UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

GISELLE RODRIGUES RIBEIRO

SAÚDE BUCAL E FUNÇÃO MASTIGATÓRIA EM PACIENTES COM DOENÇA DE PARKINSON

ORAL HEALTH AND CHEWING FUNCTION IN PATIENTS WITH PARKINSON'S DISEASE

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

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

Orientador: PROF.ª DR.ª RENATA CUNHA MATHEUS RODRIGUES GARCIA

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RESUMO

Este trabalho avaliou a saúde bucal e a função mastigatória em idosos com DP durante o período de bom funcionamento motor (período "on" da levodopa), e reabilitados com novas próteses dentárias removíveis. Para tanto, foi dividido em 4 artigos. Os artigos 1 e 2, realizados antes da reabilitação, incluíram idosos com DP (n=17; idade média=69,59±5,09 anos) e um grupo controle (n=20; idade média=72,00±5,69). O artigo 1 avaliou a saúde bucal objetiva e subjetivamente, por meio do número de dentes remanescentes, dentes cariados, perdidos e obturados (CPOD), índice de saúde bucal (ISB), fluxo salivar e condições das próteses (estabilidade, retenção, oclusão, dimensão vertical e defeitos); e do General Oral Health Assessment Index (GOHAI). Comparações entre os grupos foram realizadas pelo teste *t* ou pelo teste X^2 (P<0,05). Não houve diferença no número de dentes, CPOD, ISB e fluxo salivar, porém verificaram-se mais defeitos na prótese superior do controle (P=0,037). O GOHAI foi baixo para grupo DP e moderado para o controle (P=0,04). Conclui-se que idosos com e sem DP possuem saúde bucal similar, apesar da autopercepção mais negativa da saúde bucal nos idosos com DP. O artigo 2 avaliou a higienização das próteses removíveis por meio do biofilme revelado por corante, antes, e 7, 14 e 30 dias após as instruções verbais de limpeza e reforço positivo. Os dados foram analisados por teste *t*, U Mann-Whitney, ANOVA e Tukey post hoc (P<0,05). Houve redução no acúmulo de biofilme e, após 30 dias, não houve diferenças entre os grupos (P>0,05). Conclui-se que similar aos controle, idosos com DP são capazes de reduzir o biofilme em resposta às instruções verbais e reforço positivo. Nos artigos 3 e 4, incluiu-se idosos com DP (n=17; idade média=69,59±5,09 anos) e controle (n=17; idade média=70,71±4,65). O artigo 3 avaliou a função mastigatória 2 meses após a adaptação às novas próteses, pela amplitude dos movimentos mandibulares e movimentos durante a mastigação do Optocal; performance mastigatória (PM) e força máxima de mordida (FMM). Os dados foram analisados pelo teste *t* (P<0,05). O grupo DP mostrou menor amplitude de movimento da mandíbula, maior duração e menor velocidade da mastigação, pior PM, e menor FMM (P<0,05). Conclui-se que a DP está associada ao comprometimento da função mastigatória. O artigo 4 avaliou a qualidade de vida relacionada à saúde bucal (QVRSB) e a eficiência mastigatória (EM), antes e 2 meses após a reabilitação, pelo Oral Health Impact Profile (OHIP-49) e mastigação do Optocal. Analisou-se os dados pelos testes Wilcoxon sign test ou signed-rank; ou teste *t* pareado (P<0,05). Os grupos melhoraram a QVRSB e EM comparando antes e após a reabilitação. Após a reabilitação, os idosos DP mostraram pior EM, porém impacto positivo na QVRSB, similar ao controle (P<0,05). Conclui-se que a

reabilitação melhora a QVRSB e a EM em idosos com DP. De maneira geral, conclui-se que os idosos com DP possuem a saúde bucal similar aos idosos sem a doença e que a DP compromete a função mastigatória durante o período “on” da levodopa.

Palavras-chave: Doença de Parkinson, saúde bucal, mastigação, prótese dentária.

ABSTRACT

This study evaluated the oral health and masticatory function in older adults with PD during the good motor function (levodopa "on" period) and rehabilitated with new removable dental prosteses. Thus, it was divided into 4 articles. Articles 1 and 2, assessed before rehabilitation, included elderly patients with PD (n = 17, mean age = 69.59 ± 5.09 years) and a control group (n = 20, mean age = 72.00 ± 5, 69). Article 1 evaluated the oral health objective and subjectively, including the number of remaining teeth, decayed, missing, and filled teeth (DMFT), oral health index (OHI), salivary flow and conditions of prostheses (stability, retention, occlusion, vertical dimension and defects); and General Oral Health Assessment Index (GOHAI). Data were analyzed by t-test or X^2 test (P <0.05). There was no difference in number of teeth, DMFT, OHI and salivary flow, but more defects in the upper prosthesis were observed in controls (P=0.037). The GOHAI was low for PD group and moderate for control (P = 0.04). We conclude that elders with and without PD have similar oral health, despite the more negative self-perception of oral health in the elderls with PD. Article 2 evaluated the removable prosthesis hygiene by the biofilm stained before and 7, 14 and 30 days after hygiene verbal instructions and positive reinforcement. Data were analyzed by t-test, Mann-Whitney U, ANOVA and post hoc Tukey test (P <0.05). There was a reduction in biofilm and, after 30 days, there were no differences between groups (P> 0.05). In conclusion, similar to the control, older people with PD are able to reduce the biofilm in response to verbal instructions and positive reinforcement. Articles 3 and 4 included elderly patients with PD (n = 17; age mean = 69.59 ± 5.09 years) and controls (n = 17, mean age = 70.71 ± 4.65). Article 3 evaluated the masticatory function after 2-month adaptation period with the new removable prostheses, by the range of the jaw motion, movements during Optocal chewing; masticatory performance (MP) and maximum bite force (MBF). Data were analyzed by t test (P <0.05). The PD group showed decreased range of jaw motion, longer duration and slower velocity of the masticatory cycle, worse MP, and lower MBF (P <0.05). We conclude that PD is associated with impairment of masticatory function. Article 4 evaluated the oral health related quality of life (OHRQoL) and masticatory efficiency (ME) before and 2 months after rehabilitation, using the Oral Health Impact Profile (OHIP-49) and Optocal chewing. Data were analysed by Wilcoxon sign or signed-rank tests; or paired t test (P <0.05). The groups improved OHRQoL and ME comparing before and after rehabilitation. After rehabilitation, elders with PD showed worse ME, but positive impact on OHRQoL, similar to controls (P <0.05). In conclusion, rehabilitation improves OHRQoL and ME in

elderly patients with and without PD. In general, it can be concluded that elders with PD have similar oral health than controls, and that the PD impair the masticatory function during the levodopa “on” period.

Key Words: Parkinson's disease, oral health, mastication, dental prostheses.

SUMÁRIO

1 INTRODUÇÃO

A doença de Parkinson (DP) é uma das doenças neurodegenerativas mais prevalentes (Pringsheim *et al.*, 2014). A prevalência da DP é de cerca de 0,5 a 1% entre as pessoas com idade entre 65 e 69 anos, aumentando para 1 a 3% entre as pessoas com mais de 80 anos (Nussbaum e Ellis, 2003). A DP é causada pela perda de neurônios produtores de dopamina, resultando em quatro sintomas motores principais: tremor em repouso; bradicinesia, ou lentidão de movimentos; rigidez; e instabilidade postural (Friedlander *et al.*, 2009). Os sintomas não-motores ocorrem em mais de 90% dos pacientes e incluem disfunção neuropsiquiátrica e autonômica, tais como depressão, ansiedade, apatia, perturbações cognitivas e distúrbios do sono, sintomas sensoriais, fadiga e dor (Chaudhuri *et al.*, 2011).

O diagnóstico da DP requer a presença de pelo menos dois dos sintomas motores, juntamente com a progressão gradual dos sintomas, boa resposta à terapia com levodopa (Gazewood *et al.*, 2013), e que as potenciais causas de parkinsonismo secundário sejam excluídas (de Lau e Breteler, 2006). A administração de levodopa, que é a medicação padrão, tem o objetivo de controlar os sintomas causados pela DP e manter o paciente o maior tempo possível com autonomia, independência funcional e equilíbrio psicológico (Pinheiro, 2002). A administração prolongada de levodopa por 5 anos ou mais, torna o paciente parcialmente sem resposta ao medicamento em 50 a 75% dos casos, havendo uma flutuação nos sintomas num período de 24h, alternando entre um período de boa função motora (período “on”), quando a medicação está funcionando, e período de severa imobilidade (período “off”) (Friedlander *et al.*, 2009).

Com a evolução dos sintomas, os pacientes podem ter dificuldade em completar tarefas simples, como caminhar, falar e realizar higiene pessoal e bucal (Rajeswari, 2010). Sintomas motores podem interferir nos pequenos movimentos automatizados das mãos (Schwarz *et al.*, 2006), causando prejuízo na capacidade de escovar os dentes e, consequentemente, atuando como fator de risco para a saúde bucal em pacientes com DP (Müller *et al.*, 2011). A higiene bucal prejudicada pode levar ao acúmulo de biofilme em dentes naturais e próteses dentárias (Nakayama *et al.*, 2004; Friedlander *et al.*, 2009). Além disso, os sintomas não-motores, como demência ou apatia, e os sintomas motores podem influenciar na qualidade e frequência dos cuidados de higiene bucal diários por esses pacientes (Müller *et al.*, 2011).

Os resultados de estudos prévios sobre a avaliação de saúde bucal em pacientes com DP são controversos (Fukayo *et al.*, 2003; Schwarz *et al.*, 2006; Einarsdóttir *et al.*, 2009; Bakke *et al.*, 2011). Estudos envolvendo grande número de participantes demonstraram que

pacientes com DP possuem maior número de dentes ausentes, cárie, biofilme dental (Einarsdóttir *et al.*, 2009), e pior saúde periodontal (Schwarz *et al.*, 2006; Einarsdóttir *et al.*, 2009) quando comparados a indivíduos com ausência da doença (Einarsdóttir *et al.*, 2009). Em contraste, Fukayo *et al.* (2003) verificaram que pacientes com DP tiveram maior número de dentes e menos cáries do que um grupo controle de mesma idade (Fukayo *et al.*, 2003). Além disso, foi relatado que pacientes com DP higienizam menos as suas próteses dentárias diariamente quando comparados a indivíduos sem DP (Nakayama *et al.*, 2004).

A saúde bucal significa mais do que dentes saudáveis, sendo um componente do estado geral de saúde essencial para o bem-estar (Petersen, 2003). Avaliação da saúde bucal, baseada exclusivamente no diagnóstico clínico realizado por cirurgiões-dentistas, muitas vezes leva à superestimação da verdadeira necessidade de tratamento nos idosos (McGrath e Bedi, 1999), pois não avalia a autopercepção dos mesmos quanto à saúde bucal. A autopercepção da saúde bucal é uma medida multidimensional que reflete a experiência subjetiva dos indivíduos relativa ao seu bem-estar funcional, social e psicológico (Atchison e Dolan, 1990) e, muitas vezes, motiva a busca por tratamento odontológico (da Silva e Castellanos Fernandes, 2001). As avaliações subjetivas (Atchison e Dolan, 1990; Slade e Spencer, 1994) foram desenvolvidas para aprimorar a habilidade dos clínicos em avaliar a autopercepção e também a qualidade de vida relacionada com a saúde bucal (QVRSB) em idosos. A QVRSB tornou-se uma importante preocupação dos profissionais de Odontologia, desempenhando um papel importante na prática clínica em termos de identificação de necessidades, planejamento, e proservação dos pacientes (Locker *et al.*, 2004; Campos *et al.*, 2015). Em pacientes com DP, estudos anteriores avaliaram a QVRSB (Nakayama *et al.*, 2004; Bakke *et al.*, 2011; Silva *et al.*, 2015), e verificaram que pacientes com DP queixaram-se mais sobre a sua saúde bucal devido à dificuldades de mastigação, desconforto das próteses totais, e problemas relativos às práticas de saúde bucal do que os voluntários do grupo controle (Nakayama *et al.*, 2004).

Sintomas da DP podem levar a numerosas manifestações orofaciais, tais como ausência de expressão facial, frequência reduzida de piscar de olhos, tremores na testa, nas pálpebras, lábios e na musculatura da língua, além de movimentos involuntários da mandíbula, que podem causar problemas na mastigação (Friedlander *et al.*, 2009). A mastigação é a primeira etapa da digestão, consistindo em um processo rítmico e intermitente dos músculos da língua, face e mandíbula, que agem em coordenação para posicionar o alimento entre os dentes, cortá-lo, e, em seguida, prepará-lo para a deglutição (Lund, 1991). Todos estes passos são controlados pelo tronco cerebral, que é a única parte do sistema

nervoso central considerada essencial para a mastigação (Lund, 1991). O tronco cerebral contém o padrão gerador central, que é responsável pela geração da atividade rítmica da mandíbula (van der Bilt, 2011). Assim, problemas de mastigação podem ocorrer não apenas devido à ausência de dentes ou mau funcionamento dos maxilares e/ou articulações da mandíbula e músculos, mas também devido a problemas neurológicos (van der Bilt, 2011).

Estudos anteriores sugerem que a DP não altera apenas um tipo de movimento da mandíbula, mas influencia diversas variáveis de movimentos voluntário e automático (Robertson e Hammerstad, 1996). Além disso, a dificuldade de deglutir (disfagia) é comum na DP devido às deficiências motoras da faringe (Friedlander *et al.*, 2009). Em pacientes com DP, a perda de controle neuromuscular contribui para a perda de estabilidade de próteses totais (Clifford e Finnerty, 1995). Estudos anteriores (Clifford e Finnerty, 1995; Nakayama *et al.*, 2004) relataram que pacientes com DP têm dificuldades de mastigação e desconforto no uso de próteses totais (Nakayama *et al.*, 2004). Em relação às próteses parciais removíveis, estudos anteriores não avaliaram os problemas relacionados a esse tipo de prótese nos pacientes com DP. No entanto, a função mastigatória prejudicada (Bakke *et al.*, 2011), juntamente com problemas relacionados às próteses, podem agravar as dificuldades de mastigação e deglutição já existentes nos pacientes com DP (Lorefält *et al.*, 2006).

Uma porcentagem substancial de idosos são usuários de próteses fixas e/ou removíveis (van der Bilt *et al.*, 1994). Packer *et al.* (2009) relataram melhora da qualidade de vida em pacientes com DP por meio da instalação de implantes dentários, usados para estabilizar uma overdenture ou para suportar uma prótese fixa, nos domínios de satisfação com a prótese, alimentação e bem-estar oral (Packer *et al.*, 2009). No entanto, um número significativo de pacientes com DP na sociedade ainda requer a prótese total e prótese parcial removível para a reabilitação funcional, estética e psicológica (Haralur, 2015).

Devido à literatura controversa sobre saúde bucal em pacientes com DP, estudos que avaliem a saúde bucal e a função mastigatória de idosos com DP ainda são necessários. Assim, o objetivo geral do presente estudo foi avaliar a saúde bucal e a função mastigatória em idosos com DP durante o período "on" do tratamento com levodopa e reabilitados com novas próteses dentárias removíveis, comparando-os com idosos saudáveis. Como objetivos específicos, o presente estudo avaliou: *1)* a saúde bucal de idosos com DP objetiva e subjetivamente, por meio de avaliações bucais e do General Oral Health Assessment Index (GOHAI), respectivamente; *2)* se os idosos com DP poderiam melhorar a higiene da prótese removível após receber instruções verbais e reforço positivo; *3)* a função mastigatória em pacientes com DP após a instalação de novas próteses dentárias removíveis; e *4)* a QVRSB e

a eficiência mastigatória em idosos com DP antes e após a instalação de novas próteses dentárias removíveis.

