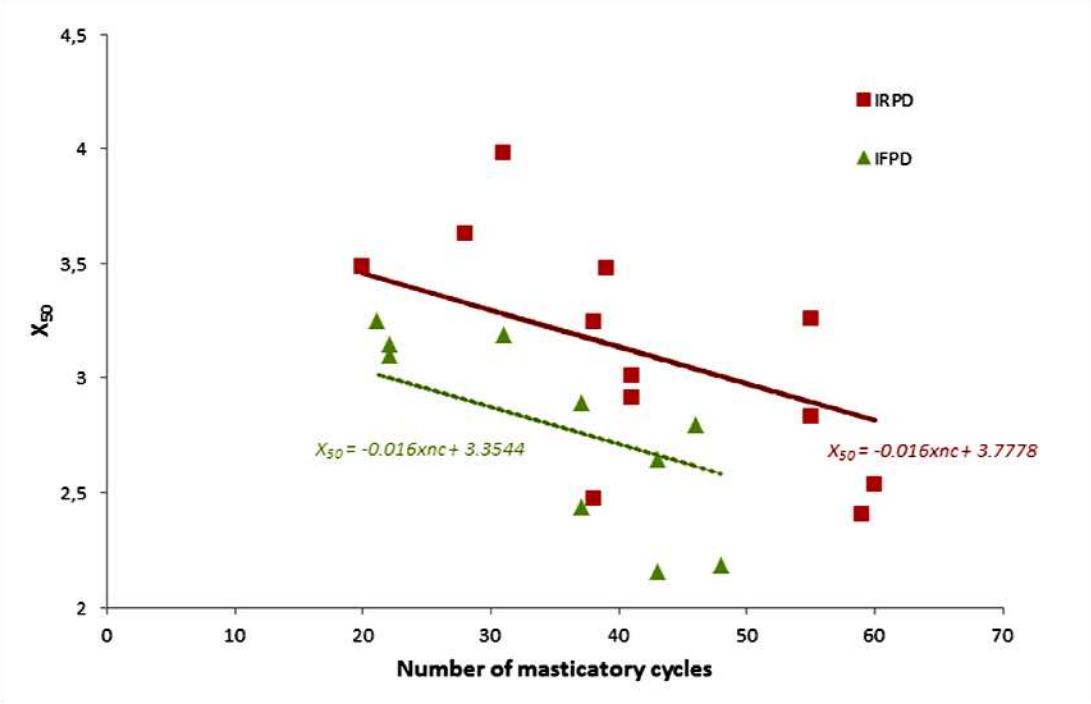

Figure 1. X_{50} values (mm) for Optocal chewing as a function of the number of chewing cycles until swallowing according to the prosthetic treatment. A significant correlation was observed between the variables (r^2 = .73; p = .007).

TABLE 1 Swallowed threshold variables (X_{50} and masticatory cycles mean and standard deviation values) after the IRPD and IFPD use.

	IRPD	IFPD	F	*p*
X_{50} (mm)	3.10 (± 0.48)	2.78 (± 0.41)	18.54	.002
Number of masticatory cycles	42.14 (± 12.69)	34.90 (± 10.59)	12.67	.006

Repeated measures ANOVA, Tukey HSD, $p < .05$.

TABLE 2 Nutritional intake assessment by subjects using IRPD and IFPD (n = 12).

	IRPD	IFPD	F	*p*
BMI (kg/m^2)	28.12 (± 5.75)	28.24 (± 5.06)	0.36	.56
Energy (kcal)	1770.38 (± 584.36)	1837.75 (± 442.35)	0.8	.39
Protein (g/day)	91.97 (± 24.48)	93.12 (± 39.02)	0.04	.84
Fat (g/day)	48.50 (± 11.77)	39.13 (± 15.43)	3.08	.11
Carbohydrates (g/day)	236.41 (± 85.04)	262.87 (± 80.11)	4.04	.07
Fiber (g/day)	26.17 (± 12.88)	35.60 (± 19.43)	11.6	.007
Calcium (mg/day)	483.99 (± 209.47)	559.21 (± 184.73)	19.48	.001
Iron (mg/day)	10.49 (± 5.27)	14.07 (± 9.16)	6.92	.02
Cholesterol (mg/day)	274.57 (± 118.27)	218.79 (± 60.62)	7.55	.02

Repeated measures ANOVA, Tukey HSD, $p < .05$.

TABLE 3 OHIP-49 mean scores (standard deviation) after the IRPD and IFPD use.

	IRPD	IFPD	F	*p*
OHIP-49 summary score	11.71 (± 8.84)	4.77 (± 2.27)	5.64	.04
Functional limitation	5.57 (± 4.13)	3.05 (± 1.42)	3.13	.11
Physical pain	2.91 (± 2.38)	0.98 (± 1.4)	7.27	.02
Psychological Discomfort	0.86 (± 1.93)	0.16 (± 0.5)	1.17	.30
Physical disability	1.43 (± 3.01)	0.32 (± 0.68)	1.11	.32
Psychological disability	0.19 (± 0.61)	0.00 (± 0)	1.21	.29
Social disability	0.12 (± 0.43)	0.19 (± 0.61)	0.1	.76
Handicap	0.13 (± 0.45)	0.00 (± 0)	0.83	.39

Repeated measures ANOVA, Tukey HSD, $p < .05$.

TABLE 4 Mean values (standard deviation) of VAS scores (mm) evaluating the patient satisfaction after IRPD and IFPD use.

