CAMILA HEITOR CAMPOS

“INFLUÊNCIA DA PRÓTESE PARCIAL REMOVÍVEL IMPLANTO-RETIDA SOBRE A MASTIGAÇÃO E INGESTÃO DE NUTRIENTES“

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Orientadora: Prof.ª Dr.ª Renata Cunha Matheus Rodrigues Garcia

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RESUMO

A reabilitação de arcos parcialmente dentados por meio de próteses parciais removíveis (PPR), sobretudo aqueles com ausência de dentes posteriores, apresentam limitações relativas ao suporte da prótese, que nestes casos é dividido entre dentes e mucosa, estruturas com diferentes resiliências. A associação de implantes osseointegrados à base da PPR tem como proposta atenuar estas limitações e trazer benefícios para o paciente, porém, a literatura sobre este assunto é escassa. Desta forma, este estudo se propôs a avaliar o efeito da associação de implantes osseointegrados pela adição de encaixe posterior implanto-retido à base de PPR mandibulares sobre o limiar de deglutição e ingestão de nutrientes. Oito voluntários (idade média = 60,1 ± 6,6 anos) apresentando edentulismo total maxilar e parcial mandibular (Classe I de Kennedy) foram selecionados e reabilitados com próteses totais (PT) maxilares e PPR mandibulares. Após dois meses de uso das novas próteses, as variáveis acima citadas foram mensuradas. Em uma segunda etapa, os mesmos voluntários receberam dois implantes osseointegrados bilaterais na região de molares inferiores. Após o período de osseointegração, foram adicionados encaixes do tipo bola aos implantes e à base da PPR, e após dois meses de uso das PPR implanto-retidas as variáveis foram novamente mensuradas. O limiar de deglutição foi avaliado por meio da contagem do número de ciclos mastigatórios realizados para a mastigação de uma porção de amendoim até o paciente sentir que está na iminência de deglutir. Foi ainda realizado o cálculo do tamanho mediano de partículas trituradas (X_{50}), utilizando o material teste mastigável Optocal, pelo método de fracionamento de peneiras. O estado nutricional foi avaliado por meio de diário alimentar de três dias, e posteriormente foi traduzido em valores nutricionais por meio da utilização da Tabela Brasileira de Composição de Alimentos. Foram realizadas análises comparativas pareadas, sendo utilizados os testes T de Student e Wilcoxon para nível de significância de 5%. Embora não tenha ocorrido mudança no número de ciclos mastigatórios necessários à

deglutição após a inserção do encaixe implanto-retido (P>0,05), houve redução significativa do X_{50} (P<0,05). Observou-se, ainda, aumento na ingestão de calorias (P=0,008) e no consumo diário de carboidratos (P=0,003), proteína (P=0,023), cálcio (P=0,006), fibras (P=0,040) e ferro (P=0,038). Não foram detectadas alterações na ingestão de gordura e no IMC (P>0,05). Pode-se concluir que a associação de implantes às PPR por meio encaixe do tipo bola apresenta efeito positivo sobre a mastigação e ingestão de nutrientes em pacientes com arcos Classe I de Kennedy.

Palavras chave: Implantes dentários, estado nutricional, mastigação.

ABSTRACT

The rehabilitation of partially dentate arches with removable partial dentures (RPD), especially those with absence of posterior teeth, have limitations regarding RPD support, divided between teeth and mucosa, with different structures resilience. The association of dental implants beneath RPD base proposal is to reduce these limitations and bring benefits to patients; however, the literature on this is scarce. Therefore, this study aimed to assess the impact of the use of a posterior implant retainer for free-end RPD on the swallowing threshold and nutrient intake. For this purpose, eight volunteers (mean age = 60.1 ± 6.6 years) presenting maxillary edentulism and mandibular partially dentate arch (Kennedy Class I) were selected and rehabilitated with maxillary complete dentures (PT) and mandibular RPD. After two months of use of the new prosthesis, the variables were measured. In a second step, the same volunteers received two osseointegrated implants, bilaterally in the region of mandibular first molars. After healing time, ball attachments were added to the implants and fitted on the RPD base, providing retention, and after two months of using, the variables were again measured. The swallowing threshold was assessed by counting the number of masticatory cycles and by calculating the median particle size reduction (X_{50}). The number of masticatory cycles performed for chewing a portion of peanuts until the patient felt need to swallow was registered by the researcher. The X_{50} value was determined by sieve fractioning method using the chewable test material Optocal. Nutritional state was assessed by three-day food diary and further compared to the Brazilian Food Composition Table. Comparative analyzes were made by using the Paired Student's t-test and Wilcoxon Rank-test, depending on the normality distribution of data, and for 5% of significance level. Although there was no change in the number of chewing cycles needed to swallow after implant insertion ($P>0.05$), there was a significant reduction in the average size of the particle to be swallowed ($P<0.05$). There was also an increase in energy intake ($P=0.008$) and daily consumption of carbohydrates ($P=0.003$), protein ($P=0.023$), calcium ($P=0.006$), fiber ($P=0.040$)

and iron (P=0.038). No changes were detected in fat intake and BMI (P>0.05). It can be concluded that the association of implants to RPD by ball attachment insertion may have positive effect on chewing and nutrient intake in patients with Class I Kennedy arches.

Keywords: removable partial denture, dental implants, nutrition, mastication.

SUMÁRIO

INTRODUÇÃO

A alimentação é um processo que envolve não somente o ato de comer, mas fatores de ordem social, econômica, familiar, ambiental, psicológica, física e funcional (1). Desta forma, a ausência de dentes pode ter reflexos em diversos aspectos, tanto funcionais, comprometendo a mastigação e deglutição (2), quanto sociais, causando alterações na autoestima e no convívio do indivíduo (3).