2 ARTIGOS

Este trabalho foi realizado no formato alternativo, conforme a Informação CCPG/001/2015, da Comissão Central de Pós-Graduação (CCPG) da Universidade Estadual de Campinas.

2.1 Oral health in elders with Parkinson's disease

Giselle Rodrigues Ribeiro (Ribeiro GR), Camila Heitor Campos (Campos CH), Renata Cunha Matheus Rodrigues Garcia (Rodrigues Garcia RCM).

Artigo será submetido à publicação no periódico *Brazilian Dental Journal*.

2.2 Removable prostheses hygiene in elders with Parkinson's disease

Giselle Rodrigues Ribeiro (Ribeiro GR), Camila Heitor Campos (Campos CH), Renata Cunha Matheus Rodrigues Garcia (Rodrigues Garcia RCM).

Artigo submetido ao periódico *Gerodontology* (ANEXO 2)

2.3 Parkinson's disease impairs masticatory function

Giselle Rodrigues Ribeiro (Ribeiro GR), Camila Heitor Campos (Campos CH), Renata Cunha Matheus Rodrigues Garcia (Rodrigues Garcia RCM).

Artigo será submetido à publicação no periódico *Clinical Oral Investigations*.

2.4 Oral health–related quality of life and masticatory efficiency in elders with Parkinson's disease after oral rehabilitation

Giselle Rodrigues Ribeiro (Ribeiro GR), Camila Heitor Campos (Campos CH), Renata Cunha Matheus Rodrigues Garcia (Rodrigues Garcia RCM).

Artigo será submetido à publicação no periódico *The Journal of Prosthetic Dentistry*.

2.1 Artigo: Oral health in elders with Parkinson's disease

Short title: Oral health in Parkinson's disease.

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Summary

This study aimed to objectively and subjectively evaluate oral health of elders with Parkinson's disease (PD), using clinical oral assessments and the General Oral Health Assessment Index (GOHAI). Subjects included 37 removable prosthesis wearers, 17 with PD (mean age = 69.59 ± 5.09 years) and 20 without PD (mean age = 72.00 ± 5.69 years). The objective assessment included an evaluation of oral characteristics, including the number of remaining teeth, decayed, missing, and filled teeth (DMFT), oral health index (OHI), salivary flow rate, and removable prosthesis conditions. The subjective assessment included self-perception of oral health, collected using the GOHAI index. The number of remaining teeth, DMFT, OHI, salivary flow rate, and GOHAI data were compared between groups using t-tests. Removable prosthesis conditions were analyzed using χ^2 tests ($P < 0.05$). There were no group differences in the number of remaining teeth, DMFT, OHI, or salivary flow rate ($P > 0.05$). Greater upper prosthesis defects were observed in the control group ($P = 0.037$). GOHAI scores were low for the PD group and moderate for controls, yielding a group difference ($P = 0.04$). In conclusion, elders with PD have similar oral health to controls. Although all elders had few remaining teeth, high DMFT, and good OHI, PD elders had more negative self-perceptions of their oral health than did controls.

Key Words: Parkinson's disease, oral hygiene, oral health, removable dental prosthesis.

Introduction

Parkinson's disease (PD) is the second most common neurodegenerative disorder. It is characterized by intracellular α-synuclein-positive inclusions called Lewy bodies and by nigrostriatal cell loss, which cause motor and non-motor symptoms (1). Cardinal motor symptoms include resting tremor, bradykinesia, rigidity, and postural instability (2), and diagnosis requires the presence of at least two of these symptoms, coupled with asymmetric symptom onset and a good response to levodopa (1). Non-motor symptoms occur in over 90% of patients across all stages and include neuropsychiatric and autonomic dysfunction, such as depression, anxiety, apathy, cognitive and sleep disturbances, sensory symptoms, fatigue, and pain (3).

Motor symptoms may interfere with automated small hand movements (4), causing impairment in tooth brushing ability, which is considered a primary risk factor for deteriorated oral health in PD patients (5). In addition to non-motor symptoms, such as dementia or apathy, altered motor behavior and particularly motor fluctuations may influence the quality and frequency of daily oral hygiene care by these patients (5).

Results of studies assessing oral health in patients with PD have been controversial (5, 7-9). Surveys with larger numbers of participants showed that PD patients have more missing teeth, caries, dental biofilm (7), and poorer periodontal health (5, 8) compared to individuals without the disease (7). In contrast, a smaller study by Fukayo et al. (6) found that PD patients had significantly more teeth and less caries than a control group of similar age (6). These controversial results underscore the need for further studies of oral health in PD patients.

Oral health means more than good teeth; it is a component of general health that is essential for well-being (8). Assessment of oral health, based solely on clinical diagnosis by dentists, often leads to an overestimation of the true need for treatment in elders (9) because it does not evaluate self-perceptions about oral health. Self-perception of oral health is a multidimensional measurement that reflects individuals' subjective experience of their functional, social, and psychological well-being (10) and often motivates seeking dental treatment (11). Subjective assessments (10,12) were developed to enhance the clinicians' ability to assess self-perception of oral health and oral-health related quality of life in elders.

In patients with PD, previous studies assessed subjective data using a structured questionnaire (13) and Oral Health Impact Profile (OHIP) (9, 16). The former (13) demonstrated that, compared to controls, PD patients complained more about their oral health due to chewing difficulties, denture discomfort, and problems with oral health behavior.

Subjective assessments using OHIP (14, 15) also showed that PD patients reported more oral health-related problems than controls (14) and that the oral health impact in PD patients was greatest on the "physical disability" and "psychological discomfort" subscales (15). However, studies evaluating self-perception of oral health in PD patients using the General Oral Health Assessment Index (GOHAI) have not been published yet.

Due to the controversial literature on oral health in PD subjects and their greater oral health complaints, additional studies in this area are necessary. Therefore, the present study aimed to evaluate the oral health of elders with PD both objectively and subjectively, using oral assessments and the GOHAI, respectively.

Material and Methods

Subjects

This cross-sectional study included 17 elders with PD (mean age 69.41 ± 4.65 years; 8 women and 9 men) who were members of the Brazilian Parkinson's Association (Piracicaba, São Paulo, Brazil) and 20 elders without PD (mean age 72.00 ± 5.69; 10 women and 10 men), selected from friends and relatives of the PD volunteers or from elders who sought prosthetic treatment at the dental clinic of the Piracicaba Dental School, University of Campinas. All PD subjects were diagnosed by a neuropsychiatrist using clinical diagnostic criteria (16), were receiving daily levodopa treatment, and had mean of 6.76 ± 3.80 years since PD diagnosis. Elders with other neurodegenerative disorders or secondary Parkinsonism were excluded from the study. All participants gave written informed consent. The Ethics Committee of the Piracicaba Dental School, University of Campinas (Piracicaba, Brazil) approved the study (protocol # 097/2012). The study was also registered in the Brazilian Registry of Clinical Trials database (#RBR-3czhsf), which is linked to the International Clinical Trials Registration Platform (ICTRP/World Health Organization).

Sociodemographic characteristics were collected including age, educational level, and monthly income. Characteristics of the prostheses were verified, including the type of upper and lower removable dental prosthesis and prosthesis age.

Objective assessment

To assess oral health, all participants received a clinical examination, which was carried out using a probe, mouth mirror, and flashlight. Each subject's teeth, hygiene, and removable dental prosthesis conditions were evaluated as follows:

(1)Number of remaining teeth: the number of teeth present in the mouth was registered in the partially dentate volunteers.

(2)Decayed, missing, and filled teeth (DMFT) index (17): the teeth were categorized as decayed if they were cavitated; missing if they were extracted or extraction was indicated; and filled if they presented amalgam, resin, or prosthetic crowns. The sum of the decayed, missing, and filled teeth was the DMFT index (17).

(3) Oral Hygiene Index (OHI): the level and position of biofilm and calculus on buccal and lingual exposed tooth surfaces were scored as described by Greene and Vermillion (18). The biofilm and calculus indices were calculated as averages: biofilm or calculus scores were summed, then divided by the number of teeth scored (18). Biofilm and calculus indices could range from 0 to 6, and the two indices were summed to yield the OHI, which could range from 0 to 12 (18);

(4) Salivary flow rate: stimulated salivary flow rate was determined by having participants chew on a piece of parafilm with a thickness of 0.02″ (Parafilm M®, Bemis Company, Inc., USA) for 5 min, expectorating saliva at 30 s intervals into a pre-weighed dish. Salivary flow rate (g/min) was then calculated (19) by subtracting the initial weight from the final weight of the glass; and

(5) Removable prosthesis conditions: upper and lower complete dentures (CD) and/or removable partial dentures (RPD) were evaluated according to Vigild criteria (20). Within the mouth, the upper and lower prosthesis were evaluated for stability, retention, occlusion, and vertical height; outside the mouth, they were evaluated for defects, such as wear and/or missing/fractured teeth, broken flanges, and loss of pieces of the prosthesis base (20).

Subjective assessment

Self-perception of oral health was evaluated using the GOHAI (10) Portuguese version, which has been validated (11). A single trained examiner administered the GOHAI, asking participants to respond to the 12 items in reference to the previous three months using a 3-point scoring scale (always, sometimes, or never) (11). The final GOHAI score was calculated as previously described by Atchison and Dolan (10) and could range from 12 to 36. Scores of 34 to 36 were classified as high, scores of 31 to 33 as moderate, and scores less than 30 as low (21). Higher GOHAI scores indicate more positive perceptions of oral health, and lower GOHAI scores are associated with more self-reported oral health problems and poorer oral health conditions (10).

Statistical analysis

Data were evaluated using SAS 9.3 (SAS Institute Inc., SAS Campus Drive, Cary, North Carolina, USA). Exploratory analysis using the Shapiro-Wilk test showed that data were normally distributed. T-tests were used to analyze age, educational level, monthly income, and prosthesis age, as well as the number of remaining teeth, DMFT, OHI, salivary flow rate, and subjective data from the GOHAI. $\chi 2$ tests were used to analyze the type and condition of upper and lower removable dental prosthesis. All statistical analyses were carried out using a 5% significance level.

Results

As shown in Table 1, sociodemographic and prosthesis characteristics of PD patients and controls were similar ($P > 0.05$). As shown in Table 2, both groups had few remaining teeth, high DMFT, good OHI, and normal salivary flow rate (> 0.70 g/ml) ($P > 0.05$). Still about DMFT, results showed no differences between groups for the decayed ($P = 0.876$), missing ($P = 0.422$) and filled teeth ($P = 0.284$), with mean number of 0.24 ± 0.75 decayed, 22.18 ± 6.30 missing and 2.41 ± 3.45 filled teeth for PD group; and 0.20 ± 0.62 decayed, 25.40 ± 4.52 missing and 1.25 ± 2.77 filled teeth for controls. GOHAI scores showed a group difference: controls had moderate scores, and PD patients had low scores, indicating more self-reported oral health issues ($P = 0.04$) (Table 2). Group differences were observed in the upper prosthesis, which had greater defects in the control group ($P < 0.05$), as shown in Table 3. The most common defects observed were wearing of artificial teeth and missing/fractured teeth.

Table 1. Sociodemographic and removable prosthesis characteristics of PD patients and controls.

Characteristics	PD (*n* = 17)	Control (*n* = 20)	*P*
Age	69.41 (± 4.65)	72.00 (± 5.69)	0.186
Educational level (year)	7.94 (± 5.66)	4.48 (± 3.50)	0.064
Monthly income (BRL)	2.84 (± 1.29)	2.65 (± 2.31)	0.839
Edentulous	7 (41.18)	14 (70.00)	0.078
Partially dentate	10 (58.82)	6 (30.00)	0.078
Upper prosthesis	17 (100.00)	20 (100.00)	
CD	11 (64.70)	18 (90.00)	0.063
RPD	6 (35.30)	2 (10.00)	0.063
Lower prosthesis	9 (52.94)	17 (85.00)	
CD	6 (66.67)	13 (76.47)	0.072
RPD	3 (33.33)	4 (23.53)	0.855
Prosthesis age (years)			
Upper	9.44 (± 10.25)	12.71 (± 13.84)	0.525
Lower	7.94 (± 6.52)	11.78 (± 11.18)	0.595

Data represent mean (± standard deviation) or frequency (%). BRL, Brazilian real; PD, Parkinson's disease; CD, complete denture; RPD, removable partial denture.

Table 2. Number of remaining teeth, DMFT, OHI, salivary flow rate, and GOHAI in PD patients and controls.

	PD (*n* = 17)	Control (*n* = 20)	*P*
Number of teeth	10.00 (± 5.23)	8.66 (± 3.83)	0.597
DMFT	24.82 (± 3.76)	26.85 (± 2.18)	0.111
OHI	3.72 (± 1.20)	2.24 (± 1.97)	0.081
Salivary flow rate (g/min)	0.78 (0.56)	1.00 (0.70)	0.312
GOHAI	27.35 (± 4.23)	30.50 (± 4.65)	0.040

Data represent mean (± standard deviation). PD, Parkinson's disease; OHI, Oral Heath Index; GOHAI, General Oral Health Assessment Index.

Table 3. Removable prosthesis conditions for the upper and lower prosthesis of PD patients and controls.

	PD (n = 17)	Control (n = 20)	P
Stability of upper prosthesis			0.054
Satisfactory	15 (88.24)	12 (60.00)	
Unsatisfactory	2 (11.76)	8 (40.00)	
Stability of lower prosthesis			0.700
Satisfactory	4 (36.36)	5 (29.41)	
Unsatisfactory	7 (63.64)	12 (70.59)	
Retention of upper prosthesis			0.985
Satisfactory	11 (64.71)	13 (65.00)	
Unsatisfactory	6 (35.29)	7 (35.00)	
Retention of lower prosthesis			0.463
Satisfactory	4 (36.36)	4 (23.53)	
Unsatisfactory	7 (63.64)	13 (76.47)	
Occlusion			0.911
Satisfactory	2 (33.33)	4 (30.77)	
Unsatisfactory	4 (66.67)	9 (69.23)	
Vertical height			0.252
Acceptable	4 (66.67)	5 (38.46)	
Low	2 (33.33)	8 (61.54)	
Defects of upper prosthesis			0.037
Absent	10 (58.82)	5 (25.00)	
Present	7 (41.18)	15 (75.00)	
Defects of lower prosthesis			0.184
Absent	6 (54.55)	5 (29.41)	
Present	5 (45.45)	12 (70.59)	

Data represent frequency (%). PD, Parkinson's disease.

Discussion

This cross-sectional study on oral health of elders with PD revealed similar numbers of remaining teeth, DMFT and OHI between PD and control subjects. Interestingly, PD elders had more negative self-perceptions about their oral health, despite having fewer defects in the upper prostheses than controls.

PD and control subjects had similar age, educational level, monthly income, and prosthesis characteristics. Both groups had few remaining teeth; no group difference was observed. This result may be influenced by the variability of the sample, which included edentulous and partially edentulous elders in both groups. In addition, all of the PD subjects were able to perform their own oral hygiene. Previous studies also found similar numbers of teeth between PD subjects and controls (14), and those authors reported that problems such as missing teeth become more marked in advanced PD. In contrast, Nakayama et al. (13) and Hanaoka and Kashihara (22) found few teeth in PD patients and reported that caries and periodontal disease are frequent complications in this population. These complications were not observed in our study. Since greater severity of PD predisposes individuals to a poorer state of oral health (5), these contrasting results may be due to inclusion of patients with different degrees of PD severity (15, 22).