		IRPD	IFPD	F	*p*
Overall		71 (± 8.93)	93.5 (± 7.26)	68.14	< .0001
Retention	Upper	79 (± 9.73)	90.7 (± 5.85)	33.41	.0003
	Lower	80.5 (± 7.96)	99.8 (± 0.63)	44.61	< .0001
Comfort	Upper	81.25 (± 8.09)	93 (± 5.44)	28.29	.0005
	Lower	71.58 (± 11.97)	98.7 (± 1.83)	63.15	< .0001
Masticatory capacity	Upper	79.75 (± 7.98)	92 (± 6.78)	88.37	< .0001
	Lower	78.08 (± 8.31)	99.7 (± 0.95)	78.54	< .0001
Speech	Upper	79.67 (± 7.41)	89.3 (± 5.72)	16.46	.003
	Lower	78.17 (± 9.03)	98.6 (± 2.88)	59.16	< .0001
Cleaning	Upper	84.91 (± 6.89)	86.7 (± 7.51)	4.99	.052
	Lower	77.5 (± 9.55)	80.9 (± 10.76)	0.58	.47
Appearance	Upper	82.58 (± 6.35)	96.7 (± 3.74)	37.25	.0002
	Lower	72.58 (± 13.81)	99.5 (± 16.28)	73.68	< .0001

Repeated measures ANOVA, Tukey HSD, $p < .05$.

TABLE 5 A matrix of correlation among variables related to IRPD and IFPD use.

		1	2	3	4	5	6	7	8	9	10	11
1	X_{50}	.										
2	Number of chewing cycles	- .73**	.									
3	Overall satisfaction	.05	-.26	.								
4	General OHIP score	-.33	.07	-.05	.							
5	Calories	.20	-.34	-.32	-.43	.						
6	Protein	-.04	-.35	-.21	-.23	.83***	.					
7	Fat	.07	-.17	-.17	-.25	.68*	.48	.				
8	Carbohydrates	.31	-.35	-.36	-.46	.95***	.69*	.49	.			
9	Fiber	.03	-.29	-.27	-.16	.76**	.82**	.49	.68*	.		
10	Calcium	.05	-.48	-.13	-.33	.63*	.80**	.32	.55	.61*	.	
11	Iron	.20	-.61*	.01	-.13	.29	.42	.22	.25	.33	.80**	.
12	Cholesterol	-.48	.06	.13	.17	.27	.62*	.01	.14	.59*	.43	.11

* $p < .05$, ** $p < .01$, *** $p < .001$ (Pearson correlation test)

CONSIDERAÇÕES FINAIS

A reabilitação protética de pacientes parcialmente edêntulos representa um importante aspecto da saúde oral dos indivíduos, levando ao crescente interesse pelo tema por parte da comunidade científica. O aumento na expectativa de vida, a retenção de um maior número de dentes em idade avançada e a maior consciência do valor da saúde oral, revelam a importância de determinar-se o melhor tratamento reabilitador no restabelecimento da função mastigatória, debilitada pela perda dental.

Segundo os resultados obtidos neste estudo, o uso de próteses sobre implantes potencializou a função mastigatória, ou seja, um menor número de ciclos mastigatórios foi necessário para a trituração dos alimentos além da maior eficiência durante a mastigação, representado pela redução no tamanho da partícula triturada. Além disso, o uso de implantes na reabilitação dos pacientes parcialmente edêntulos reduziu significativamente o tempo do ciclo mastigatório e resultou em alterações nos músculos mastigatórios, aumentando significativamente a espessura do músculo masseter durante a contração máxima, podendo assim explicar a maior força de mordida encontrada.

Um aspecto importante a ser destacados em relação à reabilitação protética com implantes refere-se às mudanças positivas no padrão alimentar e na qualidade de vida dos voluntários. Pode-se notar o aumento considerável no consumo de alimentos fibrosos e mais nutritivos por parte dos indivíduos além da redução do impacto da saúde oral na qualidade de vida e nas relações sociais destes pacientes após o tratamento reabilitador.

Em acréscimo, o uso de implantes osseointegrados na reabilitação de pacientes parcialmente edêntulos apresenta características positivas como a preservação do tecido ósseo ao redor dos mesmos que ocorre por meio do constante estímulo e remodelação óssea. Partindo-se deste princípio, estudos futuros avaliando o uso de implantes curtos associados às PPRs de extremidade livre poderiam viabilizar mais uma alternativa de tratamento, uma vez que o custo

é drasticamente reduzido quando comparado ao uso de próteses parciais fixas sobre implantes. Além disso, pacientes com rebordo reabsorvido, desfavorável à instalação de implantes de comprimento regular, poderiam ser beneficiados pelo uso desta retenção adicional, prevenindo assim a realização de procedimentos cirúrgicos mais invasivos.

Vale salientar que, segundo os resultados obtidos, a prótese parcial removível com encaixe implanto-retido restabeleceu adequadamente a função mastigatória. Além disso, características positivas destas próteses em relação às próteses fixas podem ser citadas como o custo reduzido, a técnica de confecção simplificada e sua natureza removível sendo, portanto, fáceis de serem higienizadas. Essa característica é de suma importância em relação aos pacientes idosos e/ou hospitalizados e institucionalizados, os quais apresentam redução na habilidade motora ou estão impossibilitados de realizarem a higienização de suas próteses. Sendo assim, as próteses removíveis podem ser facilmente removidas e higienizadas por um cuidador.