A mastigação corresponde à fase inicial do processo digestivo, sendo definida como um conjunto de fenômenos estomatognáticos que tem 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 (4). A mastigação adequada favorece o processo digestivo e o aproveitamento dos alimentos ingeridos por permitir maior superfície de contato do alimento com as enzimas digestivas (5).

Em decorrência de prejuízos funcionais na mastigação, muitos indivíduos alteram a composição de suas dietas (6, 7), dando preferência a alimentos de menor consistência e de mastigação facilitada, muitas vezes com altas taxas de gordura saturada e de carboidratos refinados (5, 8). Além disso, estes pacientes tendem a aumentar o tempo de cozimento dos alimentos a fim de torná-los mais macios (8), o que pode reduzir o valor nutricional dos mesmos (9). Estes fatores, em conjunto, podem levar à desnutrição pela ingestão insuficiente de nutrientes (5, 10). Além das mudanças na quantidade de alimentos e de nutrientes consumidos, a dificuldade em mastigar pode causar constrangimento às pessoas, e levar ao aparecimento de distúrbios psicossociais (11).

Considerando que a alimentação é fundamental para a saúde geral, e a deficiência na ingestão de nutrientes pode contribuir para o aparecimento de doenças sistêmicas e na determinação de sua gravidade (10), justifica-se a preocupação com o padrão alimentar e com as alterações nutricionais (12) decorrentes da substituição de dentes naturais por próteses dentárias.

Pacientes parcialmente desdentados podem ser reabilitados por diversos tipos de próteses dentárias, cujo objetivo é devolver não somente a função, mas também recuperar a estética e satisfação dos pacientes, conservando os tecidos remanescentes (13). A instalação de próteses parciais removíveis (PPR) apresentam vantagens como a maior conservação de estrutura dental, quando comparado ao tratamento por meio de próteses fixas dento-suportadas, menor custo e a facilidade de higienização (14). Contudo, podem estar associadas a desvantagens biomecânicas, principalmente nos casos de extremidade livre, problemas estéticos devido à localização de alguns retentores, e o desgaste irreversível de estrutura dental para a confecção de nichos. Além disso, sobrecarga aos tecidos de suporte (15) pode estar relacionado a este tipo de reabilitação protética, podendo ocorrer reabsorção do rebordo ósseo sob a extensão distal da base da PPR (15).

Uma alternativa à reabilitação por meio de PPR para os casos de extremidade livre seria a instalação de apenas um implante na região posterior do rebordo edêntulo, e a colocação de um pilar com encaixe do tipo bola, unindo o implante à base da PPR (15). Este procedimento melhora a retenção e a estabilidade da PPR por reduzir, de forma considerável, possíveis movimentações rotacionais durante a mastigação (15, 16). Em acréscimo, promove a manutenção do nível ósseo do rebordo alveolar posterior, uma vez que estimula a neoformação óssea na região (17); mantêm os contatos oclusais posteriores; reduz o número de retentores necessários para a PPR; e se constitui em alternativa de tratamento de menor custo em relação à reabilitação com próteses parciais fixas sobre implantes (18, 19).

Ohkubo *et al.* (2008) revelaram que a instalação de um implante osseointegrado na região posterior do rebordo edêntulo e a utilização do dispositivo cicatrizador atuando como um apoio posterior à base da PPR foi suficiente para melhorar a movimentação mandibular durante a mastigação e aumentar a força de mordida e a satisfação do paciente no que diz respeito ao conforto, retenção e estabilidade da PPR.

A relação entre mastigação e estado nutricional vem sendo discutida, em função de achados que mostram que indivíduos com mastigação deficiente alteram negativamente sua dieta, o que interfere no seu estado nutricional. O estado nutricional pode ser estimado por meio de métodos antropométricos e diário alimentar (20). O índice de massa corpórea (IMC) é o método antropométrico mais utilizado e apresenta como vantagens o baixo custo, uso de técnicas não invasivas, precisão e exatidão, além da facilidade de aplicação, e da existência de padrões de referência que permitem comparações entre as populações (8). Por meio do diário alimentar é possível avaliar e quantificar os alimentos e bebidas consumidos durante um determinado período relatados pelo próprio paciente e, utilizando-se de tabelas nutricionais, pode se então estimar a ingestão de nutrientes (9).

A ausência de elementos dentários e o uso de próteses têm relação direta com perda de apetite e o estado nutricional (21). A melhora na capacidade mastigatória obtida após o tratamento protético pode ter reflexos na dieta do indivíduo (22). Entretanto, estudos que avaliam o conteúdo nutricional da dieta de pacientes parcialmente dentados reabilitados por meio de próteses parciais sobre implantes são escassos na literatura. A reabilitação por meio de próteses totais implanto-suportadas reduziu a dificuldade em mastigar alimentos de maior consistência e elevou o consumo de frutas e vegetais em estudos prévios (23, 24). Entretanto, controvérsias permanecem, pois alguns autores (25, 26) não encontraram diferença no padrão alimentar após a reabilitação protética associada a implantes osseointegrados.

Tendo em vista a influência que a mastigação exerce sobre a seleção de alimentos e diante da literatura ainda inconclusiva sobre o assunto, a presente pesquisa se propôs a comparar diferentes tratamentos reabilitadores realizados em um mesmo paciente, sobre o limiar de deglutição e ingestão de nutrientes. Os pacientes foram primeiramente reabilitados por meio de próteses totais superiores e PPR convencionais na arcada dentária inferior (Classe I de Kennedy), e posteriormente implantes osseointegrados foram instalados no rebordo posterior

da mandíbula e adicionados encaixes do tipo bola unindo os implantes à base da PPR. As variáveis acima citadas foram analisadas após 2 meses de uso de cada uma das reabilitações protéticas.