Regarding to DMFT, no difference was observed between groups in the total DMFT, as well as in their components (decayed, missing and filled teeth), demonstrating the same need for dental treatment in PD and control participants. Previous studies also found similar DMFT values for PD and control subjects (Kennedy et al. 1994). In contradiction, Einarsdóttir et al. (7) found higher DMFT in the PD group than controls, and they justified it because the largely missing teeth in the PD subjects. On the other hand, Fukayo et al. (6) found that DMFT was lower in PD patients because they kept better routine of oral hygiene than control ones, which may explain the difference in results.

In the present study, OHI values were similar between groups, and all participants were considered to have good OHI, similar to the study by Kennedy et al. (23). In contrast, Fukayo et al. (6) observed more frequent tooth brushing and better oral health in PD patients with mild symptoms than in controls, and Müller et al. (5) reported that hospitalized PD patients had poorer OHI compared to controls, which may influence their results and support to explain our contrasting data.

In addition to that PD subjects were able to perform their own oral hygiene in the current study; the salivary flow rate could also help to explain the similarity of OHI values between groups. Salivary flow rate plays an important role in the buffering capacity of the saliva (23), which is essential to maintain oral health due to its protective functions, including flushing plaque and bacteria from oral mucosal and dental surfaces (5). Although PD participants in the current study were receiving levodopa, which can reduce salivary secretion (6), no difference in salivary flow rate was observed between our PD and control elders. Thus,

similar levels of salivary protective functions in PD and control elders could have influenced the good OHI observed in both groups in the current study.

Removable prosthesis conditions showed group differences only in defects of the upper prosthesis, which were greater in controls. These defects were mainly due to wear of artificial teeth and missing/fractured teeth. Although no published studies have evaluated prosthesis conditions in PD patients, Bakke et al. (14) reported impaired masticatory performance in PD patients. Thus, we hypothesize that the higher frequency of artificial teeth wear, and consequently the greater defects of the upper prosthesis observed in controls in the current study, was due to their better masticatory ability.

The GOHAI index showed that PD participants had a more negative self-perception of their oral health than controls. This finding supports previous reports (9, 15), despite the use of different methodologies for this subjective evaluation. Since our PD and control participants had the same need for dental treatment as was observed in the DMFT results, the PD symptoms may contribute for the GOHAI results. PD tremors and rigidity can affect the orofacial musculature, and they may also induce orofacial pain, cracked teeth, and dental attrition (24) and could probably create difficulties in controlling and retaining dentures (25). Thus, the motor symptoms of PD may explain the more negative self-perceptions of oral health in these patients.

The GOHAI usually requires a larger sample size than the current study (17 PD, 20 controls), which could be considered a limitation. However, standardizing by age, educational level, and monthly income improved our confidence levels. Another potential limitation is that oral health parameters deteriorate as PD progresses (5), and PD patients in the current study were not stratified by disease severity (2). However, our PD volunteers had mean of 6.76 years since PD diagnosis, and all of them were able to attend clinical care sessions and perform their own oral hygiene.

In conclusion, this study showed that elderly individuals with PD have similar oral health as elderly individuals without the disease. Although all elders showed few remaining teeth and good OHI, those with PD had more negative self-perceptions of their oral health.

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References

1. Alves G, Forsaa EB, Pedersen KF, Dreetz Gjerstad M, Larsen JP. Epidemiology of Parkinson's disease. J Neurol 2008 Sep;255 Suppl(S5):18–32.
2. Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. Neurology 1967;17(5):427–42.
3. Chaudhuri KR, Odin P, Antonini A, Martinez-Martin P. Parkinson's disease: the non-motor issues. Parkinsonism Relat Disord 2011 Dec;17(10):717–23.
4. Schwarz J, Heimhilger E, Storch A. Increased periodontal pathology in Parkinson's disease. J Neurol 2006;253(5):608–11.
5. Müller T, Palluch R, Jackowski J. Caries and periodontal disease in patients with Parkinson's disease. Spec Care Dentist 2011;31(5):178–81.
6. Fukayo S, Nonaka K, Shimizu T, Yano E. Oral health of patients with Parkinson's disease: factors related to their better dental status. Tohoku J Exp Med 2003;201(3):171–9.
7. Einarsdóttir ER, Gunnsteinsdóttir H, Hallsdóttir MH, Sveinsson S, Jónsdóttir SR, Ólafsson VG, et al. Dental health of patients with Parkinson's disease in Iceland. Spec Care Dent 2009;29(3):123–7.
8. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century--the approach of the WHO Global Oral Health Programme. Community Dent Oral Epidemiol 2003;31 Suppl 1:3–23.
9. McGrath C, Bedi R. The importance of oral health to older people's quality of life. Gerodontology 1999;16(1):59–63.
10. Atchison KA, Dolan TA. Development of the Geriatric Oral Health Assessment Index. J Dent Educ 1990;54(11):680–7.
11. da Silva S, Castellanos Fernandes R. [Self-perception of oral health status by the elderly]. Rev Saude Publica 2001;35(4):349–55.
12. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health 1994;11(1):3–11.
13. Nakayama Y, Washio M, Mori M. Oral health conditions in patients with Parkinson's disease. J Epidemiol 2004;14(5):143–50.
14. Bakke M, Larsen SL, Lautrup C, Karlsborg M. Orofacial function and oral health in patients with Parkinson's disease. Eur J Oral Sci 2011;119(1):27–32.
15. Silva PF da C, Biasotto-Gonzalez DA, Motta LJ, Silva SM, Ferrari RAM, Fernandes KPS, et al. Impact in oral health and the prevalence of temporomandibular disorder in

individuals with Parkinson's disease. J Phys Ther Sci 2015;27(3):887–91.

16. Reichmann H. Clinical criteria for the diagnosis of Parkinson's disease. Neurodegener Dis 2010;7(5):284–90.
17. World Health Organization. Oral health surveys: basic methods. 4th ed. Geneva: World Health Organization; 1997.
18. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J 1975 Dec;25(4):229–35.
19. van der Bilt A. Assessment of mastication with implications for oral rehabilitation: A review. J Oral Rehabil 2011;38(10):754–80.
20. Vigild M. Denture status and need for prosthodontic treatment among institutionalized elderly in Denmark. Community Dent Oral Epidemiol 1987;15:128–33.
21. Silva DD da, de Sousa M da LR, Wada RS. [Self-perception and oral health conditions in an elderly population]. Cad Saude Publica 2005;21(4):1251–9.
22. Hanaoka A, Kashihara K. Increased frequencies of caries, periodontal disease and tooth loss in patients with Parkinson's disease. J Clin Neurosci 2009;16(10):1279–82.
23. Kennedy MA, Rosen S, Paulson GW, Jolly DE, Beck FM. Relationship of oral microflora with oral health status in Parkinson's disease. Spec Care Dentist 1994;14(4):164–8.
24. Dirks SJ, Paunovich ED, Terezhalmy GT, Chiodo LK. The patient with Parkinson's disease. Quintessence Int 2003 May;34(5):379–93.
25. Friedlander AH, Mahler M, Norman KM, Ettinger RL. Parkinson disease: systemic and orofacial manifestations, medical and dental management. J Am Dent Assoc 2009;140(6):658–69.

2.2 Artigo: Removable prostheses hygiene in elders with Parkinson's disease

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Running Title: Prosthesis hygiene in Parkinson disease

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Key Words: Parkinson's disease, dental prosthesis, denture, oral hygiene

Abstract

Objective: To evaluate changes in removable prosthesis hygiene in elders with Parkinson's disease (PD) in response to verbal instructions and positive reinforcement. **Background**: PD may compromise oral hygiene, leading to biofilm accumulation on teeth and prostheses, which can favor opportunistic oral infections. Providing information and positive reinforcement about prosthesis hygiene could improve oral health. **Material and Methods**: A total of 37 elderly individuals with removable prosthesis were divided into two groups: 1) PD participants (n = 17, aged 69.59 ± 5.09 years) and 2) controls (n = 20, aged 72.00 ± 5.69 years). At baseline, the presence of biofilm on prostheses was evaluated using a biofilm-disclosing agent (1% neutral red), and verbal instructions on prosthesis hygiene were given. After 7, 14, and 30 days, the presence of biofilm was re-evaluated, and visible biofilm staining on prostheses was shown to participants coupled with repetition of cleaning instructions. Data were analyzed by t-test, Mann-Whitney U, ANOVA, and Tukey post hoc tests ($p < 0.05$). **Results**: At baseline, PD participants had more biofilm on upper prostheses than controls ($p = 0.009$). However, after 30 days, no group differences were found in biofilm on upper and lower prostheses ($p > 0.05$). Both groups showed a reduction in biofilm accumulation on prostheses over time, but PD participants took longer to show this effect for the lower prosthesis ($p < 0.05$). **Conclusion**: After receiving verbal instructions and positive reinforcement, elderly individuals with and without PD improve prosthesis hygiene. Brazilian Registry of Clinical Trials database: #RBR-3czhsf

Introduction

Parkinson's disease (PD) is one of the most prevalent neurodegenerative conditions (1), and it is expected to impose increasing social and economic burden on society as populations age (2). The prevalence of PD is about 0.5 to 1% among persons aged 65 to 69, increasing to 1 to 3% among persons aged 80 and older (3). PD is caused by the loss of dopamine-producing brain cells, resulting in four primary symptoms: resting tremor; bradykinesia, or slowness of movement; rigidity; and postural instability (4). A diagnosis of parkinsonism requires the presence of at least two of these symptoms, coupled with gradual symptom progression and a sustained response to therapy with levodopa (5). In addition, diagnosis requires that potential causes of secondary parkinsonism have been excluded (2).

As PD symptoms become more pronounced, patients may have difficulty completing simple tasks, such as walking, talking, and performing personal and oral hygiene (6). Impaired oral hygiene may lead to biofilm accumulation on natural teeth and dental prostheses (4,7). Consequently, it has been reported that PD patients have fewer remaining teeth, more caries, and a higher incidence of deep periodontal pockets (8). Furthermore, fewer PD patients clean their dental prosthesis every day compared to subjects without PD (7).

Biofilm accumulation due to inadequate prosthesis hygiene may contribute to microorganism colonization of the intaglio surface of prostheses, engendering opportunistic oral infections (9). These microorganisms can cause development of local and systemic infections, such as denture stomatitis, respiratory airway diseases, bacterial endocarditis, and gastrointestinal infections (10). Thus, careful daily removal of biofilms from the oral cavity and surface of removable prostheses is important to minimize the risk of infections, contribute to good oral and overall systemic health (10), and maintain esthetic and odor-free dentures (11).

Mechanical hygiene (brushing) can efficiently remove accumulated biofilm, but it requires manual dexterity and visual acuity, which are frequently diminished in the elderly (12). Thus, a combination of mechanical and chemical methods (13,14) seems to be a good option for geriatric or handicapped denture wearers (15). Unfortunately, only about half of elderly individuals clean their dentures daily (16), and according to some authors (13), poor denture cleaning may result from negligence of clinicians to inform patients about hygiene methods (13) and failure of patients to remember to perform this task (17).

Because involuntary muscle movements of the hands and/or face may compromise oral and prosthesis hygiene in PD patients, educating patients about prosthesis

hygiene could improve their oral health. Therefore, this study aimed to evaluate whether PD elderly individuals could improve removable prosthesis hygiene after receiving verbal instructions and positive reinforcement.

Material and Methods

Participants were divided into two groups based on the presence or absence of PD. There were 17 PD elders (aged 69.41 ± 4.65) and 20 controls without PD (aged 72.00 ± 5.69). PD participants aged 60 and older were selected from the Brazilian Parkinson's Association "Colibri" (Piracicaba, São Paulo, Brazil), had a PD diagnosis from a neuropsychiatrist based on clinical diagnostic criteria (5,18), and received daily levodopa treatment. PD participants had total or partial edentulism, wore complete dentures (CD) and/or removable partial dentures (RPD) in at least one jaw, and were able to perform daily prosthesis hygiene independently. Individuals using relined or fractured removable prosthesis were excluded. Elders with diseases of aging such as hypertension and/or diabetes were included if symptoms were controlled by medication.

Control participants were selected from friends or relatives of PD participants, as well as from elderly who received prosthetic treatment at Piracicaba Dental School, University of Campinas. Study inclusion criteria for controls were similar to those for PD participants, except controls were required to not have PD, secondary parkinsonism, or other neurodegenerative disorders.

A full explanation of the clinical trial was given to each participant, and written informed consent was received prior to enrollment. The Ethics Committee of the Piracicaba Dental School, University of Campinas (Piracicaba, Brazil) approved the study (protocol # 097/2012).

At baseline, biofilm evaluation was performed on prostheses using a biofilm-disclosing agent (1% neutral red) (19) to identify the presence of biofilm on the upper and/or lower removable prostheses (20). CD and/or RPD were rinsed in running water for 5 seconds to remove food debris. For CDs, 1% neutral red was applied with a swab at eight regions, including four regions on the buccal surface and four regions located on the basal tissue contact surface. For RPDs, 1% neutral red was applied with a swab on the buccal and basal tissue contact surfaces of the major edentulous area. The biofilm present in each region of the CD and/or RPD was scored according to the amount of area covered: 0 = no biofilm; 1 = light biofilm (1-25% of area); 2 = moderate biofilm (26-50%); 3 = heavy biofilm (51-75%); 4 = very heavy biofilm (76-100%) (21). CD biofilm indices were obtained by averaging the eight

scores (21), and RPD biofilm indices were obtained by averaging the scores for the major edentulous area (21,22).

All biofilm evaluations for each subject were performed by one experienced researcher during a single appointment. Prior to study initiation, the researcher was trained by visually inspecting 99 CD pictures, in which biofilm had been stained by 1% neutral red (21). Two visual evaluations of these pictures were carried out at an interval of two weeks. The Kappa index was 0.80, demonstrating very high intra-examiner agreement (23).

After baseline evaluation, elderly participants from both groups received verbal instructions on how to properly clean their prostheses using a combination of mechanical and chemical methods. Mechanical instructions included how to brush all surfaces of the CD and/or RPD (buccal surface; basal tissue contact surface; artificial teeth; clasp, occlusal rest, and minor and major connectors of the RPD) using a denture brush (Condor®, Sao Bento do Sul, Santa Catarina, Brazil) and neutral liquid soap after main meals (breakfast, lunch and dinner) (14,15). It was also emphasized that prosthesis hygiene should be performed over a washbasin (14) filled with several inches of water to minimize the possibility of damaging a dropped denture (11,24). Before reinserting prostheses in the mouth, it was recommended they be rinsed in running water (14) and the tongue and remaining natural teeth be brushed with a toothbrush and fluoride toothpaste. Chemical cleaning instructions included immersing prostheses in bleach (sodium hypochlorite), diluted 1:10 in water (11) for 10 min once a week. Participants were instructed to create the bleach solution by dissolving one tablespoon (15 ml) of household bleach in 150 ml of water.

After 7, 14, and 30 days, the presence of biofilm on prostheses was re-evaluated, and positive reinforcement was given. A positive reinforcer is defined as a reward (26) that is separable from the behavior itself and that increases the likelihood that the behavior will be performed (25). In this case, the reward was verbal praise accompanied by information: participants received feedback on their oral hygiene when they viewed their prostheses stained with biofilm disclosing-agent and received verbal instructions for oral hygiene at each evaluation. While conveying feedback, researcher expressed emotion as part of the positive reinforcement or, if participants did not improve prostheses hygiene, it was given verbal stimulation in order to make it better.

Statistical analysis

Data were evaluated using SAS 9.3 (SAS Institute Inc., SAS Campus Drive, Cary, North Carolina, USA). Data were first analyzed using Shapiro-Wilk to test for normal distribution, then comparisons between groups were carried out using *t*-tests. Data obtained

after 7, 14, and 30 days did not meet parametric analysis assumptions and were subjected to Mann-Whitney U tests. ANOVA and Tukey post hoc tests were used to compare the presence of biofilm across time for both groups. The significance level was set at 5%.