A manutenção de dentes remanescentes na cavidade oral é de suma importância, devido à presença dos mecanoreceptores localizados no ligamento periodontal. Essas estruturas neuronais periféricas contribuem sobremaneira na sensibilidade tátil, auxiliando no controle das forças mastigatórias conforme as características de textura e consistência dos alimentos bem como na modulação destas forças segundo o grau de trituração do bolo alimentar. A substituição dos dentes naturais por próteses sobre implantes, principalmente no caso de edêntulos totais, resulta na eliminação do ligamento periodontal reduzindo consideravelmente a sensibilidade tátil durante a mastigação. Assim, usuários de próteses totais fixas sobre implantes não controlam a força mastigatória de força adequadamente, exercendo uma força mastigatória demasiada, o que poderia, no futuro, ser a causa de insucesso do tratamento. Desta forma, o tratamento avaliado no presente estudo utilizando ou não implantes osseointegrados, são de grande importância na prática clínica pois auxiliam no restabelecimento da função mastigatória enquanto permitem a manutenção dos dentes remanescentes.

CONCLUSÃO

Diante dos resultados obtidos pode-se concluir que a utilização de implantes osseointegrados na reabilitação protética de pacientes parcialmente edêntulos aumenta consideravelmente a capacidade mastigatória dos pacientes, além de alterar o padrão alimentar, elevando o consumo de alimentos mais consistentes e nutritivos, aumentando a satisfação e qualidade de vida dos indivíduos.

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* De acordo com a norma da UNICAMP/FOP, baseadas na norma do International Commitee of Medical Journal Editors - Grupo de Vancouver. Abreviatura dos periódicos em conformidade com o Medline.

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ANEXOS

ANEXO 1 – Certificado de Aprovação do Comitê de Ética em Pesquisa da Faculdade de Odontologia de Piracicaba

COMITÊ DE ÉTICA EM PESQUISA
FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa **"Avaliação da função mastigatória em pacientes reabilitados por diferentes tipos de prótese dental"**, protocolo nº 011/2010, dos pesquisadores Renata Cunha Matheus Rodrigues Garcia, Camila Heitor Campos e Thaís Marques Simek Vega Gonçalves, satisfaz as exigências do Conselho Nacional de Saúde - Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 20/10/2011.

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project **"Rehabilitation of masticatory function in patients with different types of dental prostheses"**, register number 011/2010, of Renata Cunha Matheus Rodrigues Garcia, Camila Heitor Campos and Thaís Marques Simek Vega Gonçalves, comply with the recommendations of the National Health Council - Ministry of Health of Brazil for research in human subjects and therefore was approved by this committee at 10/20/2011.

Profa. Dra. Lívia Maria Andaló Tenuta
Secretária
CEP/FOP/UNICAMP

Prof. Dr. Jacks Jorge Junior
Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo aparece como fornecido pelos pesquisadores, sem qualquer edição.
Notice: The title of the project appears as provided by the authors, without editing.

ANEXO 2 – Termo de Consentimento Livre e Esclarecido

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Título da pesquisa: "Avaliação da função mastigatória em pacientes reabilitados por diferentes tipos de prótese dental"

Pesquisadores Responsáveis: Profa. Dra. Renata Cunha Matheus Rodrigues Garcia
Thais Marques Simek Vega Gonçalves
Camila Heitor Campos

Justificativa:
O senhor(a) está sendo convidado(a) a participar desta pesquisa porque precisa de uma dentadura superior e uma prótese inferior e deseja uma prótese sobre implantes. Esta pesquisa será feita para sabermos a importância do tipo de prótese na mastigação de pacientes que usam dentadura superior e ponte móvel inferior ou prótese sobre implantes inferior. Os resultados nos farão saber qual é a melhor prótese, se fixa ou removível, para triturar os alimentos durante a mastigação e se esses diferentes tratamentos influenciam a sua qualidade de vida, satisfação e nutrição.
Objetivos: Esta pesquisa está sendo realizada para saber como é a mastigação de diferentes tipos de próteses se esses diferentes tratamentos influenciam a qualidade de vida, satisfação e nutrição.
Procedimentos:
Para alcançarmos nossos objetivos precisamos de sua participação. Se o senhor(a) decidir participar desta pesquisa, o senhor(a) receberá nova dentadura superior e, em um primeiro momento ponte móvel inferior. Após um tempo de uso destas novas próteses, sua capacidade de mastigar será avaliada. Primeiramente será feito um exame clínico e físico avaliando-se as condições de saúde bucais e gerais. Nesta sessão também será feito a avaliação do seu peso e altura. Para medir sua força de mordida você precisará morder com a maior força que conseguir um sensor que se parece com uma tira de cartolina encapada por um plástico e que será colocado entre seus dentes. O plástico será trocado a cada exame. O senhor(a) também deverá mastigar normalmente alguns cubos pequenos de um material borrachóide e depois o senhor(a) deverá cuspir todos os pedacinhos mastigados em um cone de papel absorvente. Em seguida, o senhor(a) deverá bochechar um pouco de água e cuspir neste filtro de papel até que não reste mais nenhum pedaço em sua boca. Enquanto estiver mastigando estes cubos, os movimentos do seu queixo também serão avaliados. Para isto, um aparelho parecido com um grande par de óculos será colocado no seu rosto e um pequeno imã será colado em seus dentes inferiores. Após a avaliação, o imã e a cola serão retirados de seus dentes. Depois, o senhor(a) receberá uma pequena porção de amendoim para mastigar até sentir vontade de engolir. Logo depois, o senhor(a) receberá um pouco de água para bochechar e cuspir até que não reste mais nenhum pedaço em sua boca. Logo depois, o senhor(a) deverá mastigar novamente alguns cubos pequenos daquele material borrachóide e depois o senhor(a) deverá cuspir todos os pedacinhos mastigados em um cone de papel absorvente, sendo fornecido água para bochechar e cuspir até que não reste mais nenhum pedaço mastigado. Feito isso, o senhor(a) deverá responder a um questionário sobre a dificuldade que teve para mastigar estes cubos, dizendo se foi fácil ou

difícil. O senhor(a) também responderá dois outros questionários sobre as alterações que ocorrem no seu cotidiano devido ao uso das próteses e também sobre a satisfação do senhor(a) em relação às próteses. Ainda, o senhor(a) levará para casa um formulário onde deverá anotar todos os alimentos e bebidas que consumir durante três dias consecutivos e trazer esse formulário preenchido no dia da última avaliação. Estas avaliações serão realizadas após o uso e quando a nova prótese não estiver mais machucando. Essas avaliações serão feitas primeiramente após a colocação da dentadura superior e da ponte móvel inferior e posteriormente, serão repetidas após a instalação dos implantes com o encaixe bola e das próteses parciais fixas sobre os implantes inferiores. Cada tipo de prótese será avaliada durante três dias consecutivos num total de 3 avaliações por prótese, sendo necessário 9 avaliações ao final da pesquisa. Cada avaliação demorará aproximadamente 30 minutos.