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O artigo apresentado no Capítulo 1 intitulado “Implant retainer for free-end removable partial dentures affects mastication and nutrient intake” foi submetido à publicação no periódico *Clinical Oral Implants Research* (Anexo 5).

CAPÍTULO 1

Implant retainers for free-end removable partial dentures affects mastication and nutrient intake

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Abstract

Objectives: This study measured swallowing threshold parameters and nutrient intake in partially dentate subjects rehabilitated by conventional free-end removable partial dentures (RPD) and by RPD over posterior implant retainers and ball attachments (BA).

Materials and methods: Eight subjects (2 male and 6 female; mean age 60.1 ± 6.6 years old) received conventional total maxillary dentures and free-end RPD in the mandible. Two months after denture insertion, swallowing threshold and nutrient intake assessments occurred, which included an evaluation of the number of masticatory cycles and medium particle size (X_{50}) of a silicone test material (Optocal). A 3-day food diary verified nutrient intake based on a standard Brazilian Food Composition Table. Then, osseointegrated implants were placed bilaterally in the mandibular first molar region, followed by BA, which was fitted in the RPD bases after healing. After two months of the RPD over implants and BA use, variables were again assessed. Paired t-tests and Wilcoxon rank-tests evaluated the data ($P < 0.05$).

Results: Masticatory cycles did not differ ($P > 0.05$); however, subjects showed decreased X_{50} values at the swallowing moment ($P = 0.003$), and increased daily energy ($P = 0.008$), carbohydrate ($P = 0.003$), protein ($P = 0.030$), calcium ($P = 0.006$), fiber ($P = 0.040$), and iron ($P = 0.038$) intake with RPD implants and BA inserts. No differences were found in fat consumption ($P < 0.05$).

Conclusion: Implants and BA retainers over a free-end RPD resulted in smaller swallowed median particle size and improved nutrient intake.

Keywords: dental implants, dental prosthesis, deglutition, nutrition.

Introduction

Chewing is part of the initial digestive process, which consists of events that mechanically degrade food into smaller particles with the aid of saliva (van der Bilt et al. 1993). Higher rates of digestion are associated with reduced particles due to increased surface area exposed to digestive enzymes (Stahl et al. 2002; Ranawana et al. 2010).

Dental state largely influences particle size reductions during normal mastication (Toman et al. 2012). In this context, partially dentate patients and/or those who wear removable dentures show decreased masticatory ability, which is typically caused by prosthetic-related problems such as poor retention and stability (Sánchez-Ayala et al. 2010). However, increasing the number of masticatory cycles or adapting to swallowing larger food particles allows these subjects to feed (N'gom & Woda 2002) To address dental prosthesis concerns, patients may adjust their diet composition by refusing foods that require significant chewing, such as raw vegetables, fresh fruits, stringy meats, and dry breads (Hildebrandt et al. 1997; Kagawa et al. 2012). Subjects also tend to cook foods longer to make them easier to chew (de Oliveira & Frigerio 2004), which can reduce the food's nutritional value (Stahl et al. 2002). Moreover, subjects usually prefer softer food, often containing high levels of saturated fat, refined carbohydrates, and cholesterol (de Oliveira & Frigerio 2004). In addition, decreased masticatory function may result in swallowing a coarser bolus, which can interfere with digestion and nutrient extraction (Stahl et al. 2002; Hildebrandt et al. 1997; Carretero et al. 2011). Taken together, evidence suggests that removable denture wearers are at risk for nutritional imbalance (Miura et al. 2005; Sánchez-Ayala et al. 2010).

In a distal-extension removable partial denture (RPD), occlusal forces tends to move the denture base into a tissue ward direction, allowing RPD rotational movements to produce terminal torqueing forces against the abutment teeth and the soft tissue (Ohkubo et al. 2008). Denture movement can be minimized by implants placed in the posterior region of the edentulous ridge (Keltjens et al. 1993) with a ball abutment attaching the implant to the free-end

RPD base (Ohkubo et al. 2008). This procedure not only reduces possible rotational movement during mastication, but it also increases free-end RPD retention and stability (Ohkubo et al. 2008). In addition, this implant placement maintains the level of alveolar bone, reduces the number of abutment teeth and clasps required for RPD (Keltjens et al. 1993), improves patient comfort, and costs less compared to rehabilitation with fixed partial dentures on implants (Wolfart et al. 2012).

Implant-retained free-end RPD wearers have fewer complaints on their prosthesis, improved chewing ability, and are more satisfied than conventional RPD wearers (Ohkubo et al. 2008; Wolfart et al. 2012). Despite these positive outcomes, free-end RPD effects on objective masticatory variables, such as swallowing threshold, remain unclear. For example, some authors have found that volunteers with implant-supported dentures require a decreased number of masticatory cycles for swallowing (van Kampen et al. 2004), while others have not detected cycle changes in this population (Liedberg et al. 2004). The impact of these implant prosthetics on dietary intake and food selection are also controversial. While several studies have shown no effects of prosthesis on nutritional intake (van Kampen et al. 2004; Morais et al. 2003), recent research reveals an association between chewing ability and nutrient intake (Kagawa et al. 2012), such that implant-retained dentures positively influence diet (Moynihan et al. 2012), suggesting that food selection depends not only on the capacity to triturate it, but is also influenced by social and cultural factors (Shepherd 1999).

Appropriate nutrition is fundamental to overall health and may delay or prevent the onset of systemic diseases (Brennan & Singh 2012). Consequently, it is important to understand dietary patterns and nutritional changes that may result from prosthetic rehabilitation. Unfortunately, data on the impact of oral rehabilitation on nutrient intake in partially edentulous subjects remain scarce. Thus, this clinical study measured swallowing threshold and nutrient intake in partially dentate subjects rehabilitated by conventional RPD, and then by RPD over a posterior implant retainer.