Results

Table 1 shows demographic information for PD participants and controls, including age, gender, type of prostheses, prosthesis age, and oral hygiene habits for each group. As shown in Table 2, at baseline, PD participants had more biofilm on their upper prostheses than controls ($p = 0.009$). In contrast, there was no difference ($p = 0.194$) for the lower prostheses. Greater biofilm continued to be observed on upper prostheses of PD participants at 7 days ($p = 0.009$) and 14 days ($p = 0.008$). Greater biofilm was observed on the lower prostheses of PD participants only at 7 days ($p = 0.042$). After 30 days, no group differences in the presence of the biofilm were observed for the upper ($p = 0.092$) or lower prostheses ($p = 0.306$).

Over time, both groups showed a significant reduction ($p < 0.05$) in the presence of biofilm on prostheses. Controls showed improvement for upper and lower prostheses by 7 days, which was maintained through 30 days. PD participants showed improvement for the upper prostheses by 7 days, which was maintained for 30 days. Improvement for the lower prostheses in PD participants only became significant at 14 days but was maintained at 30 days.

Table 1. Sociodemographic and prosthesis characteristics of PD participants and controls.

Characteristics	PD (n = 17)	Control (n = 20)
Age	69.41 ± 4.65	72.00 ± 5.69
Gender		
Male	9 (52.94)	10 (50.00)
Female	8 (47.06)	10 (50.00)
Educational level (year)	7.94 ±5.66	4.48 ±3.50
Monthly income (real minimum wage)	2.84 ±1.29	2.65 ±2.31
Upper prosthesis	17 (100.00)	20 (100.00)
CD	11 (64.70)	18 (90.00)
RPD	6 (35.30)	02 (10.00)
Lower prosthesis	9 (52.94)	17 (85.00)
CD	6 (66.67)	13 (76.47)
RPD	3 (33.33)	04 (23.53)
Prosthesis age (years)		
Upper	9.44 (10.25)	12.71 (13.84)
Lower	7.94 (6.52)	11.78 (11.18)
Prosthesis hygiene habits		
Brushing only	16.00 (94.12)	17.00 (85.00)
Brushing and soaking	1.00 (5.88)	3.00 (15.00)

Data represent mean ± standard deviation or frequency (%). CD, complete denture; PD, Parkinson's disease; RPD, removable partial denture.

Table 2. Presence of biofilm on the upper and lower dental prosthesis in PD participants and controls over time.

Groups	Baseline	7 days	14 days	30 days
PD				
Upper	2.66 ± 0.89 Aa	1.35 ± 0.84 Ab	1.04 ± 0.91 Ab	0.94 ± 1.04 Ab
Lower	2.51 ± 0.98 Aa	1.54 ± 1.03 Aa	1.03 ± 0.78 Ab	0.92 ± 1.29 Ab
Control				
Upper	1.70 ± 1.19 Ba	0.65 ± 0.80 Bb	0.41 ± 0.64 Bb	0.28 ± 0.42 Ab
Lower	1.89 ± 1.18 Aa	0.59 ± 0.76 Bb	0.53 ± 0.79 Ab	0.23 ± 0.34 Ab

Data represent means ± standard deviations. Distinct uppercase letters indicate differences between groups for upper and lower prosthesis ($p < 0.05$) by *t*-test or Mann-Whitney U test. Distinct lowercase letters indicate differences among time points ($p < 0.05$) by ANOVA and Tukey post hoc test ($p < 0.05$). PD, Parkinson's disease.

Discussion

To our knowledge, this cross-sectional study is the first to evaluate changes in removable prosthesis hygiene in PD participants in response to verbal instructions and positive reinforcement. For upper and lower prostheses, PD participants showed improvement relative to baseline by 7 and 14 days, respectively, and they achieved similar biofilm reduction to controls within 30 days. Thus, PD participants were able to improve prosthesis hygiene in response to intervention.

Controls also showed reductions in the presence of biofilm on the upper and lower prostheses in response to intervention. It is interesting that controls showed improvement on both prostheses after 7 days, while PD participants only showed improvement on the upper prosthesis by 7 days, requiring 14 days to show improvement on the lower prosthesis. This may have been due to the smaller extension of the lower prosthesis surface, which could have been more difficult for PD participants to handle and clean due to their motor impairments (4).

Previous surveys (27,28) have found reduced biofilm scores 7 days after providing hygiene instructions for CD of elderly individuals (27) and RPD of adults (28). However, these individuals had no neurodegenerative disease. There are few reports about prosthesis hygiene in PD patients (6,7), and none have investigated the ability of PD patients to clean prostheses by themselves. Nakayama et al. (7) verified that few PD patients cleaned

their own dentures daily, and some authors (6) have recommended the use of denture cleansers for PD patients.

The present study recommended both brushing and hypochlorite soaking, since combined physical and chemical methods have been reported to provide the best prosthesis cleaning (13,14). The methodology prevents determination of the relative effects of brushing versus weekly use of hypochlorite. However, we believed that it was crucial to reinforce daily brushing at each time point, since most participants did not have this habit at baseline (Table 1). The most important prerequisite for behavior change is the conviction that one can successfully execute the behavior required to produce the desired outcome (26). Participants in this study were positively engaged and responsive, and positive reinforcement of their abilities probably stimulated them to clean their prosthesis adequately. Similarly, Ribeiro et al. (28) observed that RPD wearers were capable of being motivated to maintain a high level of hygiene with careful oral and denture hygiene programs.

Our study only assessed biofilm accumulation over the artificial teeth and acrylic resin of the CD and/or RPD (21,22), not over the metallic components of the RPD. However, it must be emphasized that hygiene instructions were similar for CD and RPD and included brushing not only artificial teeth and acrylic resin, but also all of the RPD metallic components. The importance of giving instructions about cleaning these components was reported by Cakan et al. (17), who found that clasps and connectors were the most difficult parts of RPDs to clean.

It is important to emphasize that this study had a cross-sectional design, including a relatively short 30-day period to evaluate prosthesis hygiene, and previous studies (29) have stated that a greater benefit in denture hygiene would be expected at shorter periods, such as 14 days. In addition, we did not stratify our PD participants according to disease severity (30), which may have resulted in a greater heterogeneity of motor symptoms (31). However, all participants were required to be able to perform daily prosthesis hygiene independently. In addition, it was not carried out evaluation of the dental hygiene in the current study, requiring further study for this assessment. Despite these limitations, this study demonstrated that PD elders are able to adequately clean their removable prosthesis independently in response to instructions.

Conclusion

Similar to healthy participants, PD elderly individuals were able to reduce the presence of biofilm on removable prostheses in response to verbal instructions and positive reinforcement.

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References

1. Pringsheim T, Jette N, Frolkis A, Steeves TDL. The prevalence of Parkinson's disease: A systematic review and meta-analysis. Mov Disord 2014; 29(13): 1583-1590.
2. de Lau LM, Breteler MM. Epidemiology of Parkinson's disease. Lancet Neurol 2006; 5(6): 525-535.
3. Nussbaum RL, Ellis CE. Alzheimer's disease and Parkinson's disease. N Engl J Med 2003; 348(14): 1356-1364.
4. Friedlander AH, Mahler M, Norman KM, Ettinger RL. Parkinson disease: Systemic and orofacial manifestations, medical and dental management. J Am Dent Assoc 2009; 140(6): 658-669.
5. Gazewood JD, Richards DR, Clebak K. Parkinson disease: An update. Am Fam Physician 2013; 87(4): 267-273.
6. Rajeswari CL. Prosthodontic considerations in Parkinson's disease. People's J Sci Res 2010; 3: 2-4.
7. Nakayama Y, Washio M, Mori M. Oral health conditions in patients with Parkinson's disease. J Epidemiol 2004; 14(5): 143-150.
8. Hanaoka A, Kashihara K. Increased frequencies of caries, periodontal disease and tooth loss in patients with Parkinson's disease. J Clin Neurosci 2009; 16(10): 1279-1282.
9. Emami E, Séguin J, Rompré PH, de Koninck L, de Grandmont P, Barbeau J. The relationship of myceliated colonies of Candida albicans with denture stomatitis: An in vivo/in vitro study. Int J Prosthodont 2007; 20(5): 514-520.
10. de Sousa Porta SR, de Lucena-Ferreira SC, da Silva WJ, Del Bel Cury AA. Evaluation of sodium hypochlorite as a denture cleanser: a clinical study. Gerodontology. 2013 [Epub ahead of print].

11. Shay K. Denture hygiene: A review and update. J Contemp Dent Pract 2000;1(2): 28-41.
12. Odman PA. The effectiveness of an enzyme-containing denture cleanser. Quintessence Int 1992; 23(3): 187-190.
13. Kanli A, Demirel F, Sezgin Y. Oral candidosis, denture cleanliness and hygiene habits in an elderly population. Aging Clin Exp Res 2005; 17(6): 502-507.
14. Paranhos HFO, Silva-Lovato CH, Souza RF, Cruz PC, Freitas KM, Peracini A. Effects of mechanical and chemical methods on denture biofilm accumulation. J Oral Rehabil 2007; 34(8): 606-612.
15. Budtz-Jørgensen E. Materials and methods for cleaning dentures. J Prosthet Dent 1979; 42(6): 619-623.
16. Saha A, Dutta S, Varghese RK, Kharsan V, Agrawal A. A survey assessing modes of maintaining denture hygiene among elderly patients. J Int Soc Prev Community Dent 2014; 4(3): 145-148.
17. Cakan U, Yuzbasioglu E, Kurt H, Kara HB, Turunç R, Akbulut A, et al. Assessment of hygiene habits and attitudes among removable partial denture wearers in a university hospital. Niger J Clin Pract 2015; 18(4): 511-515.
18. Reichmann H. Clinical criteria for the diagnosis of Parkinson's disease. Neurodegener Dis 2010; 7(5): 284-290.
19. Silva CHL da, Paranhos H de FO, Ito IY. Biofilm disclosing agents in complete denture: Clinical and antimicrobial evaluation. Pesqui Odontol Bras 2002; 16(3): 270-275.
20. Paranhos HF, da Silva CH, Venezian GC, Macedo LD, de Souza RF. Distribution of biofilm on internal and external surfaces of upper complete dentures: The effect of hygiene instruction. Gerodontology 2007; 24(3): 162-168.
21. Augsburger RH, Elahi JM. Evaluation of seven proprietary denture cleansers. J Prosthet Dent 1982; 47(4): 356-359.
22. Ribeiro GR, Costa JLR, Bovi Ambrosano GM, Rodrigues Garcia RCM. Oral health of the elderly with Alzheimer's disease. Oral Surg Oral Med Oral Pathol Oral Radiol 2012; 114(3): 338-343.
23. Sumi Y, Kagami H, Ohtsuka Y, Kakinoki Y, Haruguchi Y, Miyamoto H. High correlation between the bacterial species in denture plaque and pharyngeal microflora. Gerodontology 2003; 20(2): 84-87.
24. Jagger DC, Harrison A. Denture cleansing--the best approach. Br Dent J 1995; 178(11): 413-417.

25. Ryan RM, Lynch MF, Vansteenkiste M, Deci EL. Motivation and autonomy in counseling, psychotherapy, and behavior change: A look at theory and practice. Couns Psychol 2011; 39(2): 193-260.
26. Institute of Medicine (US) Committee on Health and Behavior: Research, Practice, and Policy. Individuals and Families: Models and Interventions. In: Health and Behavior: The Interplay of Biological, Behavioral, and Societal Influences. Washington, D.C.: National Academies Press, 2001: 183-240.
27. Sheen SR, Harrison A. Assessment of plaque prevention on dentures using an experimental cleanser. J Prosthet Dent 2000; 84(6): 594-601.
28. Ribeiro DG, Pavarina AC, Giampaolo ET, MacHado AL, Jorge JH, Sasso Garcia PPN. Effect of oral hygiene education and motivation on removable partial denture wearers longitudinal study. Gerodontology 2009; 26(2): 150-156.
29. Souza RF, Regis RR, Nascimento C, Paranhos HFO, Silva CHL. Domestic use of a disclosing solution for denture hygiene: A randomised trial. Gerodontology 2010; 27(3): 193-198.
30. Hoehn MM, Yahr MD. Parkinsonism: Onset, progression and mortality. Neurology 1967; 17(5): 427-442.
31. Movement Disorder Society Task Force on Rating Scales for Parkinson's Disease. The Unified Parkinson’s Disease Rating Scale (UPDRS): Status and recommendations. Mov Disord 2003; 18(7): 738-750.

2.3 Artigo: Parkinson's disease impairs masticatory function

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Abstract

Objective: To evaluate masticatory function in individuals with PD during levodopa "on" period using new removable dental prosthesis. *Materials and Methods:* A total of 34 elderly individuals with PD (n = 17, mean age = 69.41 ± 4.65 years) or without PD (n = 17, mean age = 70.71 ± 4.65 years) were recruited for this study. Participants received new complete dentures and/or removable partial dentures. Two months after subjects were free of any prostheses discomfort, masticatory function was assessed. A kinesiographic device was used to measure the range of jaw motion and jaw movements while chewing a silicone test material (Optocal). Masticatory performance was determined by median particle size (X_{50}) of the Optocal after 40 masticatory cycles. Maximum bite force was assessed by a strain sensor placed in the bilateral first molar regions. Data were analyzed by t-test ($P < 0.05$). *Results:* The PD group showed a decreased range of jaw motion, longer duration and slower velocity of the masticatory cycle ($P < 0.05$), higher X_{50} value, and lower maximum bite force ($P < 0.05$). *Conclusion:* PD patients have impaired masticatory function during levodopa "on" period compared to controls. *Clinical Relevance*: Knowledge that PD is associated with impaired masticatory function is important to dental professionals in decision making related to prosthetics and general dental treatment.

Key words: Parkinson disease, dental prosthesis, mastication, jaw movements

Introduction

Mastication is the first stage of digestion, which consists of an intermittent rhythmic process in which the tongue, face, and jaw muscles act in coordination to position the food between the teeth, chop it, and then prepare it for swallowing (1). All these steps are controlled by the brain stem, which is the only part of the central nervous system considered essential for mastication (1). The brain stem contains the central pattern generator (CPG), which is responsible for generation of basic jaw rhythmic activity (2). Thus, mastication problems may occur not only due to missing teeth or malfunction of the jaws and/or jaw joints and muscles, but also due to neurological problems (2).

Neurological disorders, such as Parkinson's Disease (PD), may also cause chewing problems (3). PD involves progressive loss of dopamine-producing brain cells within the substantia nigra (3). This results in four primary motor symptoms: resting tremor, bradykinesia or slowness of movement, rigidity, and postural instability (3). These symptoms may lead to numerous orofacial manifestations, such as lack of facial expression with a characteristic "masklike" face; reduced blink rate; tremors in the forehead, eyelids, lip, and tongue musculature; and involuntary mandibular movements (3). Previous studies suggest that parkinsonism does not alter just one type of jaw movement, but affects several variables of voluntary and automatic movement (4). Moreover, difficulty in swallowing (dysphagia) is common in PD due to pharyngeal motor deficits (3).

A diagnosis of parkinsonism requires the presence of at least two of the four primary motor symptoms described above, coupled with gradual symptom progression and a sustained response to levodopa therapy (5). Long-term administration of levodopa results in 50-75% of patients becoming partially unresponsive to the medication, experiencing symptom fluctuations between "on" periods of good motor function and "off" periods of severe immobility (3). Moreover, patients also may develop levodopa-induced dyskinesia and dystonia, which can affect the tongue and muscles of mastication and, when combined with chewing and swallowing problems, may result in weight loss, reducing quality of life (3).