Benefícios e Vantagens ao Voluntário:

O senhor(a) terá o benefício de receber o diagnóstico e tratamento odontológico geral necessário, e também serão confeccionadas primeiramente novas dentadura superior e ponte removível inferior e posteriormente serão instalados implantes na região dos prés-molares e molares inferiores e as novas próteses fixas serão confeccionadas sobre os implantes. O tratamento odontológico geral, bem como o seu tratamento protético será realizado pelos pesquisadores responsáveis: Prof.ª Dr.ª Renata Cunha Matheus Rodrigues Garcia e Cirurgiãs-Dentistas Thais Marques Simek Vega Gonçalves e Camila Heitor Campos. O tratamento cirúrgico será feito por um único Cirurgião-Dentista especializado na colocação de implantes da Área de Cirurgia e Traumatologia Buco-Maxilo-Facial da Faculdade de Odontologia de Piracicaba.

Grupo Placebo ou Controle

Não existe grupo placebo neste estudo.

Métodos alternativos e benefícios:

As avaliações a serem realizadas representam o método menos invasivo para a avaliação da sua mastigação.

Desconfortos e riscos previsíveis:

Não existe risco previsível durante o exame clínico, realização das próteses, mastigação dos cubinhos de borracha, avaliação dos movimentos da sua mandíbula, preenchimento da entrevista e avaliação da sua mordida. Além disso, os tratamentos odontológico geral, cirúrgico e protético que você irá receber são idênticos àqueles que você estaria recebendo se não fizesse parte da pesquisa. Os possíveis desconfortos estarão relacionados à cirurgia para a colocação dos implantes, a qual poderá causar dor, inchaço no pós-operatório. Porém o senhor(a) será acompanhado durante todo esse período.

Forma de acompanhamento e garantia de esclarecimento:

O senhor (a) será acompanhado durante toda a pesquisa e qualquer problema observado deverá ser relatado. O senhor(a) tem a garantia de que receberá respostas a qualquer pergunta, ou esclarecimento a qualquer dúvida relacionada à pesquisa. Os pesquisadores responsáveis assumem o compromisso de proporcionar toda a informação necessária e acompanharão e assistirão todos os voluntários em qualquer momento durante a pesquisa. Se o senhor(a) tiver qualquer dúvida, o senhor(a) deverá entrar em contato com a Prof.ª Renata, pessoalmente ou por telefone (2106-5240), ou com Thais e Camila (2106-5295).

Formas de ressarcimento

O senhor(a) será ressarcido de despesas como o transporte para os dias de coleta dos dados. O tratamento restaurador, cirúrgico e protético serão gratuitos. Ao finalizar a pesquisa, o senhor(a) terá próteses fixas sobre implante que oferecem maior conforto e estabilidade.

Formas de indenização

Como não existe a possibilidade de danos decorrentes desta pesquisa, não existe forma de indenização prevista.

Garantia de sigilo

Os pesquisadores responsáveis se comprometem a resguardar todas as informações da pesquisa. Nunca será revelada a identidade do senhor(a). Os dados desta pesquisa serão utilizados para fins estritamente científicos.

Liberdade para se recusar em participar da pesquisa

A decisão de fazer parte ou não desta pesquisa é voluntária. O senhor(a) pode escolher se quer ou não participar dela, e da mesma maneira, o senhor(a) é livre para desistir dela em qualquer momento. Caso o senhor(a) não possa participar ou se retire da pesquisa por qualquer motivo, o senhor(a) não sofrerá nenhum tipo de prejuízo, assim como sua decisão não afetará seu tratamento odontológico na Faculdade de Odontologia de Piracicaba – UNICAMP. Caso o senhor(a) aceite livremente participar desta pesquisa, o senhor(a) receberá uma segunda via assinada do Termo de Consentimento Livre e Esclarecido, ficando a primeira via com a Profa. Responsável pela pesquisa, sendo que as duas vias poderão ser anuladas em qualquer momento do desenvolvimento da pesquisa, segundo sua livre decisão.

Eu,_____cer
tifico que tendo lido e entendido todas as informações acima descritas, estou de acordo com a realização do estudo e aceito participar voluntariamente do mesmo.

Piracicaba,_____de_____de 2010

_____ _____

Nome do voluntário / RG Assinatura do voluntário

_____ _____

Nome do pesquisador / RG Assinatura do pesquisador

Qualquer dúvida sobre este pesquisa, por favor comunicar-nos, a fim de responder a suas perguntas:

- Thais Marques Simek Vega Gonçalves ou Camila Heitor Campos
Estudantes de Pós-Graduação FOP/UNICAMP; Telefone: (19) 21065295
E-mail: thaisgonc@fop.unicamp.br ou camilaheitor@fop.unicamp.br
- Renata Cunha Matheus Rodrigues Garcia
Professor FOP/UNICAMP; Telefone: (19) 34125240
E-mail: regarcia@fop.unicamp.br

A sua participação em qualquer tipo de pesquisa é voluntária. Em caso de dúvidas quanto aos seus direitos como voluntário de pesquisa entre em contato com:
Comitê de Ética em Pesquisa da FOP: Av Limeira 901, FOP-Unicamp, CEP 13414-903, Piracicaba – SP. Fone/Fax 19- 21065349, e-mail cep@fop.unicamp.br e webpage www.fop.unicamp.-br/cep.