Materials and Methods

The present study followed the Helsinki Declaration, and the local Ethics Committee approved all forms and procedures. Volunteers provided written consent for study participation.

This was a paired study, such that selected partially edentulous subjects were submitted to two different mandible treatments: 1) conventional free-end RPD and 2) free-end RPD over a posterior implant with ball attachment (BA) retainers.

To be included in this study, subjects had to meet the following criteria: *(1)* were totally edentate in the maxilla and partially dentate in the mandibular dental arch, presented only canines and incisor teeth, *(2)* displayed adequate bone volume and height for implant insertion on the mandibular molar region, with no need for major bone augmentation procedures, and *(3)* did not display signs or symptoms of temporomandibular disorder or parafunctional habits. Subjects were excluded if they had severe periodontal diseases, physical or cognitive limitations that may have interfered with masticatory test performance or regular oral hygiene, and systemic or neurological diseases that would contraindicate implant surgery (i.e., uncontrolled diabetes, cardiovascular disease).

Seventy-four patients were initially recruited from individuals seeking prosthetic treatment at Piracicaba Dental School, University of Campinas. After clinical and radiographic evaluation, four subjects were excluded due to periodontal disease, thirty one presented remaining molars or pre-molars, twenty four did not present bone height for implant insertion and therefore were also excluded. In addition one patient refused to participate. Thus, eleven subjects were selected, however one of them has died during the research period, and two could not conclude the study because of bone resorption complications with the implants. Consequently, the final sample was composed by eight volunteers (2 males and 6 females), with a mean age of 60.2 (± 6.6, ranging from 48 to 68) years old. This sample size leads to a minimum power of 0.8 % for minimum significant differences of 0.97 and 0.86 for the median particle size (swallow threshold

parameter) and caloric intake, respectively. Study participants received a general dental treatment, including periodontal and dental care for remaining teeth and new complete maxillary dentures and mandibular free-end RPD, which were prepared with acrylic resin according to conventional techniques. One dental technician performed all procedures. Cobalt-chromium (Co-Cr) alloy (Degussa-Hüls AG, Hanau, Germany) processed mandibular free-end RPD frameworks that included lingual cingulum rests and circumferential or bar clasps on canines. A lingual bar served as the major RPD connector (Sánchez-Ayala et al. 2012). Occlusal denture support was established through the first molars, and a bilateral balanced occlusal scheme was used. All prostheses were adjusted according to individual subject needs.

Following a two-month adaptation period with the new prosthesis, subjects were evaluated on swallowing threshold parameters and nutrient intake and underwent cone beam computed tomography. In addition, two implants (Neodent, Curitiba, PR, Brazil), measuring 6.0, 4.0, or 3.75 mm in diameter and 6.0, 7.0, 9.0 or 11.0 mm in length (depending on a subject's bone level), were placed in the right and left first molar regions, according to a standardized two-stage implant protocol (Cordaro et al. 2009). After 4 months of healing time, BA retainers of standard dimensions (2.25 and 4.0 mm) (Neodent, Curitiba, PR, Brazil) were added to implants. Similar to the initial prosthesis adaptation period, free-end RPD with BA retainers was used for 2 months, at which point swallowing threshold and nutrient intake were again measured.

Swallowing threshold

A 3.7g portion of non-salted peanuts was given to each subject, who was instructed to habitually chew the food until he/she felt the urge to swallow. During this time, a trained researcher recorded the number of completed masticatory cycles (Engelen et al. 2005). Next, particle size reduction was evaluated by artificial test cubes (Optocal) (Pocztaruk et al. 2008), based upon a silicone component (Optosil Comfort, Heraeus Kulzer GmbH & Co KG, Hanau,

Alemanha) (Slagter et al. 1993), and the sieving method (van der Bilt & Fontijn-Tekamp 2004). Subjects received a 3.7g Optocal portion (17 cubes measuring 5.6 mm edge and 3 cm^3 in volume) and, when they reached the same number of masticatory cycles used to chew peanuts, spit the chewed material into filter paper (Engelen et al. 2005).

Chewed particles were air-dried for at least one week and then sieved for 20 min in a machine with a stack of ten vibrating sieves and a bottom plate (Bertel Indústria Metalúrgica, Caieiras, SP, Brazil). The sieves had square apertures with edge-lengths decreasing from 5.6 to 0.5 mm. Remaining particles in each sieve were weighed (Mark, Bel Engineering, Monza, Milano, Italy), and the Rosin-Rammler equation calculated X_{50} (Slagter & Olthoff 1992). Each subject performed this procedure three times across different days, and averaged outcomes were recorded.

Dietary assessment

A comprehensive 3-day food diary, which has been validated for both children and adults, assessed dietary intake (Moynihan et al. 2009). Subjects wrote detailed records of all food and drink consumed during 3 days and, following diary completion, were interviewed for additional food clarification (Moynihan et al. 2009). Computerized food tables evaluated nutrients including daily intake of energy (kcal), fat (g/day), carbohydrate (g/day), protein (g/day), calcium (mg/day), fiber (g/day), and iron (mg/day) (NEPA-Unicamp 2006).

Height (m^2), weight (kg), and body mass index (kg/m^2) (BMI) measurements were obtained for all subjects.

Statistical analysis

Swallowing threshold (masticatory cycles and X_{50}) and nutrient intake were compared before and 2 months after free-end RPD posterior implants and BA insertion. Shapiro-Wilk tests assessed data distributions, and results showed that a normal distribution existed for swallowing threshold parameters (number of masticatory cycles and X_{50}), BMI, and daily intake of fat, carbohydrates, calcium,

fiber, and iron. Consequently, Paired t-tests evaluated the significance of these variables. Shapiro-Wilk test results determined that energy and protein intake values did not present a normal distribution; therefore, a Wilcoxon Ranked Test evaluated these parameters. SigmaStat software (version 3.5, Systat Software Inc) conducted all tests, with $P < 0.05$ as the significance level.