Previous studies (4, 6) that assessed mandibular movements during chewing in PD patients showed that levodopa increased chewing cycle duration and opening and closing velocities during chewing of peanuts (6). During the off period, PD patients had lower amplitude and velocity than controls during jaw opening and closing, showing aberrant patterns and low EMG amplitude during jaw clenching (4). However, one of these studies did not consider the number of residual teeth and/or functional tooth units (4), and teeth (7),

coupled with bite force and salivary flow rate (2), are considered the key determinants of masticatory performance in older adults (8).

On the other hand, Bakke et al. (9) reported decreased masticatory performance of PD patients, measured by the change in weight of chewing gum, after mastication for 2 minutes. Although these authors recorded the number of natural teeth and presence of prostheses, they did not consider the condition of the prostheses, such as retention and stability, which are known to influence masticatory function (10). For PD patients, loss of neuromuscular control must be considered a major contributory factor in the loss of stability of complete dentures (11). Previous studies (11, 12) reported that PD patients have chewing difficulties, denture discomfort (12), and problems such as loose dentures and poor denture control (11). Impaired masticatory performance (9), coupled with denture-related problems, may compound the existing difficulties that PD patients have in eating and swallowing (13).

A substantial percentage of older individuals lose teeth, resulting in impaired masticatory function later in life (8), and most of them have their missing teeth replaced by fixed or removable prosthodontic appliances (14). However, comprehensive studies on masticatory function of elderly individuals with PD are lacking. Thus, this study evaluated masticatory function in PD patients during levodopa “on” period after insertion of new removable dental prostheses.

Materials and Methods

Design

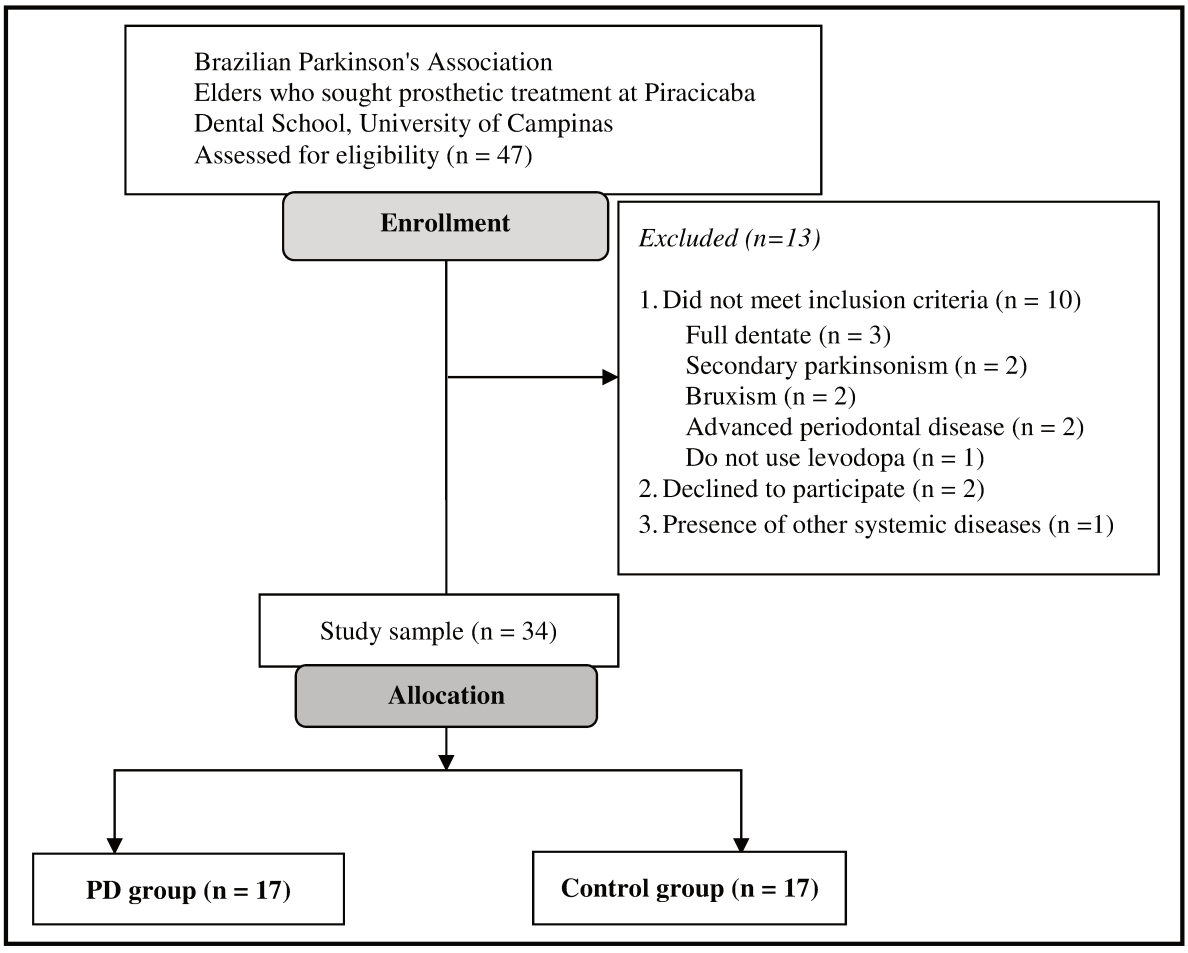
This cross-sectional study evaluated the range of jaw motion, chewing movements, masticatory performance, and maximum bite force (dependent variables) in elderly patients with or without PD (independent variable). Participants first received general dental treatment, and new complete dentures (CD) and/or removable partial dentures (RPD) were inserted. Two months after subjects were free of any discomfort from their new prostheses, dependent variables were evaluated. Study participation was completely voluntary, and subjects signed an informed consent document. The local ethics committee of Piracicaba Dental School, University of Campinas approved the research protocol (#097/2012). The study was also registered in the Brazilian Registry of Clinical Trials (#RBR-3czhsf), which is linked to the International Clinical Trials Registration Platform (ICTRP/World Health Organization).

Subjects

PD patients were recruited from the Brazilian Parkinson's Association (Piracicaba, São Paulo, Brazil), and elderly individuals without PD were recruited from the dental clinic of Piracicaba Dental School, University of Campinas. To be included, individuals had to be elderly, edentulous or partially edentulous, using or not unsatisfactory complete dentures (CD) and/or removable partial dentures (RPD) according to Vigild's criteria (15). Individuals were excluded if they had dementia, secondary parkinsonism, or other neurodegenerative disorders besides PD; bruxism; symptoms of temporomandibular disorders; and/or advanced periodontal disease. Participants presenting with other diseases of aging that were controlled by medication, such as hypertension and/or diabetes, were accepted. An effort was made to match PD and control subjects by their prosthesis needs: both groups received CD and/or RPD in both jaws.

A total of 47 subjects were screened, and 17 subjects each were selected for the PD and control groups (Figure 1). PD was diagnosed by a neuropsychiatrist using clinical diagnostic criteria (5, 16), and all PD subjects received daily levodopa treatment. Table 1 shows demographic data, including time since PD diagnosis, age, gender, educational level, monthly income, dental prosthesis type, number of teeth in partially dentate volunteers, and stimulated salivary flow rate (2).

Figure 1. Flowchart of recruitment.



Prosthetic Treatment

All study participants received a general dental treatment addressing their individual needs, including periodontal and dental care for their remaining teeth. To standardize prosthetic and oral status, all volunteers received new maxillary and mandibular removable dentures. New CD and/or RPD were prepared with acrylic resin according to conventional techniques (17, 18) by one dental technician. Cobalt-chromium (Co-Cr) alloy (Degussa-Hüls AG, Hanau, Germany) was used to process RPD frameworks, which included a major connector, rests, and clasps designed for the supporting tissues and remaining teeth of each participant. 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 removable prostheses, the range of jaw motion, chewing movements, masticatory performance and maximum bite force were evaluated. PD participants were evaluated in the morning, one hour

after ingestion of levodopa ("on" period). Control participants were also evaluated in the morning.

Range of jaw motion and chewing movements

Mandibular movements were evaluated using a jaw-tracking kinesiograph device (JT-3D; BioResearch, Milwaukee, WI, USA) to assess range of jaw motion and chewing movements. Subjects were seated comfortably in a dental chair with the Frankfort plane parallel to the ground. A small magnet was temporarily attached to the mandibular natural or artificial 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 frontal, horizontal, and sagittal planes.

Range of jaw motion was evaluated by first asking the subject to keep the teeth in maximum intercuspal position. Next, subjects were requested to perform maximum opening, right and left lateral movements, and protrusion. The range of these movements was measured in the frontal (maximum opening and lateral movements), horizontal (maximum lateral movements), and sagittal planes (anteroposterior movement).

Chewing movements were evaluated during mastication of Optocal, an artificial chewable material used for masticatory tests (19). Optocal was prepared by mixing 58.3% of condensation silicone (Optosil Comfort; Heraeus Kulzer GmbH & Co) with 7.5% of conventional toothpaste (Colgate-Palmolive Co), 11.5% of solid vaseline (Pharmaceutical Industry Rioquímica Ltd), 10.2% of common powder of dental plaster (Empresa e Indústria Gesso Mossoró SA), 12.5% of irreversible hydrocolloid powder (Jeltrate, Dentsply Intl), and 4% of catalyst paste (Universal; Heraeus Kulzer GmbH & Co) (19, 20). After mixing, cubes of Optocal measuring 5.6 mm on each edge were prepared in metal molds and completely polymerized in an oven for 16 hours at 65 °C (21).

A portion of 17 cubes (approximately 3.7 g) of Optocal was placed on the tongue, and subjects were instructed to keep their teeth together in the maximum intercuspal position, until the start signal to begin mastication was given by the researcher. After 40 masticatory cycles (20), counted by a single researcher, participants were asked to stop masticating and expectorate the triturated material on a paper filter by repeated mouth rinses using 200 mL of tap water. The custom computer program BioPack (BioResearch; SAS Institute, Cary, NC, USA) was used to analyze the following parameters: opening, closing, and occlusal phase times; total masticatory cycle time; opening and closing maximum velocities; and opening

and closing angles (frontal plane) (22). The first masticatory cycle was discarded because it involves the initial positioning of the test material over the teeth (23).

Masticatory performance

Masticatory performance was evaluated using a sieving procedure. After subjects expectorated the comminuted particles on a paper filter, they were dried at room temperature for 1 week, then vibrated in a sieving machine (Bertel Indústria Metalúrgica, Caieiras, Brazil), using a sieve stack ranging from 5.6 to 0.5 mm mesh. Materials retained on each sieve and in the bottom plate were weighed on a 0.001 g analytical balance (Mark; BEL Engineering, Milan, Italy). Masticatory performance was determined by median particle size (X_{50}), calculated using the Rosin-Rammler cumulative function (20). The median particle size (X_{50}) is the aperture of a theoretical sieve through which 50% of the test food particles can pass by weight (20). Optocal was used to determine the X_{50} because this material allows standardization of weight, size, and shape of particles using the sieve method (19).

Maximum bite force

Maximum bite force was measured using a bite force transducer (Spider 8; Hottinger Baldwin Messtechnik GmbH, Darmstadt, Germany). Sensors (FSR no. 151) with 12.7 mm diameter and 0.25 mm thickness (Interlink Electronics Inc., Camarillo, California, USA) were protected from moisture and deformities during clenching using metal disks of 0.7 mm in thickness, held by a plastic film. Thus, the total thickness of the sensor assembly was 2.25 mm (24). Sensors were placed in the bilateral first molar regions, and subjects were requested to occlude with maximum force for 7 seconds on right and left sides together. The procedure was repeated after five minutes. Signals were recorded and analyzed by Catman Easy software (version 1.0; Hottinger Baldwin Messtechnik GmbH, Darmstadt, Germany). Maximum bite force was calculated as the sum of the maximum values from both sides (24, 25).

Statistical analysis

Data were evaluated using SAS 9.3 (SAS Institute Inc., SAS Campus Drive, Cary, North Carolina, USA). Exploratory analysis using the Shapiro-Wilk test showed that data were normally distributed. Sociodemographic and oral characteristics, such as age, educational level, monthly income, number of teeth, and salivary flow rate, were analyzed using t-tests. Analyses of gender and prosthesis type were performed using χ^2 tests. Range of

jaw motion, chewing movements, masticatory performance (X_{50}), and maximum bite force were analyzed using t-tests for comparisons between groups. P values were set at 0.05 for statistical significance.

Results

PD and control groups were similar across age, gender, and monthly income, but had different educational levels (Table 1). They had similar types of removable prostheses, natural teeth, and salivary flow rates (Table1).

Compared to controls, all parameters for the range of jaw motion were lower ($P < 0.05$) in the PD group (Table 2). PD subjects showed longer cycle times for opening, closing, occlusal phase, and total mastication, and slower opening and closing velocities during Optocal mastication ($P < 0.05$) (Table 3). However, no group differences were observed in opening and closing angles ($P > 0.05$) (Table 3). Compared to elderly controls, PD patients had higher mean X_{50} values ($P < 0.05$), indicating impaired mastication of the test material (Table 4). Finally, maximum bite force values were decreased in PD subjects (Table 4).

Table 1. Sociodemographic and prosthesis characteristics.

Characteristics	PD (n = 17)	Control (n = 17)	*P*
Time since PD diagnosis	6.76 (± 3.80)	N/A	-
Age	69.41 (± 4.65)	70.71 (± 4.65)	0.4230
Gender			0.7300
Male	9 (52.94)	10 (58.82)	
Female	8 (47.06)	7 (41.18)	
Monthly income (BRL min wage)	2.84 (± 1.29)	2.64 (± 2.21)	0.7510
Educational level, years	7.94 (± 5.66)*	4.23 (± 3.43)	0.0354
Prostheses type			0.3150
CD in both jaws	6 (35.29)	9 (52.94)	
Upper CD and lower RPD	4 (23.53)	5 (29.41)	
RPD in both jaws	7 (41.18)	3 (17.65)	
Natural teeth	10.00 (± 5.23)	8.20 (± 4.09)	0.5150
Salivary flow rate (g/min)	0.77 (± 0.55)	1.00 (± 0.68)	0.2959

Data represent mean (± SD) or number (percentage). PD, Parkinson's disease; BRL, Brazilian real; CD, Complete Denture; RPD, Removable Partial Denture. *$P < 0.05$ compared to controls.

Table 2. Range of jaw motion.

Range of motion (mm)	PD	Control	*P*
Frontal plane			
Maximum opening	21.86 (± 12.72)*	34.79 (± 8.62)	0.0015
Lateral deviation	2.75 (± 2.85)*	6.73 (± 4.04)	0.0023
Sagittal plane			
Anteroposterior (protrusion)	18.94 (± 13.44)*	31.71 (± 8.38)	0.0022
Horizontal plane			
Maximum lateral left	7.53 (± 6.20)*	11.44 (± 4.83)	0.0488
Maximum lateral right	4.22 (± 2.98)*	12.56 (± 6.44)	< 0.0001

Data represent mean (± SD). *$P < 0.05$ compared to controls.

Table 3. Chewing movements.