ANEXO 3 – Questionários utilizados durante as avaliações subjetivas

QUESTIONÁRIO DE HABILIDADE MASTIGATÓRIA

Nome:_____

Fase da pesquisa: _____

01. Qual o seu grau de habilidade em mastigar?

Pão

Muito fácil _____Muito difícil

Queijo duro

Muito fácil _____Muito difícil

Salsicha

Muito fácil _____Muito difícil

Alface

Muito fácil _____Muito difícil

Amendoim

Muito fácil _____Muito difícil

Maça

Muito fácil _____Muito difícil

Cenoura

Muito fácil _____Muito difícil

QUESTIONÁRIO DE SATISFAÇÃO

Nome:_____ Fase da pesquisa: _____

01. Qual o seu grau de satisfação geral com as suas próteses?

Completamente Insatisfeito_____Completamente Satisfeito

02. Qual o seu grau de satisfação quanto aos seguintes aspectos das suas próteses?

Retenção e estabilidade

Superior

Completamente Insatisfeito_____Completamente Satisfeito

Inferior

Completamente Insatisfeito_____Completamente Satisfeito

Conforto da prótese

Superior

Completamente Insatisfeito_____Completamente Satisfeito

Inferior

Completamente Insatisfeito_____Completamente Satisfeito

Facilidade para mastigar

Superior

Completamente Insatisfeito_____Completamente Satisfeito

Inferior

Completamente Insatisfeito_____Completamente Satisfeito

Facilidade para falar

Superior

Completamente Insatisfeito_____Completamente Satisfeito

Inferior

Completamente Insatisfeito_____Completamente Satisfeito

Facilidade para limpar

Superior

Completamente Insatisfeito_____Completamente Satisfeito

Inferior

Completamente Insatisfeito_____Completamente Satisfeito

Aparência da sua prótese

Superior

Completamente Insatisfeito_____Completamente Satisfeito

Inferior

Completamente Insatisfeito_____Completamente Satisfeito

QUESTIONÁRIO OHIP-49.

Nome:_____

Fase da pesquisa: _____

Instruções

Marque a resposta que indique com qual freqüência cada um dos problemas ocorreu com você no último ano.

1. Você teve dificuldade em mastigar qualquer alimento por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

2. Você teve problemas em pronunciar alguma palavra por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

3. Você notou que algum dente parece estar com problemas?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

4. Você sentiu que a sua aparência foi afetada por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

5. Você sentiu que seu hálito estava mal cheiroso por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

6. Você sentiu que o seu paladar piorou por causa de problemas nos dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

7. Você teve alimentos presos nos dentes ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

8. Você sentiu que a sua digestão piorou por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

9. Você teve dores na sua boca?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

10. Você teve dores nos maxilares?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

11. Você teve dores de cabeça por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

12. Você teve dentes sensíveis, por exemplo, por causa de alimentos ou bebidas frias ou quentes?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

13. Você teve dor de dente?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

14. Você teve dores na gengiva?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

15. Você achou desconfortável mastigar algum alimento por causa de problemas com seus dentes, boca ou dentadura?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

16. Você teve pontos ou locais doloridos na sua boca?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

17. Você sentiu que as suas dentaduras não estavam bem adaptadas?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

18. Você teve desconforto com as suas dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

19. Você esteve preocupado por causa de problemas dentários?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

20. Você já se sentiu constrangido por causa de seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

21. Problemas dentários lhe fizeram sentir triste?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

22. Você se sentiu desconfortável com a aparência dos seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

23. Você se sentiu tenso por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

24. Sua dicção foi prejudicada por causa de problemas com seus dentes, boca ou dentadura?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

25. Alguém compreendeu errado algumas de suas palavras por causa de problemas com seus dentes, boca ou dentadura?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

26. Você notou menos sabor em sua comida por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

27. Você esteve incapaz de escovar adequadamente seus dentes por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

28. Você teve de evitar algum tipo de alimento por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

29. Sua alimentação ficou prejudicada por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

30. Você ficou impossibilitado de comer com suas dentaduras por causa de problemas com elas?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

31. Você evitou sorrir por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

32. Você teve que parar suas refeições por causa de problemas com seus dentes, boca ou dentadura?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

33. O seu sono foi interrompido por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

34. Você ficou chateado por causa de problemas com seus dentes, boca ou dentadura?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

35. Você teve dificuldade de relaxar por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

36. Você se sentiu deprimido por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

37. Sua concentração ficou afetada por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

38. Você ficou envergonhado por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

39. Você evitou sair por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

40. Você foi menos tolerante com seu companheiro (a) ou familiares por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

41. Você teve problemas em se relacionar com outras pessoas por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

42. Você ficou um pouco irritado com outras pessoas por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

43. Você teve dificuldades em fazer suas atividades diárias por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

44. Você sentiu que a sua saúde geral piorou por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

45. Você teve alguma perda financeira por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

46. Você deixou de aproveitar a companhia de outras pessoas por causa problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

47. Você sentiu que a vida em geral ficou pior por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

48. Você ficou totalmente incapaz de exercer qualquer atividade por causa de problemas com seus dentes, boca ou dentaduras?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

49. Você teve sua capacidade de trabalho reduzida por causa de problemas com seus dentes, boca ou dentadura?

0	1	2	3	4
Nunca	Raramente	Ocasionalmente	Frequentemente	Sempre

ESTADO NUTRICIONAL

Diário Alimentar

Nome: _____ Data: _____

Fase da Pesquisa:_____

Favor preencher da forma mais detalhada possível. Especificar a quantidade e o alimento e/ou líquido consumidos, a hora em que se alimentou e o tipo de refeição realizada (café da manhã, almoço, janta, lanche, etc.).