Results

Swallowing threshold

Table 1 shows the comparison between the mean number of masticatory cycles used to chew Optocal with conventional RPD and RPD retained by implants and BA. Although masticatory cycles did not differ between prosthesis treatments ($P > 0.05$), X_{50} values were significantly lower with implants and BA insertion ($P < 0.05$).

Table 1. Mean values and SD of the number of masticatory cycles and X_{50} obtained with conventional RPD and RPD retained by implants and BA *(n=8)*

	Conventional RPD	RPD retained by implants and BA	P-value
Number of masticatory cycles	43.75 ± 11.24	40.67 ± 9.71	0.646
X_{50}	3.79 ± 0.66	2.95 ± 0.48	0.003

Dietary intake

Table 2 presents dietary intake during each of the prosthetic treatment periods. Results showed that daily energy, carbohydrate, protein, calcium, fiber, and iron intake significantly increased after implants and BA insertion ($P < 0.05$).

Subject's BMI was not statistically different before (28.05 ± 5.10) and after (28.26 ± 5.79) implants and BA insertion therapy ($P > 0.05$).

Table 2. Dietary intake assessment by subjects using conventional RPD and RPD retained by implants and BA *(n=8)*

	Conventional RPD	RPD retained by implants and BA	P-value
Energy (kcal)*	1333.46 (1159.14 – 1712.81)	1746.86 (1415.74 – 2484.56)	0.008
Fat (g/day)§	35.66 ± 12.97	48.54 ± 16.57	0.110
Carbohydrates (g/day)§	183.23 ± 67.01	270.72 ± 105.75	0.003
Protein (g/day)*	75.38 (62.37 – 86.95)	90.61 (71.87 – 120.01)	0.023
Calcium (mg/day)§	306.37 ± 169.21	481.32 ± 127.05	0.006
Fiber (mg/day)§	20.66 ± 12.92	30.77 ± 18.62	0.040
Iron (mg/day)§	6.81 ± 2.42	9.93 ± 5.13	0.038

*Wilcoxon test applied: median (minimum – maximum).

§Paired t-test applied: mean ± standard deviation.

Discussion

This study aimed to elucidate the ability of conventional free-end RPD, supported by osseointegrated implants and BA insertion, (Ohkubo et al. 2008) to influence swallowing threshold parameters and nutrient intake. These results showed that subjects using free-end RPD retained by implants and BA experienced better mastication and increased nutrient intake compared to conventional RPD.

The number of chewing cycles was determined by habitual mastication of peanuts until swallowing, and this number of masticatory cycles was used in posterior test carried out with Optocal to allow the measurement of the particle size. This methodology was used because of chewing natural foods, as peanuts, provide a more reliable number of masticatory cycles (van der Bilt et al. 1984). However, as natural foods undergo changes during the mastication due to the action of saliva, it is difficult to determine its particle size at the moment to swallow by the sieving method (Slagter et al. 1992). Thus, Optocal instead of peanuts was

used for determine the X_{50} value until swallow, since it allows standardization of weight, size and shape of particles by using the sieve method (Pocztaruk et al. 2008).

Swallowing thresholds, including number of masticatory cycles, were similar among the prosthetic treatments in the current study. Concurrent results are reported by Fontjin-Tekamp (2004), who evaluated the number of chewing strokes of totally edentulous patients rehabilitated with conventional complete dentures or overdentures retained by ball attachments. In contrast, van der Bilt *et al*. (2010) found that replacing conventional complete dentures with implant-retained overdentures significantly decreased the number of masticatory cycles in edentulous subjects. These contradictory results may be explained by differences in sample composition, as totally edentulous subjects are thought to have severely altered mechanosensory mechanisms compared to partially dentate subjects (Luraschi et al. 2012; Jacobs et al. 1998). Since implant therapy improves mechanosensory mechanisms (Luraschi et al. 2012), it is reasonable to conclude that totally edentulous patients would show greater improvements in masticatory parameters than partially dentate subjects.

Although the number of masticatory cycles did not differ, Optocal particle size decreased when subjects chewed with their free-end RPD prosthesis with BA retainers. This finding is supported by previous studies showing reduced X_{50} values when patients use implant-retained overdentures (van Kampen et al. 2004; Fontijn-Tekamp et al. 2004). Consequently, it may be hypothesized that with the same number of masticatory cycles, subjects using free-end RPD over implants and BA chew more efficiently since particle size is smaller than that obtained with conventional free-end RPD (Toman et al. 2012). Importantly, smaller particles are favorable for the digestive process and nutrient absorption (Stahl et al. 2002), which suggests that patients may prefer free-end RPD retained by implants and BA to maintain dietary health.

Indeed, it is hypothesized that efficient chewing allows individuals to select healthier food, thereby improving their nutrient intake (Kagawa et al. 2012).

The current results showed an increased intake of energy, carbohydrates, protein, fiber, calcium, and iron after two months with free-end RPD over implants and BA. This finding compliments results by Moyniham (2012), which showed moderately greater dietary improvements in implant-supported overdentures patients compared with conventional denture ones. Our findings are also in accordance with another study (Ellis et al. 2010) showing increased carrot, apple, and nut consumption in subjects with conventional dentures and implant-supported overdentures. Although a recent study (Gjengedal & Berg 2012) did not find significant differences in nutrient intake between subjects using conventional and implant-supported complete dentures, these unexpected results are likely explained by methodological differences, since authors have used a 24-hour verbal dietary phone-recall compared to the written food diary used in this study.