Chewing movements	PD	Control	*P*
Opening time (ms)	237.10 (± 50.09)*	195.90 (± 33.28)	0.0081
Closing time (ms)	348.20 (± 93.23)*	262.60 (± 64.44)	0.0039
Occlusal phase time (ms)	207.70 (± 86.46)*	142.30 (± 36.43)	0.0089
Masticatory cycle time (ms)	766.50 (± 163.60)*	614.90 (± 104.40)	0.0029
Maximum open velocity (mm/s)	92.31 (± 33.04)*	143.20 (± 47.96)	0.0021
Maximum closing velocity (mm/s)	68.90 (± 25.50)*	112.70 (± 40.57)	0.0014
Opening angle (frontal plane)	87.68 (± 21.16)	86.49 (± 15.73)	0.8540
Closing angle (frontal plane)	87.60 (± 30.77)	90.90 (± 32.54)	0.7630

Data represent mean (± SD). *$P < 0.05$ compared to controls.

Table 4. Masticatory performance (X_{50}) and maximum bite force.

	PD	Control	*P*
X_{50} (mm)	5.69 (0.97)*	4.24 (1.13)	0.0003
Maximum bite force (N)	89.80 (25.50)*	157.90 (77.10)	0.0016

Data represent mean (± SD). *$P < 0.05$ compared to controls.

Discussion

This study evaluated masticatory function in elderly individuals with PD during the levodopa on period after insertion of new removable dental prostheses. Compared to controls, elderly individuals with PD had decreased range of jaw motion, chewing movements, X_{50} value, and maximum bite force, indicating impaired masticatory function.

Age, gender, number of teeth, occlusal contact area, sensory feedback, and oral motor function are known to influence masticatory function (2). Thus, PD and control participants in this study were age-and gender-matched, and oral conditions were assessed, including type of removable prostheses, presence of natural teeth, and salivary flow rate. As expected, no significant group differences were found for these factors. However, socio-economic background is known to influence oral health in elderly individuals (26), and our PD subjects had a higher educational level than controls. This difference did not influence the number of teeth or type of removable prosthesis, probably because we endeavored to match groups on these oral characteristics to minimize bias in the masticatory function assessment.

Our data on range of jaw motion are in agreement with previous authors (4, 9), who showed reduced vertical opening and lateral amplitudes of jaw movements in PD subjects. PD per se could explain these results because of rigidity and bradykinesia (3), which cause an increase in muscle tone, including slow, jerky movements (27). Initiation of voluntary movement is difficult or impossible in PD patients, and this hypokinesia regularly affects the oro-facial-pharyngeal muscles, leading to problems with speech, chewing, and swallowing (27), which could also explain the decreased jaw movement amplitude.

On the other hand, although our data on reduced chewing movements in PD support Robertson & Hammerstad (4), they are in contrast to the study by Karlsson et al. (6), which showed lower cycle times and faster velocities during chewing for PD subjects. Unlike our study, Karlsson et al. used peanuts as the test food, used an optoelectronic method to evaluate mandibular movements, and did not report whether subjects were partially edentulous and/or used removable prostheses. Thus, considering that the type, number, and size of the food influences mastication (28), and that teeth and periodontal mechanoreceptors are important for spatial control of chewing (29), differences in test material and occlusal status of subjects could explain these different results.

PD patients showed higher X_{50} values in this study, indicating impaired masticatory performance. A previous study by Bakke et al.(9) found similar results, although they assessed masticatory performance using the weight loss of gum. PD patients may have reduced tongue movement (3), hindering the transport of food from the incisor region to the

left or right occlusal region during chewing (30) with consequent loss of bolus formation (3). This could explain the current results. In addition, the masticatory deficit in patients with PD is thought to be at least partially due to hypokinesia, but not much is known about its underlying mechanisms and pathophysiology (30). It remains unclear whether this impairment is caused simply by decreased motor speed (bradykinesia), changes in masticatory rhythm, or has a more complex basis (30). Furthermore, PD patients have eating difficulties and dysphagia (31), and this deficit in masticatory performance may further impair swallowing and could even have a negative effect on digestion (32).

Masticatory performance can be also influenced by bite force (7, 33) or how forcefully a subject can clench the teeth together. Bite force is an index of the amount of muscle activity (25), and maximum bite force values were lower for PD subjects in the current study. Bite force may be decreased by PD or as a direct effect of age on muscle strength (2). Since PD participants were compared to age-matched controls in this study, we hypothesize that motor impairments in the jaw elevator muscles were responsible for the observed decrease in bite force.

The mandibular movements during Optocal chewing and bite force values obtained from the control group were in agreement with previous studies (22, 32). The X_{50} values of our controls were higher than those found by Slagter et al. (20). However, they evaluated adults as well as elderly individuals and had a small number of participants, which could explain this difference.

It is important to mention that, although the time of PD diagnosis was collected, PD participants were not stratified by disease severity (34), which may have resulted in heterogeneity of motor symptoms (35). However, none of the PD participants were in Hoehn & Yahr stage V, which is clinically characterized by confinement to bed or a wheelchair unless aided (34). Furthermore, masticatory function was evaluated during the levodopa on period, which should be the period of the best motor function in PD patients (3). Levodopa increases dopamine transmission, which modulates CPG output and thereby affects trigeminal output to the jaw muscles (6).

Conclusion

PD patients have impaired masticatory function during levodopa “on” periods compared to controls.

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Ethical Approval

All procedures were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

1. Lund JP. Mastication and its control by the brain stem. Crit Rev Oral Biol Med. 1991;2(1):33–64.
2. van der Bilt A. Assessment of mastication with implications for oral rehabilitation: A review. J Oral Rehabil. 2011;38(10):754–80.
3. Friedlander AH, Mahler M, Norman KM, Ettinger RL. Parkinson disease: systemic and orofacial manifestations, medical and dental management. J Am Dent Assoc. 2009;140(6):658–69.
4. Robertson LT, Hammerstad JP. Jaw movement dysfunction related to Parkinson's disease and partially modified by levodopa. J Neurol Neurosurg Psychiatry. 1996;60(1):41–50.
5. Gazewood JD, Richards DR, Clebak K. Parkinson disease: An update. Am Fam Physician. 2013;87(4):267–73.
6. Karlsson S, Persson M, Johnels B. Levodopa induced ON-OFF motor fluctuations in Parkinson ' s disease related to rhythmical masticatory aw movements. J Neurol Neurosurg Psychiatry. 1992;55:304–7.
7. Hatch JP, Shinkai RS a, Sakai S, Rugh JD, Paunovich ED. Determinants of masticatory performance in dentate adults. Arch Oral Biol. 2001;46(7):641–8.
8. Ikebe K, Matsuda K, Kagawa R, Enoki K, Okada T, Yoshida M, et al. Masticatory

performance in older subjects with varying degrees of tooth loss. J Dent [Internet]. Elsevier Ltd; 2012;40(1):71–6. Available from: http://dx.doi.org/10.1016/j.jdent.2011.10.007

9. Bakke M, Larsen SL, Lautrup C, Karlsborg M. Orofacial function and oral health in patients with Parkinson's disease. Eur J Oral Sci. 2011;119(1):27–32.
10. Liedberg B, Norlén P, Owall B, Stoltze K. Masticatory and nutritional aspects on fixed and removable partial dentures. Clin Oral Investig. 2004;8(1):11–7.
11. Clifford T, Finnerty J. The dental awareness and needs of a Parkinson's disease population. Gerodontology. 1995;12(2):99–103.
12. Nakayama Y, Washio M, Mori M. Oral health conditions in patients with Parkinson's disease. J Epidemiol. 2004;14(5):143–50.
13. Lorefält B, Granérus AK, Unosson M. Avoidance of solid food in weight losing older patients with Parkinson's disease. J Clin Nurs. 2006;15(11):1404–12.
14. van der Bilt A, Olthoff LW, Bosman F, Oosterhaven SP. Chewing performance before and after rehabilitation of post-canine teeth in man. J Dent Res. 1994 Nov;73(11):1677–83.
15. Vigild M. Denture status and need for prosthodontic treatment among institutionalized elderly in Denmark. Community Dent Oral Epidemiol. 1987;15:128–33.
16. Reichmann H. Clinical criteria for the diagnosis of Parkinson's disease. Neurodegener Dis. 2010;7(5):284–90.
17. Zarb GA, Hobkirk J, Eckert S, Jacob R. Prosthodontic Treatment for Edentulous Patients. 13th ed. Elsevier; 2013. 464 p.
18. Carr A, Brown D. McCracken's removable partial prosthodontics. 12th ed. St Louis: Mosby; 2011. 400 p.
19. Pocztaruk RDL, Frasca LCDF, Rivaldo EG, Fernandes EDL, Gavião MBD. Protocol for production of a chewable material for masticatory function tests (Optocal - Brazilian version). Braz Oral Res. 2008;22(4):305–10.
20. Slagter AP, Bosman F, Van der Bilt A. Comminution of two artificial test foods by dentate and edentulous subjects. J Oral Rehabil. 1993;20(2):159–76.
21. Slagter AP, van der Glas HW, Bosman F, Olthoff LW. Force-deformation properties of artificial and natural foods for testing chewing efficiency. J Prosthet Dent. 1992;68(5):790–9.
22. Gonçalves TMS V, Campos CH, Rodrigues Garcia RCM. Mastication and jaw motion of partially edentulous patients are affected by different implant-based prostheses. J Oral

Rehabil. 2014;41(7):507–14.

23. Lepley C, Throckmorton G, Parker S, Buschang PH. Masticatory performance and chewing cycle kinematics-are they related? Angle Orthod. 2010;80(2):295–301.
24. Custodio W, Gomes SGF, Faot F, Garcia RCMR, Del Bel Cury AA. Occlusal force, electromyographic activity of masticatory muscles and mandibular flexure of subjects with different facial types. J Appl Oral Sci. 2011;19(4):343–9.
25. van Der Bilt A, Tekamp A, van Der Glas H, Abbink J. Bite force and electromyograpy during maximum unilateral and bilateral clenching. Eur J Oral Sci. 2008;116(3):217–22.
26. McGrath C, Bedi R. The importance of oral health to older people's quality of life. Gerodontology. 1999;16(1):59–63.
27. Heckmann SM, Heckmann JG, Weber HP. Clinical outcomes of three Parkinson's disease patients treated with mandibular implant overdentures. Clin Oral Implants Res. 2000 Dec;11(6):566–71.
28. Woda A, Foster K, Mishellany A, Peyron MA. Adaptation of healthy mastication to factors pertaining to the individual or to the food. Physiol Behav. 2006;89(1):28–35.
29. Trulsson M. Sensory-motor function of human periodontal mechanoreceptors. J Oral Rehabil. 2006;33(4):262–73.
30. Adachi K, Kobayashi M, Kawasaki T, Yokoyama C, Waddington JL, Sakagami H, et al. Disruption of programmed masticatory movements in unilateral MPTP-treated monkeys as a model of jaw movement abnormality in Parkinson's disease. J Neural Transm. 2012;119(8):933–41.
31. Potulska A, Friedman A, Królicki L, Spychala A. Swallowing disorders in Parkinson's disease. Parkinsonism Relat Disord. 2003;9(6):349–53.
32. van der Bilt A, Burgers M, van Kampen FMC, Cune MS. Mandibular implant-supported overdentures and oral function. Clin Oral Implants Res. 2010 Nov;21(11):1209–13.
33. Fontijn-Tekamp FA, Slagter AP, Van Der Bilt A, Van 'T Hof MA, Witter DJ, Kalk W, et al. Biting and chewing in overdentures, full dentures, and natural dentitions. J Dent Res. 2000;79(7):1519–24.
34. Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. Neurology. 1967;17(5):427–42.
35. Movement Disorder Society Task Force on Rating Scales for Parkinson's Disease. The Unified Parkinson's Disease Rating Scale (UPDRS): status and recommendations. Mov Disord. 2003 Jul;18(7):738-50.

2.4 Artigo: Oral health–related quality of life and masticatory efficiency in elders with Parkinson's disease after oral rehabilitation

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ABSTRACT

Statement of the Problem: Parkinson's disease (PD) symptoms, such as tremors in the lip, tongue; and involuntary mandibular movements, may cause chewing difficulties, denture discomfort, and problems in oral health behavior. *Objective:* To evaluate the masticatory efficiency (ME) and the oral health related quality of life (OHRQoL) in PD elders before and after new removable dental prostheses (RDP). *Materials and Methods:* Thirty-four elders with PD (n = 17, mean age = 69.41 ± 4.65 years) or without PD (n = 17, mean age = 70.71 ± 4.65 years) were recruited. Participants received new RDP; ME and OHRQoL were assessed before and 2 months after subjects were free of any RDP discomfort. ME was evaluated using the 2.8 sieve. OHRQoL was measured using the Oral Health Impact Profile (OHIP-49). Data were analyzed by Wilcoxon sign test or Wilcoxon signed-rank for non-parametric distribution data; and Paired t test for normal distribution data (P<0.05). *Results:* PD and control groups showed improvement in the ME and in the OHRQoL when were compared before and after new RDP (P<0.05). Comparison between PD and control groups, before new RDP, showed worst ME and negative impact in the OHRQoL in PD subjects (P<0.05). After new RDP, PD also showed worst ME than control group, but both demonstrated similar and positive impact in the OHRQoL. *Conclusion:* The rehabilitation with RDP improves the ME and the OHRQoL in elders with PD. After rehabilitation, although PD elders showed worst ME than controls, both groups demonstrated positive impact in their OHRQoL.

Clinical Implications: Knowledge that rehabilitation with new RDP improves the ME and the OHRQoL in elders with PD, is important to dental professionals in decision making related to prosthetics treatment. Knowledge which domains the rehabilitation impacts the OHRQoL can help dental professionals in the clinical practice in terms of identifying needs, selecting treatment, and monitoring patients progress.

INTRODUCTION

Parkinson's disease (PD) is considered to be the second most common neurodegenerative disease with an onset in the 5th or 6th decade, [1] and it is estimated to affect about 1–2% of individuals in this age group.[2] Motor symptoms such as tremor, rigidity, bradykinesia, and postural instability are considered to be the cardinal signs of the disease.[2,3] The course of the disease is chronic and progressive, and may be complicated by a range of motor and non-motor features, such as depression, anxiety, apathy, cognitive and sleep disturbances, sensory symptoms, fatigue and pain, among others symptoms, [4] many of which contribute to increased disability [5] as well as diminished quality of life in these patients.[2,6]

Quality of life has a subjective feature, and can be defined as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns".[7] A systematic review did by Soh et al.[6] found that depression, and the severity and disability of PD were found to be predictive of poor health-related quality of life outcomes, being the gait impairments and complications arising from medication therapy the most influential symptoms on life quality.[6]

The subjective impact of oral health on quality of life, which is called oral health–related quality of life (OHRQoL), has become an important concern of dental professionals and it plays an important role in clinical practice in terms of perceiving needs recognized by the individual,[8] selecting therapies and monitoring patients progress.[9,10] So, subjective instruments [11] have been developed in order to identify and evaluate how oral problems interfere in people's daily lives, influencing their quality of life.[12] In patients with PD, previous studies had assessed OHRQoL,[13-15] and verified that PD patients complained more about their oral health due to chewing difficulties, denture discomfort, and problems in oral health behavior than the controls.[13] PD patients report more often oral health-related problems,[14] with greatest impact on the physical disability and psychological discomfort on the OHRQoL.[15] However, none of these previous studies had evaluated the impact of the oral rehabilitation with removable dental prostheses in the OHRQoL in PD patients.