Hora	Refeição	Alimentos consumidos

Em caso de dúvida, entrar em contato com Thais MSV Gonçalves, Camila H Campos ou Profa. Renata CM Rodrigues Garcia pelo telefone (19) 2106-5295.

ANEXO 4 – Figuras
Força Máxima de Mordida

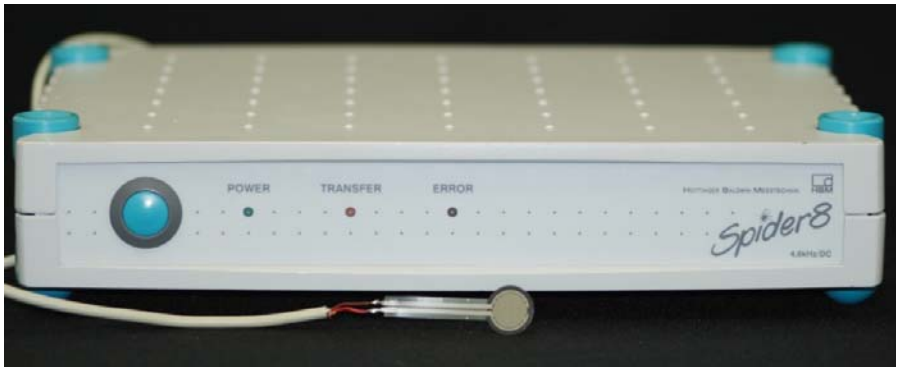


Figura 1 – Equipamento analítico de registro e amplificação do sinal emitido pelo sensor para o registro de força Spider 8 (Hottinger Baldwin Messtechnik GmbH, Darmstadt, Germany).

Figura 2 - Sensor (FSR N°151, Interlink Electronics Inc., Camarillo, California, USA) para mensuração da força máxima de mordida (vista lateral).

Figura 4 – Sensores (FSR N°151, Interlink Electronics Inc., Camarillo, California, USA) para registro da força máxima de mordida em posição (vista frontal).

Performance Mastigatória

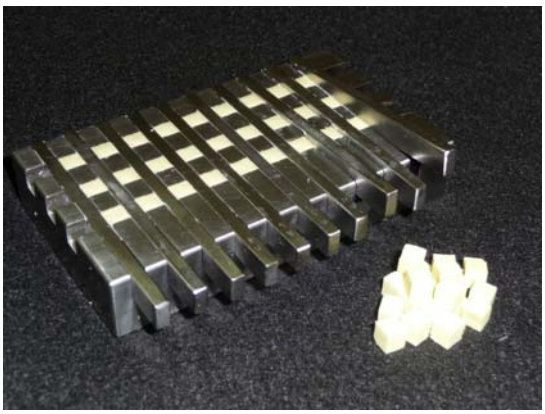


Figura 5 – Confecção de cubos de Optocal com 5,6mm de aresta, utilizando-se matriz metálica.

Figura 6 – Avaliação da performance mastigatória onde o voluntário é instruído a mastigar de forma habitual uma porção de material teste artificial Optocal.

Figura 7 - Material teste artificial triturado.

Figura 8 - Sistema de peneiras acopladas ao agitador
(Bertel Indústria Metalúrgica Ltda., São Paulo, Brasil).

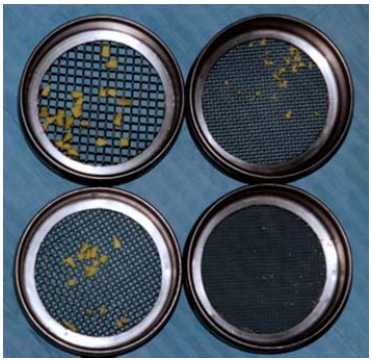


Figura 9 – Material triturado retido nas diversas peneiras.

Figura 10 – Pesagem do material triturado retido em cada peneira.

Ultrasonografia

Figura 11 – Equipamento de ultrassonografia SSA-780 A-APLIO Mx, 38 mm/7–18 MHz (Toshiba Medical System Co., Tokyo, Japan).

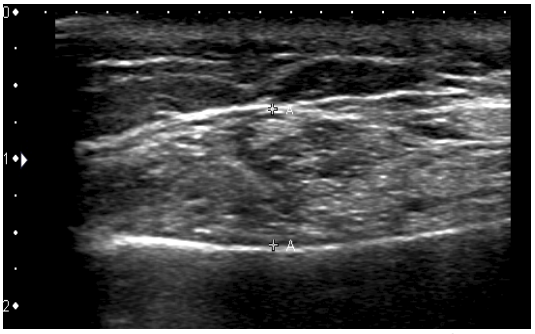


Figura 12 – Exemplo de imagem ultrassonográfica do músculo masseter durante a contração voluntária máxima.

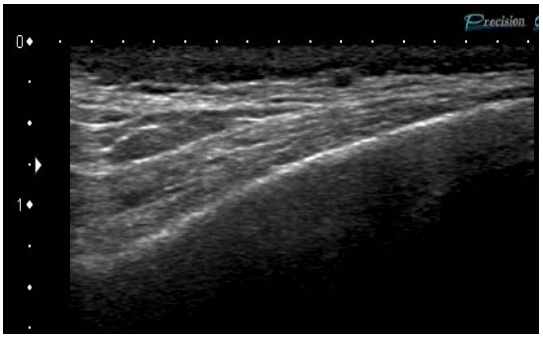


Figura 13 – Exemplo de imagem ultrassonográfica do músculo temporal anterior durante a contração voluntária máxima.