It should be noted that fat intake was the only assessed nutrient not increased after implant retainer and BA use. This finding indicates that the observed increase in energy intake was not derived from fatty sources, which are considered easier to chew (N'gom & Woda 2002). Thus, it is reasonable to conclude that improved RPD support provided by the implants and BA insertion allowed subjects to select harder to chew food.

As expected, differences in nutrient intake did not change subjects' BMI, even after the use of RPD with implants and BA. Prior research has failed to find any correlation between masticatory performance and BMI (Liedberg et al. 2004; Slagter & Olthoff 1992). Moreover, the time between evaluations is likely too short to detect changes in BMI values (Marcenes et al. 2003). Although chewing impairments affect food choices, social and cultural factors also influence eating decisions (Shepherd 1999). Thus, oral rehabilitation without nutritional counseling may not be enough to change eating habits (Moynihan et al. 2012). Therefore, it is important to provide proper chewing conditions for the patient as well as resources for healthier eating behaviors.

Comparing variables assessed with the use of conventional free-end RPD, before implant retainer and BA placement with those from the literature,

revealed that the number of chewing cycles until swallowing (van der Bilt et al. 1993; Kohyama et al. 2003), X_{50} (Slagter & Olthoff 1992; van der Bilt et al. 1994), BMI (Morais et al. 2003; Kohyama et al. 2003; Marcenes et al. 2003) and nutrient intake (Marcenes et al. 2003) are consistent with several studies. It shows reliability on the results found, in spite of the relatively small sample size and possible differences between populations studied worldwide.

Our results support oral rehabilitation by a free-end RPD with implant and BA inserts as a cost effective and beneficial therapy for Class I mandibular ridges. These implants were associated with improved chewing function and nutrient intake, suggesting that this prosthesis may facilitate health benefits in edentulous patients.

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CONCLUSÃO

Os dados coletados no presente estudo indicam que pacientes parcialmente dentados com arcos mandibulares classificados como Classe I de Kennedy podem se beneficiar da associação de implantes osseointegrados à PPR. Esta modalidade de tratamento, ao adicionar retenção à prótese, proporcionou melhora na função mastigatória, com redução significativa no tamanho da partícula a ser deglutida, e, por conseguinte, alteração positiva na dieta dos indivíduos.

Este tratamento constitui uma alternativa viável para os casos de pacientes parcialmente desdentados e de extremidade livre.

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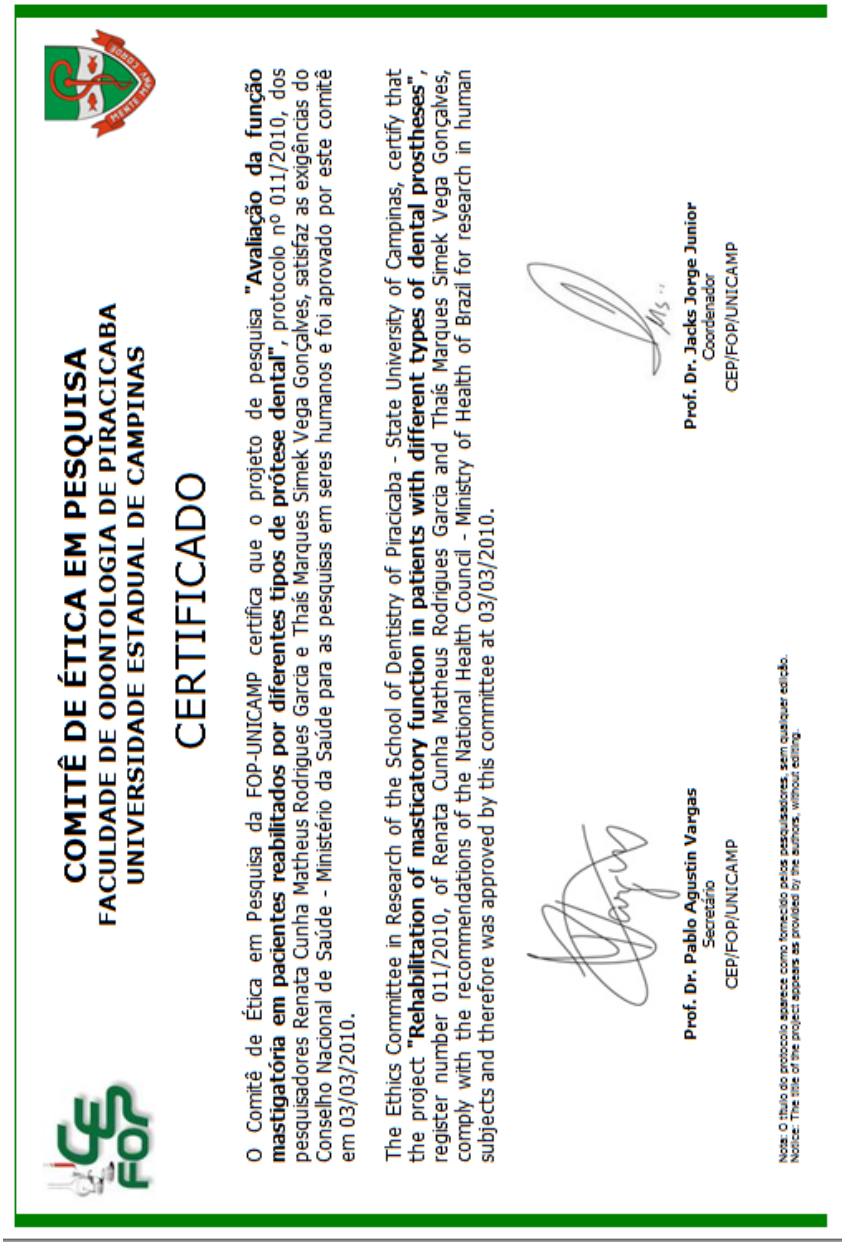
ANEXOS

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 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 03/03/2010.