Dental treatment and rehabilitation with dental prostheses are designed to restore function, esthetic, and to improve the oral function [16] and the OHRQoL.[10] Packer et al. [17] reported improvement of the quality of life of people with PD using dental implants to stabilize an overdenture or to support a fixed prosthesis, in the domains of satisfaction with the prosthesis, eating, and oral well-being.[17] However, a significant number of PD patients in society still requires the complete denture (CD) and removable partial denture (RPD) for

aesthetic, psychological, and masticatory rehabilitation.[18]

One of the functions of the masticatory system is to prepare food for swallowing by crushing it into small pieces which are moistened with saliva.[19] Chewable test material has been used in masticatory studies,[20-22] intending to evaluate the prosthetic rehabilitation success in respect to their masticatory functions.[23] Previous surveys have reported fewer number of remaining teeth [24] and decreased masticatory performance (ME) [14] in PD elders, when compared to those without the disease. Thus, problems related to removable dentures use, such as nutritional intake influence, dietary enjoyment, self-esteem, social interaction and social acceptability [17] are likely to compound the existing difficulties that elders with PD have when eating and swallowing.[25]

Since the tooth loss can affect different aspects of elders's life including appearance, phonetics and masticatory function,[26] the oral rehabilitation with removable dental prostheses may have a consequence in PD elders's OHRQoL. Thus, this study aimed to evaluate the OHRQoL and the ME in PD elders before and after new removable dental prostheses insertion. The null hypothesis tested was that the ME and the OHRQoL would not be affected by the rehabilitation with new removable dental prostheses in PD elders.

MATERIALS AND METHODS

The Ethics Committee of Piracicaba Dental School, University of Campinas (Piracicaba, Brazil), approved this research (protocol #097/2012). The research was also registered in the Brazilian Registry of Clinical Trials database (#RBR-3czhsf), which is linked to the International Clinical Trials Registration Platform (ICTRP/World Health Organization). In this observational study, the participation was voluntary, and subjects provided written informed consent before enrollment. The present study included a total of 34 participants, from Brazilian Parkinson's Association (Piracicaba, São Paulo, Brazil) and from elders who sought prosthetic treatment at the dental clinic of Piracicaba Dental School, University of Campinas. These subjects were part of a previous research where they received new CD and/or RPD in both jaws.

Subjects were required to present as inclusion criteria 60 years or older, to be edentulous or partially edentulous, using or not unsatisfactory CD and/or RPD according to Vigild's criteria.[8] They were divided in experimental (with PD) and control (without PD) groups. To be included in the PD group, they had to have PD diagnosed by a neuropsychiatrist using clinical diagnostic criteria [1] and be under daily levodopa treatment. Participants presenting others aging diseases, such as hypertension and/or diabetes, once

controlled by medication were accepted. To be included in the control group, the criteria were similar to PD group, except by the absence of PD. Elders with other neurodegenerative disorder or with secondary Parkinsonism, those presenting bruxism; symptoms of temporomandibular disorders, and/or advanced periodontal disease were excluded of the study. Therefore, the PD group consisted of 17 volunteers (nine men and eight women; mean age 69.41 ± 4.65 years; PD diagnosis 6.76 ± 3.80 years), and the control group consisted of others 17 volunteers (ten men and seven women; 70.71 ± 4.65 years).

Sociodemographic characteristics such as monthly income and educational level, as well as oral characteristics including the number of remaining teeth in partially dentate participants, the number of decayed, missing, and filled teeth (DMFT) [27] and the prosthesis type were registered. Each participant received general dental treatment according to individual subject needs, including basic periodontal therapy, endodontics treatment and tooth restoration procedures. All participants were then submitted to baseline assessment of OHRQoL and ME evaluations. After, new CD and/or RPD were installed in subjects of both groups, and OHRQoL and ME were reassessed.

Oral Health Related Quality of Life

The Portuguese version of the OHIP-49 questionnaire, translated and adapted from the English version,[11,12] was used to assess the participants' OHRQoL. This questionnaire comprises 49 items assigned to seven domains: functional limitation; physical pain; psychological discomfort; physical disability; psychological disability; social disability; and handicap. Subjects were told to rate the frequency in which they had experienced the impact of each OHIP item on a five-point Likert- like scale (4 = very often; 3 = fairly often; 2 = occasionally; 1 = hardly ever; 0 = never). Total OHIP-49 scores ranging from 0 (very good OHRQoL) to 196 (very poor OHRQoL) were calculated.

Masticatory efficiency

The ME was evaluated with Optocal artificial test material.[22] Optocal was prepared by mixing 58.3% of condensation silicone (Optosil Comfort; Heraeus Kulzer GmbH & Co), with 7.5% of conventional toothpaste (Colgate- Palmolive Co), 11.5% of solid vaseline (Pharmaceutical Industry Rioquímica Ltd), 10.2% of common powder of dental plaster (Empresa e Indústria Gesso Mossoró SA), 12.5% of irreversible hydrocolloid powder (Jeltrate, Dentsply Intl), and 4% of catalyst paste (Universal; Heraeus Kulzer GmbH & Co).[21,22] After the mixing, cubes of Optocal measuring 5.6 mm on each edge were prepared in

metal molds and completely polymerized in an oven for 16 hours at 65°C.[20] Subjects were instructed to chew a 3.7 g portion of Optocal in the habitual manner for 40 strokes [19] 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 with variably sized mesh (0.5 mm to 5.6 mm). Materials retained on sieves were weighed on a 0.001 g analytical balance (Mark; BEL Engineering, Milan, Italy), and the ME was calculated as the percentage weight of the comminuted material that passed through the 2.8 mm sieve.[19]

Removable prosthesis insertion

After baseline evaluations, all subjects received new CD and/or RPD. Prosthesis were prepared with acrylic resin according to conventional technique,[28,29] by one dental technician. Cobalt-chromium (Co-Cr) alloy (Degussa-Hüls AG, Hanau, Germany) was used to process RPD frameworks, which included a major connector, rests, and clasps designed for the supporting tissues and remaining teeth of each participant. 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 2-month adaptation period with the new removable prostheses, the masticatory efficiency and OHRQoL were re-evaluated. Considering daily variations in motor symptoms in individuals with PD due to the "on-off" phenomenon, PD participants were evaluated in the morning, one hour after ingestion of levodopa, which is a period of good motor function ("on" period).[3] As standardization, the control group was also evaluated in the morning period.

Statistical analysis

Data were evaluated using SAS 9.3 (SAS Institute Inc., SAS Campus Drive, Cary, North Carolina, USA) statistical program. Exploratory analysis using the Shapiro-Wilk test showed that of PD and control group characteristics were normally distributed. Therefore, age, monthly income, educational level, the number of teeth, and DMFT were analyzed using t-tests, and prosthesis type using $\chi 2$ tests.

Comparison between before and after new removable dental prostheses insertion for each group, Shapiro-Wilk test revealed a non-parametric distribution of the data regards to ME, being analyzed using Wilcoxon sign test or Wilcoxon signed-rank. Data of OHIP-49 revealed both normal distribution (functional limitation, physical pain, psychological discomfort and physical disability domains, and for total OHIP-49) and a non-parametric

distribution (psychological disability, social disability and handicap domains). Paired t test was used for normal distribution domains, and Wilcoxon sign test or Wilcoxon signed-rank test were used for non-parametrics domains. For comparison between groups, Shapiro-Wilk test revealed normal distribution of all data. Therefore, ME and OHIP-49 were analyzed using t test for comparison between PD and control groups. All statistical tests were carried out using a 5% significance level.

RESULTS

Data of sociodemographic characteristics showed that PD and control group were similar across age (P = 0.4230), and monthly income (P = 0.7510), but had different educational levels (P = 0.0354). PD elders had mean age 69.41 ± 4.65 years, monthly income of 2.84 ± 1.29 Brazilian real (BRL) minimum wage, and educational level of 7.94 ± 5.66 years; and control group had, respectively mean age 70.71 ± 4.65 years, 2.64 ± 2.21 BRL minimum wage, and 4.23 ± 3.43 years of educational level.

Oral characteristics of PD and control group demonstrated that they were similar across natural teeth (P = 0.5150), DMFT (P = 0.665) and types of removable prostheses (P = 0.3150). PD elders showed mean natural teeth 10.00 ± 5.23, and DMFT 24.82 ± 3.76, being 0.24 ± 0.75 decayed, 22.18 ± 6.30 missing and 2.41 ± 3.45 filled teeth. They also presented 6 CD in both jaws (35.29%), 4 Upper CD and lower RPD (23.53%), and 7 RPD in both jaws (41.18%). Control elders showed mean natural teeth 8.20 ± 4.09, and DMFT 25.35 ± 3.28, being 0.12 ± 0.49 decayed, 23.18 ± 6.31 missing and 2.06 ± 3.40 filled teeth. Controls presented 9 CD in both jaws (52.94%), 5 Upper CD and lower RPD (29.41%), and 3 RPD in both jaws (17.65%).

Comparisons of data between before and after new removable prostheses insertion in PD elders, showed a decrease of 76.14% in total OHIP-49, and in all domains of OHIP-49, except for social disability domains (P<0.05). They also showed an improvement in the ME after new prosthesis (Table 1). Control group demonstrated the same trends, with a decrease of 72.54% in total OHIP-49 and in all domains of OHIP-49 when compared before and after new removable prostheses, except for social disability and handicap domains of OHIP-49 (P<0.05). They also showed an improvement in the ME after new prosthesis (Table 1).

When the groups were compared before new removable prostheses insertion, data of functional limitation, physical disability, handicap, total OHIP-49 and ME were different (P<0.05), revealing worst ME and negative impact in the OHRQoL in PD subjects when compared to controls (Table 1). After new removable prostheses insertion, PD and control

groups also showed differences in the functional limitation and psychological disability domains of OHIP-49, and ME being worst in PD group. Besides, PD and control subjects showed similar total OHIP-49, demonstrating similar and positive impact in the OHRQoL after rehabilitation with new removable prostheses (Table 1).

Table 1. Comparison of masticatory efficiency and OHIP-49 in PD and control groups.

	PD		**Control**	
	Before	**After**	**Before**	**After**
Masticatory efficiency	7.02 (± 9.83)Aa	13.85 (± 13.18)Ba	13.02(±11.30)Ab	23.86(±17.23)Bb
Functional limitation	23.04(±9.42)Aa	8.75(± 4.28)Ba	12.76(± 6.62)Ab	5.06(± 3.43)Bb
Physical pain	14.20(±8.59)Aa	4.97(± 5.28)Ba	10.54(± 7.09)Aa	2.52(± 2.71)Ba
Psychological discomfort	11.34(±8.66)Aa	0.40(± 0.74)Ba	6.50(± 6.52)Aa	0.80(± 1.30)Ba
Physical disability	18.21(±1.25)Aa	3.59(± 4.20)Ba	5.38(± 4.97)Ab	1.95(± 2.34)Ba
Psychological disability	4.43(±5.81)Aa	0.52(± 1.23)Ba	2.62(± 3.97)Aa	0.09(± 0.35)Bb
Social disability	2.68(±6.83)Aa	0.00(± 0.00)Aa	0.94(± 2.09)Aa	0.25(± 0.67)Aa
Handicap	2.46(±3.54)Aa	0.00(± 0.00)Ba	0.00(± 0.00)Ab	0.00(± 0.00)Aa
Total OHIP-49	76.36(±5.61)Aa	18.22(±13.33)Ba	38.74(±19.62)Ab	10.67(± 8.20)Ba

Data represent mean (± standard deviation). Distinct uppercase letters indicate differences between before and after new removable prostheses, for each group (P<0.05). Distinct lowercase letters indicate differences between PD and control groups, before and after new removable prostheses (P<0.05).

DISCUSSION

This study evaluated the OHRQoL and ME in PD and control elders before and after 2-month adaptation period to new removable dental prostheses insertion. The present study rejected the null hypothesis by finding that OHRQoL and ME were improved in both groups after new prostheses insertion. Although both groups showed a positive impact in the OHRQoL after new removable prostheses insertion, PD elders still reveal worst masticatory efficiency when compared to controls.

PD elders had similar age, monthly income but had higher educational level than controls in the current study. Socio-economic background is known to influence oral health in elderly individuals,[30] but despite the difference in the educational level between groups, no difference was found in monthly income, which may characterize a homogeneous group. PD and controls also had similar number of natural teeth, and type of removable prostheses needs.

As known, these factors influence masticatory function, [16] and no significant differences between groups were expected, because our endeavored to match them to minimize bias in the ME assessment. Regarding to DMFT, no difference was observed between groups in the total DMFT, as well as in their components (decayed, missing and filled teeth), demonstrating the same need for dental treatment in PD and control participants.

As regards to PD group, data comparison between before and after new prosthesis insertion showed that the OHIP-49 values reduced while the ME increased. It means that the new removable dentures insertion promoted an improvement in mastication since more percentage weight of the comminuted material could pass through the 2.8 mm sieve. [19] As consequence, the impact of the new prostheses in the OHRQoL was positive, represented by a decrease of 76.14% in total OHIP-49 values after rehabilitation. [11] The similar result in the social disability domain means that it did not impact the OHRQoL neither before nor after rehabilitation. It may be influenced by our PD sample, which was composed by elders engaged and participatory with the social activities of the Brazilian Parkinson's Association. Previous study [17] which had used prosthetic rehabilitation with dental implants and different methodology for OHRQoL assessment, also reported improvement of the quality of life in PD patients in the domains of satisfaction with the prosthesis, eating, and oral well-being after rehabilitation. [17]

Our data concerning to comparison between PD and control participants before new prosthesis insertion, demonstrated negative impact in the OHRQoL of PD subjects, mainly in the domains of functional limitation, physical disability and handicap. The same occurred with the ME values, once PD subjects showed worst ME. Bakke et al. [14] also found impairment in mastication in PD patients when compared to controls, although they had assessed the masticatory performance using different methodology. In respect to OHRQoL, previous studies [13-15] also reported more often oral health-related problems in PD subjects, [13,14] which greatest negative impact in the domains functional limitation, psychological discomfort, physical disability, psychological disability and social disability.[14] Considering that psychological dimension means the “individuals' perception of their cognitive and affective state”, [7] and that the last study [14] included only PD subjects with moderate to advanced PD, the perception about their PD severity and motor impairment may influenced psychological dimension, explaining the difference in their OHIP-49 domains when compared with ours.

After new prosthesis insertion, PD elders demonstrated positive impact in their OHRQoL with similar results of the controls. Their OHIP-49 values were higher than

controls only in the functional limitation and psychological disability domains. In addition, PD subjects still present worst ME than control ones. PD per se could explain the impaired ME because of rigidity and bradykinesia, [1] as well as increased muscle tone and reduced tongue movement, with consequent loss of bolus formation. [3] Also, PD symptoms may have influenced the functional limitation domain, due to great difficulties in adjusting to the use of the new removable prostheses because of the PD motor impairments. As a consequence, it may also have influenced the psychological disability in the OHRQoL after rehabilitation reported by PD participants.

In the present study, the general dental treatment may influence our OHRQoL results, since the treatment may have a positive impact on the oral perception of volunteers. Nevertheless, it may have occurred in both groups, both before and after rehabilitation, and emphasizes the importance of oral health care. In addition, prosthetic rehabilitation generally improves OHRQoL of patients, regardless of the type of dental prosthesis. [10] Studies using OHIP-49 to assess OHRQoL usually include a number of participants quite greater than used in our study. Because we have evaluated a small number of subjects, this could configure a shortcoming. However, it is important to emphasize that this study's sample size was enough to evidence improvement in the ME and OHRQoL in all volunteers.

CONCLUSION

The oral rehabilitation with new removable dental prostheses improves the OHRQoL and ME in elders with PD. Although PD elders showed worst ME after oral rehabilitation than controls, both groups demonstrated positive impact in their OHRQoL.