Cinesiografia

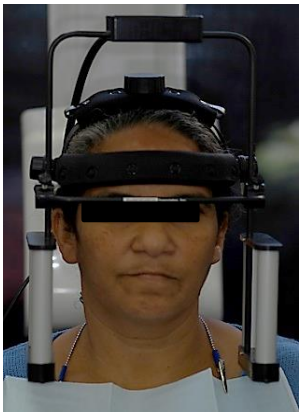


Figura 14 – Cinesiógrafo JT3D
(BioResearch, Mylwalkee, USA) em posição no voluntário.

Figura 15 – Magneto instalado provisoriamente na região dos
incisivos inferiores de modo a não interferir em máxima intercuspidação.

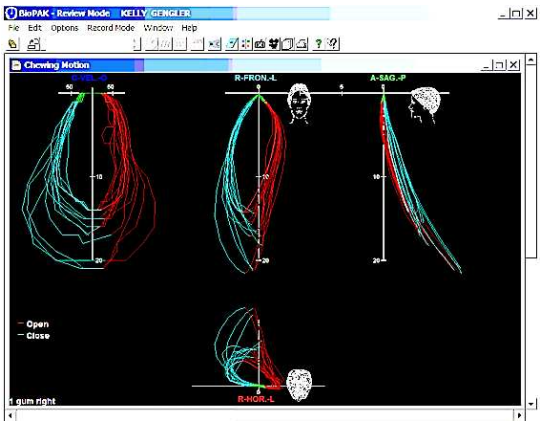


Figura 16 – Exemplo de registro do movimento mandibular
durante a mastigação de corpos de prova em Optocal.

ANEXO 5 – Confirmações de aceite e/ou submissão dos manuscritos.

Capítulo 1

De: JPD <JPD@gru.edu>
Assunto: Your Submission to The Journal of Prosthetic Dentistry
Data: 25 de junho de 2013 11:18:44 BRT
Para: regarcia@fop.unicamp.br

Jun 25, 2013

Re: Manuscript # JPD-D-13-00236

Dear Prof. Rodrigues Garcia:

Thank you for submitting manuscript #JPD-D-13-00236, entitled "Implant support for distal extension removable partial dentures: clinical outcomes and patient satisfaction.." Your manuscript was forwarded to two reviewers with expertise in the subject matter. They recommend that you revise the manuscript and resubmit it for a second review.

Please respond to the following comments and recommendations:
1. Please supply illustrations of the correct size/resolution (see guidelines)

2. Please consult the eighth edition of The Glossary of Prosthodontic Terms (J Prosthet Dent 2005 July;94(1):1-92) when revising your manuscript to make sure that the terminology that you use is current and correct (The Glossary is free of charge on the Journal website at http://www.journals.elsevierhealth.com/periodicals/ympr/home). Distal free-end removable partial dentures should be distal extension denture base partial removable dental prostheses. Acrylic should be acrylic resin.

3. "Participants" is preferred to "subjects" or "patients" to describe members of human trials

4. Superscripted reference numbers within the manuscript text should always follow the commas and periods, and no spaces should appear between multiple ref numbers. The superscripted numbers should be placed before semi-colons and colons. Example: .this is the end of the sentence.1-3 Example: .this phrase ends with a semicolon1-3; therefore, the reference numbers appear before the semicolon.

5. Eliminate trademark symbols as they are not consistent with Journal style.

6. Hyphens are not used for common suffixes and prefixes, unless their use is critical to understanding the word. Some prefixes with which we do not use hyphens include: pre-, non-, anti-, multi-, auto-, inter-, intra-, peri-

7. When referring to a product and its manufacturer, once the location of the company has been introduced, it should not reappear when the product or company is mentioned again. For instance: First mention: ". acrylic resin (Palapress; Heraeus Kulzer GmbH; Hanau, Germany)." Second mention: ".composite resin (Diamond Flow; Heraeus Kulzer GmbH)..." Please also note the semicolon after the product name.

8. This recent article might be suitable for your Introduction:
Bidra AS, Almas K. Mini implants for definitive prosthodontic treatment: a systematic review. J Prosthet Dent 2013;109:156-64

Capítulo 2

De: Tord.Berglundh@odontologi.gu.se
Assunto: Journal of Dental Research - Decision on Manuscript JDR-13-0495.R1
Data: 19 de setembro de 2013 10:48:04 BRT
Para: regarcia@fop.unicamp.br
Cc: william.giannobile@umich.edu

19-Sep-2013

Dear Prof. Rodrigues Garcia:

I am pleased to inform you that your manuscript, "Masticatory improvement after partial implant-supported prosthesis use.," has been accepted for publication in the Journal of Dental Research, with an acceptance date of 19-Sep-2013. The 3 reviewers find that amendments have been made according to suggestions. Some minor remarks on typing errors are outlined and corrections should be made accordingly at the proofs stage.

To assist us maintain a quick time from acceptance to publication please complete your Contributor Forms as soon as possible. Contributor Forms are located in your Author Center on SAGETrack. Click on "Manuscripts with Decisions" (for Corresponding Authors) or “Manuscripts I Have Co-Authored” (for all Co-Authors). When the page refreshes you will see JDR-13-0495.R1 at the bottom of the page. Under the “Status” column click “Contributor Form” to sign and date your forms. Please contact the Publications Manager at kskinner@iadr.org if any authors are government employees or a work for hire employee for further instructions.