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 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 03/03/2010.

Prof. Dr. Pablo Agustin Vargas
Secretário
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 – Figuras

Figura 1. Condição intra-bucal dos voluntários selecionados para a pesquisa.

Figura 2. Vista intra-bucal dos voluntários após reabilitação com próteses removíveis.

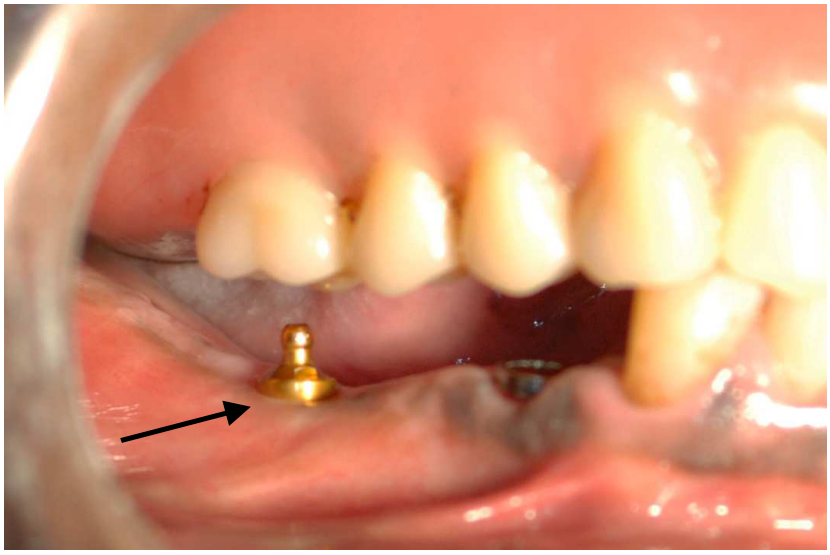


Figura 3. Detalhe intra-bucal do retentor tipo bola sobre o implante.

Figura 4. Encaixe fêmea sob a base da prótese parcial removível.

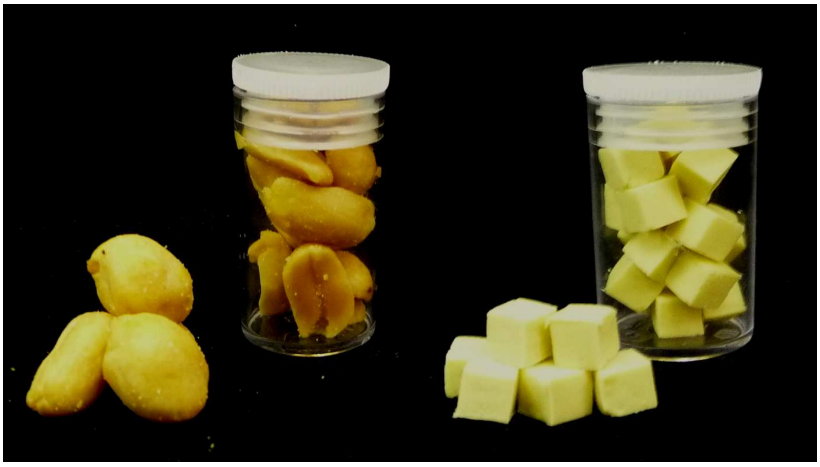


Figura 5. Porções de amendoim e Optocal contendo 3.7g cada.

Figura 6. Optocal expelido em filtro de papel após mastigação.

Figura 7. Peneiras em agitador para processamento do material teste Optocal.

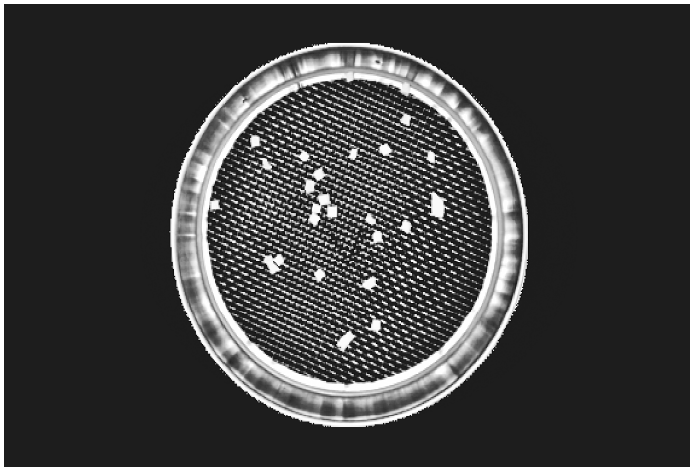


Figura 8. Material retido em uma peneira após processamento.

Anexo 3. Modelo do Diário Alimentar fornecido aos voluntários

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 Camila Heitor Campos ou Profa. Renata C. M. Rodrigues Garcia pelos telefones (19) 2106-5295 ou 2106-5240.

Anexo 4. Exemplo de análise nutricional fornecida pelo software AdsNutri.

ADSNutri - Sistema Nutricional
Relatório de Recordatório do Paciente

Paciente: [redacted]
Nascimento: [redacted] **Sexo:** Masculino **Altura:** 1.81 m **Peso:** 84.50 Kg

DESJEJUM	Qtd	Cal	Prot	Lip	Carb	Fibra	Ca	P	Fe
AÇÚCAR, REFINADO (TACO)	10	40.00	0.00	0.02	10.00	0.03	0.40	0.00	0.01
CAFÉ, INFUSÃO 10% (TACO)	50	4.50	0.35	0.05	0.75	0.00	1.50	4.50	0.00
LEITE, DE VACA, INTEGRAL (TACO)	50	0.00	0.00	0.00	0.00	0.00	61.50	41.00	0.00
MAMÃO, FORMOSA, CRU (TACO)	170	76.50	1.36	0.17	19.72	3.06	42.50	18.70	0.34
MELÃO, CRU (TACO)	90	26.10	0.63	0.00	6.75	0.27	0.00	9.00	0.18
TOTAIS	370	147.10	2.34	0.24	37.22	3.36	105.90	73.20	0.53

COLAÇÃO	Qtd	Cal	Prot	Lip	Carb	Fibra	Ca	P	Fe
BARRA DE CEREAL	150	510.00	5.70	1.65	111.00	4.50	0.00	0.00	0.00
TOTAIS	150	510.00	5.70	1.65	111.00	4.50	0.00	0.00	0.00

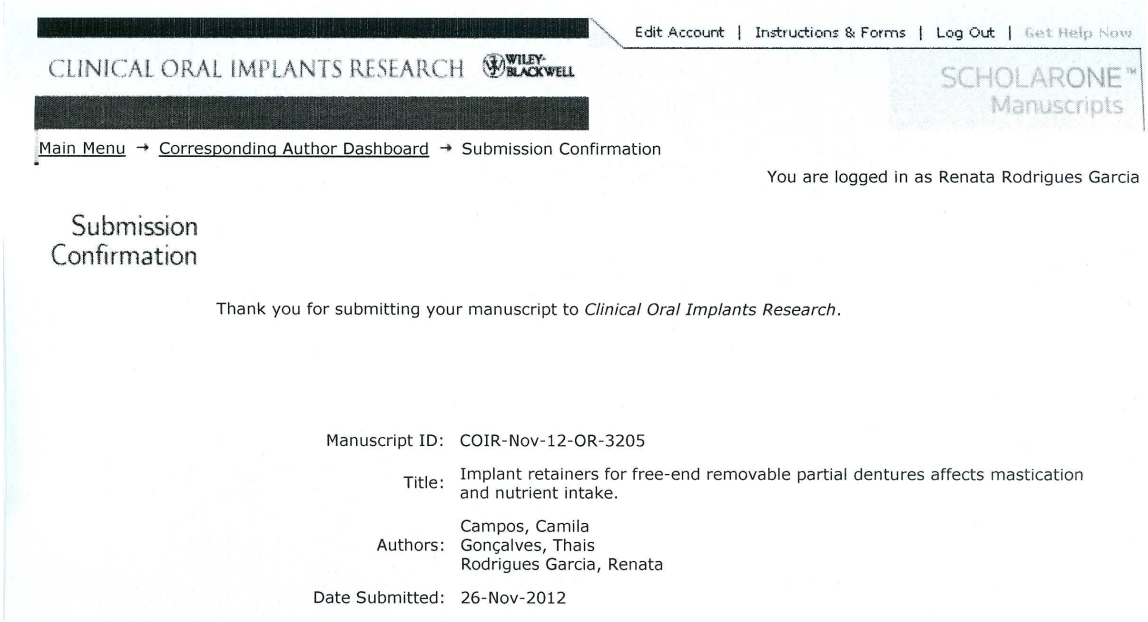
ALMOÇO	Qtd	Cal	Prot	Lip	Carb	Fibra	Ca	P	Fe
AÇÚCAR, REFINADO (TACO)	10	40.00	0.00	0.02	10.00	0.03	0.40	0.00	0.01
ARROZ, TIPO 1, COZIDO (TACO)	200	256.00	5.00	0.40	56.20	3.20	8.00	36.00	0.20
BATATA, INGLESA, COZIDA (TACO)	70	36.40	0.84	0.00	8.33	0.91	2.80	16.80	0.14
CAFÉ, INFUSÃO 10% (TACO)	50	4.50	0.35	0.05	0.75	0.00	1.50	4.50	0.00
[illegible]									
FEIJÃO, CARIOCA, COZIDO (TACO)	68	51.68	3.26	0.34	9.25	5.78	18.36	59.16	0.88
TOTAIS	640	982.26	66.35	31.71	102.76	10.84	107.76	508.06	6.57

JANTAR	Qtd	Cal	Prot	Lip	Carb	Fibra	Ca	P	Fe
ARROZ, TIPO 1, COZIDO (TACO)	200	256.00	5.00	0.40	56.20	3.20	8.00	36.00	0.20
BATATA, INGLESA, COZIDA (TACO)	70	36.40	0.84	0.00	8.33	0.91	2.80	16.80	0.14
QUEIJO, MINAS/FRESCAL (TACO)	40	105.60	6.96	8.08	1.28	0.00	231.60	49.20	0.36
REFRIGERANTE, TIPO COLA (TACO)	200	68.00	0.00	0.00	17.40	0.00	2.00	34.00	0.00
TOTAIS	510	466.00	12.80	8.48	83.21	4.11	244.40	136.00	0.70

	Qtd	Cal	Prot	Lip	Carb	Fibra	Ca	P	Fe
TOTAIS	1670	2105.36	87.19	42.08	334.19	22.81	458.06	717.26	7.80
RECOMENDAÇÃO	-	-	-	-	-	30.00	1200.00	700.00	8.00
% DE ADEQUAÇÃO	-	-	-	-	-	76	38	102	98

VCT				
	Proteinas	16,89%	348.74 Kcal	87.19 g
	Lipidios	18,35%	378.74 Kcal	42.08 g
	Carboidratos	64,76%	1336.74 Kcal	334.19 g
	VCT	2064.22 Kcal		

Anexo 5. Protocolo de submissão do artigo ao periódico *Clinical Oral Implants Research.*



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Manuscript ID:	COIR-Nov-12-OR-3205
Title:	Implant retainers for free-end removable partial dentures affects mastication and nutrient intake.
Authors:	Campos, Camila Gonçalves, Thais Rodrigues Garcia, Renata
Date Submitted:	26-Nov-2012