The publication process cannot move forward without the completion of these forms from all co-authors if they are government or work for hire employees.

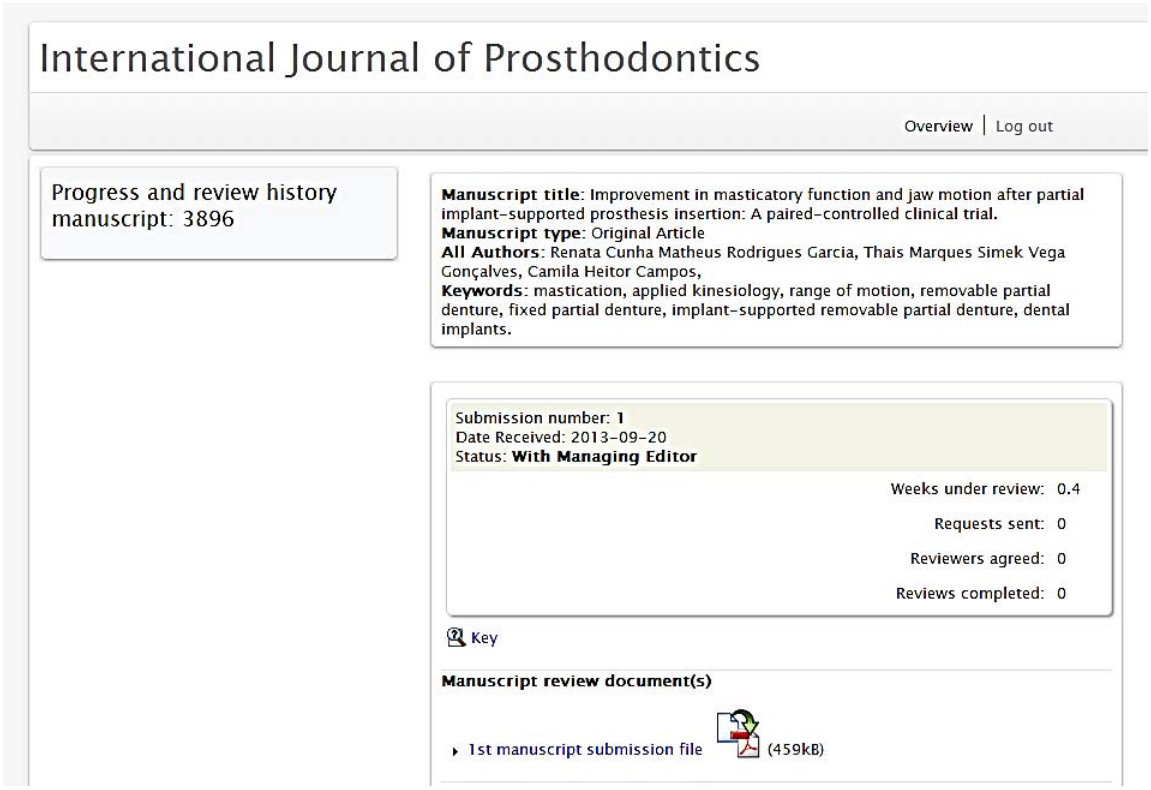
Further information regarding publication date, page proofs, and reprints will come to you directly from SAGE.

Thank you for your contribution to the Journal of Dental Research.

Congratulations,

Tord Berglundh
Guest Co-Editor
Journal of Dental Research
Tord.Berglundh@odontologi.gu.se

Capítulo 3



International Journal of Prosthodontics

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Progress and review history manuscript: 3896

Manuscript title: Improvement in masticatory function and jaw motion after partial implant-supported prosthesis insertion: A paired-controlled clinical trial.
Manuscript type: Original Article
All Authors: Renata Cunha Matheus Rodrigues Garcia, Thais Marques Simek Vega Gonçalves, Camila Heitor Campos,
Keywords: mastication, applied kinesiology, range of motion, removable partial denture, fixed partial denture, implant-supported removable partial denture, dental implants.

Submission number: 1
Date Received: 2013-09-20
Status: **With Managing Editor**

Weeks under review:	0.4
Requests sent:	0
Reviewers agreed:	0
Reviews completed:	0

Key

Manuscript review document(s)

1st manuscript submission file (459kB)

suggests the following wording: "The authors declare no conflicts of interest" or, for example, Author A receives royalties from Company W; Author B is an employee of Company X, Author C owns stock in Company Y, and Author D has served as a speaker and consultant for Company Z within the last three years. All sources of funding should be listed in an acknowledgment.

NOTE: If the time allowed for revision has elapsed, send email to: cid-admin@wiley.com to request an extension of the due date.

My Manuscripts	Author Resources
0 Unsubmitted Manuscripts **0** Revised Manuscripts in Draft **1** Submitted Manuscripts **0** Manuscripts with Decisions **0** Manuscripts I Have Co-Authored **0** Withdrawn Manuscripts **0** Invited Manuscripts	Click here to submit a new manuscript This section lists the subjects of the five most recent e-mails that have been sent to you regarding your submission(s). To view an e-mail, click on the link. To delete an e-mail from this list, click the delete link. Clinical Implant Dentistry and Related Research-CID-13-280 (19-Jul-2013) Delete Manuscript ID CID-13-280 - Clinical Implant Dentistry and Related Research (10-Jul-2013) Delete

Submitted Manuscripts

Manuscript ID	Manuscript Title	Date Created	Date Submitted	Status
CID-13-280	Effect of implant support for partially edentulous patients on swallow threshold, nutritional intake, and oral health-related quality of life. [View Submission] (Cover Letter)	10-Jul-2013	10-Jul-2013	ADM: Yehl, Rachel • Awaiting Reviewer Scores

top