REFERENCES

1. Reichmann H. Clinical criteria for the diagnosis of Parkinson's disease. Neurodegener Dis. 2010;7(5):284–90.
2. Alves G, Forsaa EB, Pedersen KF, Dreetz Gjerstad M, Larsen JP. Epidemiology of Parkinson's disease. J Neurol. 2008 Sep;255 Suppl(S5):18–32.
3. Friedlander AH, Mahler M, Norman KM, Ettinger RL. Parkinson disease: systemic and orofacial manifestations, medical and dental management. J Am Dent Assoc. 2009;140(6):658–69.
4. Chaudhuri KR, Odin P, Antonini A, Martinez-Martin P. Parkinson's disease: the non-motor issues. Parkinsonism Relat Disord. 2011 Dec;17(10):717-23.

5. Muslimovic D, Post B, Speelman JD, Schmand B, de Haan RJ; CARPA Study Group. Determinants of disability and quality of life in mild to moderate Parkinson disease. Neurology. 2008 Jun 3;70(23):2241-7.
6. Soh SE, Morris ME, McGinley JL. Determinants of health-related quality of life in Parkinson's disease: a systematic review. Parkinsonism Relat Disord. 2011 Jan;17(1):1-9.
7. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med. 1995 Nov;41(10):1403-9.
8. Vigild M. Denture status and need for prosthodontic treatment among institutionalized elderly in Denmark. Community Dent Oral Epidemiol. 1987;15:128–33.
9. Locker D, Jokovic A, Clarke M. Assessing the responsiveness of measures of oral health-related quality of life. Community Dent Oral Epidemiol. 2004;32(3):10–8.
10. Campos CH, Gonçalves TMSV, Garcia RCMR. Implant-Supported Removable Partial Denture Improves the Quality of Life of Patients with Extreme Tooth Loss. Braz Dent J. 2015 Oct;26(5):463–7.
11. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health. 1994;11(1):3–11.
12. Pires C, Ferraz M, Abreu M. Translation into Brazilian Portuguese, cultural adaptation and validation of the oral health impact profile (OHIP-49). Braz Oral Res. 2006;20(3):263–8.
13. Nakayama Y, Washio M, Mori M. Oral health conditions in patients with Parkinson's disease. J Epidemiol. 2004;14(5):143–50.
14. Bakke M, Larsen SL, Lautrup C, Karlsborg M. Orofacial function and oral health in patients with Parkinson's disease. Eur J Oral Sci. 2011;119(1):27–32.
15. Silva PF da C, Biasotto-Gonzalez DA, Motta LJ, Silva SM, Ferrari RAM, Fernandes KPS, et al. Impact in oral health and the prevalence of temporomandibular disorder in individuals with Parkinson's disease. J Phys Ther Sci. 2015;27(3):887–91.
16. van der Bilt A. Assessment of mastication with implications for oral rehabilitation: A review. J Oral Rehabil. 2011;38(10):754–80.
17. Packer M, Nikitin V, Coward T, Davis DM, Fiske J. The potential benefits of dental implants on the oral health quality of life of people with Parkinson's disease. Gerodontology. 2009;26(1):11–8.

18. Haralur SB. Clinical strategies for complete denture rehabilitation in a patient with Parkinson disease and reduced neuromuscular control. Case Rep Dent. 2015;2015:352878.
19. van der Bilt A, Fontijn-Tekamp FA. Comparison of single and multiple sieve methods for the determination of masticatory performance. Arch Oral Biol. 2004 Mar;49(3):193–8.
20. Slagter AP, van der Glas HW, Bosman F, Olthoff LW. Force-deformation properties of artificial and natural foods for testing chewing efficiency. J Prosthet Dent. 1992;68(5):790–9.
21. Slagter AP, Bosman F, Van der Bilt A. Comminution of two artificial test foods by dentate and edentulous subjects. J Oral Rehabil. 1993;20(2):159–76.
22. Pocztaruk RDL, Frasca LCDF, Rivaldo EG, Fernandes EDL, Gavião MBD. Protocol for production of a chewable material for masticatory function tests (Optocal - Brazilian version). Braz Oral Res. 2008;22(4):305–10.
23. Gonçalves TM, Campos CH, Gonçalves GM, de Moraes M, Rodrigues Garcia RC. Mastication improvement after partial implant-supported prosthesis use. J Dent Res. 2013 Dec;92(12 Suppl):189S-94S.
24. Einarsdóttir ER, Gunnsteinsdóttir H, Hallsdóttir MH, Sveinsson S, Jónsdóttir SR, Ólafsson VG, et al. Dental health of patients with Parkinson's disease in Iceland. Spec Care Dent. 2009;29(3):123–7.
25. Lorefält B, Granérus AK, Unosson M. Avoidance of solid food in weight losing older patients with Parkinson's disease. J Clin Nurs. 2006;15(11):1404–12.
26. Miura H, Kariyasu M, Yamasaki K, Arai Y, Sumi Y. Relationship between general health status and the change in chewing ability: a longitudinal study of the frail elderly in Japan over a 3-year period. Gerodontology. 2005;22(4):200–5.
27. Worl Health Organization. Oral health surveys: basic methods. 4th ed. Geneva: World Health Organization; 1997.
28. Zarb GA, Hobkirk J, Eckert S, Jacob R. Prosthodontic Treatment for Edentulous Patients. 13th ed. Elsevier; 2013. 464 p.
29. Carr A, Brown D. McCracken's removable partial prosthodontics. 12th ed. St Louis: Mosby; 2011. 400 p.
30. McGrath C, Bedi R. The importance of oral health to older people's quality of life. Gerodontology. 1999;16(1):59–63.

3 DISCUSSÃO

De maneira geral, este estudo mostrou que os idosos com DP possuem a saúde bucal similar aos idosos sem a doença e que a DP é associada com o comprometimento da função mastigatória durante o período "on" do tratamento com levodopa.

Inicialmente, os idosos do grupo DP e controle possuíam características sociodemográficas similares, como idade, nível de escolaridade e renda mensal, além de características semelhantes quanto ao número de dentes remanescentes, o tipo das próteses dentárias removíveis e o fluxo salivar. No entanto, antes de iniciar avaliação da função mastigatória, 03 voluntários foram excluídos, sendo que 01 desistiu da pesquisa e outros 02 adoeceram e não puderam continuar as avaliações. Desta forma, o perfil sociodemográfico relativo ao nível de escolaridade apresentou diferença entre os grupos, passando o grupo DP a apresentar maior nível de escolaridade. Sabe-se que o contexto socioeconômico pode influenciar a saúde bucal em idosos (McGrath e Bedi, 1999), no entanto, apesar da diferença no nível de escolaridade entre os grupos, não houve diferença na renda mensal, o que pode caracterizar um grupo homogêneo. Além disso, acreditamos que esta diferença não influenciou as características como número de dentes ou tipo de prótese removível no presente estudo, provavelmente pelo nosso esforço em parear os grupos quanto a estas características bucais para minimizar os vieses na avaliação da função mastigatória.

Em relação à avaliação da saúde bucal, antes das reabilitações, foi verificado que os voluntários com DP possuem saúde bucal similar aos idosos do grupo controle, com poucos dentes remanescentes e bom índice de saúde bucal (ISB), no entanto, àqueles com DP possuem autopercepção mais negativa da sua saúde bucal. Um estudo prévio também encontrou número de dentes similares entre os indivíduos com DP e controle (Bakke *et al.*, 2011), porém, outros estudos (Nakayama *et al.*, 2004; Hanaoka e Kashihara, 2009) encontraram menor número de dentes em pacientes com DP, reportando que a cárie e a doença periodontal são complicações frequentes nessa população. Uma vez que a severidade da DP predispõe à deterioração da saúde bucal (Müller *et al.*, 2011), estes resultados contrastantes podem ser decorrentes da inclusão de pacientes com diferentes graus de severidade da DP (Nakayama *et al.*, 2004; Hanaoka e Kashihara, 2009). Da mesma forma, este motivo também pode justificar os resultados contrastantes relativos ao ISB. O presente estudo não encontrou diferença no ISB entre os grupos, semelhante ao estudo publicado por Kennedy *et al.* (1994). Em contraste, Fukayo *et al.* (2003) observaram escovação mais frequente e melhor saúde bucal em pacientes com DP em grau leve do que nos controles; e Müller *et al.* (2011) relataram que pacientes hospitalizados com DP possuíam pior ISB

quando comparados aos controles. Em acréscimo, no presente estudo, não houve diferença no fluxo salivar entre os grupos, sendo considerado normal. Assim, níveis semelhantes de funções de proteção salivares também poderiam ter influenciado o bom ISB observado. Apesar da avaliação objetiva não ter demonstrado diferença entre os grupos, a avaliação subjetiva por meio do GOHAI mostrou autopercepção mais negativa nos idosos com DP, provavelmente pelos sintomas da DP, que afetam a musculatura orofacial, provocando dor orofacial, fraturas e desgastes dentários (Dirks *et al.*, 2003), além de dificuldades no controle e retenção de próteses (Friedlander *et al.*, 2009).

A avaliação da higienização da prótese dentária removível realizada em um período de 30 dias mostrou que os idosos com DP foram capazes de melhorar a higiene das próteses em resposta às instruções verbais de limpeza e reforço positivo. Os idosos com DP apresentaram melhora na higienização em 7 e 14 dias, para as próteses superiores e inferiores respectivamente, e alcançaram redução de biofilme semelhante ao grupo controle em 30 dias da avaliação inicial. O presente estudo recomendou a escovação e a imersão das próteses em hipoclorito diluído em água, visto que os métodos físicos e químicos combinados proporcionam a melhor opção para limpeza das próteses (Kanli *et al.*, 2005; Paranhos *et al.*, 2007). No entanto, acredita-se que seja crucial o reforço positivo semanal das instruções de higiene, visto que a maioria dos participantes não possuíam esses hábitos no início do estudo. O pré-requisito mais importante para a mudança de comportamento é a convicção de que se pode executar com sucesso o comportamento necessário para produzir o resultado desejado (Committee on Health and Behavior: Research, Practice and Policy, 2001). Os participantes deste estudo foram envolvidos de forma positiva e receptiva, e o reforço positivo de suas habilidades provavelmente os estimulou a limpar as próteses adequadamente. Da mesma forma, Ribeiro *et al.* (2009) observaram que usuários saudáveis de PPR, quando motivados, foram capazes de manter um nível elevado de higiene com cuidados bucais e programas direcionados à higienização das próteses.

No que diz respeito à função mastigatória, após a reabilitação com as novas próteses dentárias removíveis, foi encontrado no presente estudo que a DP é associada com a diminuição da amplitude dos movimentos da mandíbula, aumento nos tempos de ciclo mastigatório, menor velocidade durante a mastigação, pior performance mastigatória (PM) e redução da força máxima de mordida (FMM). Os resultados relativos à amplitude dos movimentos mandibulares estão em concordância com os trabalhos anteriores (Robertson e Hammerstad, 1996; Bakke *et al.*, 2011), que também verificaram redução na abertura e na amplitude dos movimentos laterais da mandíbula em indivíduos com DP. A DP pode explicar

esses resultados por causa da rigidez e bradicinesia (Friedlander *et al.*, 2009), que causa um aumento do tônus muscular e lentidão dos movimentos (Heckmann *et al.*, 2000), afetando regularmente os músculos orofaciais e da faringe (Heckmann *et al.*, 2000). Nossos resultados relativos aos movimentos durante a mastigação de Optocal em pacientes com DP concordam com aqueles de Robertson e Hammerstad (1996), porém discordam com os de Karlsson *et al.* (1992), que mostraram tempos de ciclo menores e velocidades mais rápidas durante a mastigação em indivíduos com DP. A diferença no material teste utilizado durante a mastigação por estes autores (Karlsson *et al.*, 1992) e as diferenças no estado oclusal não-informado dos voluntários poderiam explicar estes diferentes resultados. Quanto à PM, os voluntários com DP apresentaram maiores valores de X_{50}, indicando pior PM quando comparados ao controle. Além dos sintomas previamente citados da DP, estes pacientes podem ter o movimento da língua reduzido (Friedlander *et al.*, 2009), dificultando o transporte de alimento da região de incisivos para região oclusal durante a mastigação (Adachi *et al.*, 2012) e a formação do bolo alimentar (Friedlander *et al.*, 2009). Além disso, a PM pode também ser influenciada pela FMM (Fontijn-Tekamp *et al.*, 2000; Hatch *et al.*, 2001), ou pela força com que um indivíduo oclui seus dentes. A FMM é um índice de atividade muscular (van Der Bilt *et al.*, 2008), e os valores encontrados foram menores nos voluntários com DP. A FMM pode ser diminuída pela própria DP ou como um efeito direto do envelhecimento muscular (van der Bilt, 2011). Desde que os voluntários com DP e controle foram pareados pela idade, pode-se hipotetizar que as deficiências motoras nos músculos elevadores da mandíbula causadas pela DP podem ser responsáveis pela diminuição na FMM observada nos idosos com DP.

Em relação à avaliação da QVRSB e da eficiência mastigatória (EM), antes e após a reabilitação com novas próteses removíveis, o presente estudo demonstrou que a reabilitação oral melhora estas variáveis nos idosos, independente da presença da doença. No que diz respeito ao grupo DP, a comparação de dados entre antes e após a reabilitação oral, mostrou que os valores da EM aumentaram, significando que a instalação das próteses promoveu uma melhoria na mastigação, devido ao maior percentual de material triturado que passou pela peneira de 2,8 mm (van der Bilt e Fontijn-Tekamp, 2004). Como consequência, o impacto das novas próteses no QVRSB foi positivo, representado por valores mais baixos OHIP-49 após a reabilitação (Slade e Spencer, 1994). Comparando os idosos com DP e controle, antes das reabilitações orais, os resultados mostraram impacto negativo na QVRSB nos idosos com DP, principalmente nos domínios da limitação funcional, deficiência física e handicap. O mesmo ocorreu com os valores da EM, uma vez que indivíduos com DP

apresentaram os menores valores. Bakke *et al.* (2011) também encontraram comprometimento da mastigação em pacientes com DP, e outros estudos (Nakayama *et al.*, 2004; Bakke *et al.*, 2011; Silva *et al.*, 2015) também relataram mais problemas relacionados com QVRSB em pacientes com DP (Nakayama *et al.*, 2004; Bakke *et al.*, 2011). Após a reabilitação, apesar de terem apresentado pior EM, os idosos com DP mostraram impacto positivo em sua QVRSB com resultados semelhantes aos controles, exceto para os domínios limitação funcional e incapacidade psicológica. A DP por si só poderia explicar a pior EM por causa da rigidez e bradicinesia (Reichmann, 2010). Além disso, os sintomas da DP podem ter influenciado o resultado na QVRSB nos domínios de limitação funcional e incapacidade psicológica, devido às dificuldades em adaptar-se à utilização das novas próteses removíveis, devido às deficiências motoras da doença.

É importante ressaltar que, embora o tempo de diagnóstico da DP tenha sido registrado no presente estudo, os voluntários não foram estratificados de acordo com a gravidade da doença (Hoehn e Yahr, 1967), o que pode ter resultado em heterogeneidade dos sintomas motores (Movement Disorder Society, 2003). No entanto, nenhum dos participantes com DP estavam no estágio V de Hoehn e Yahr (1967), que se caracteriza clinicamente por confinamento à cama ou cadeira de rodas a não ser que receba ajuda (Hoehn e Yahr, 1967). No entanto, as avaliações foram realizadas durante o período “on” da levodopa, que é o período de melhor função motora em pacientes com DP (Friedlander *et al.*, 2009), e todos os indivíduos com DP eram capazes de realizar a higiene bucal e das próteses de forma independente.

4 CONCLUSÃO

Pode-se concluir que os idosos com DP possuem a saúde bucal similar aos idosos sem a doença, e que a DP é associada com o comprometimento da função mastigatória durante o período “on” do tratamento com levodopa. De maneira específica, pode-se concluir que:

1) Idosos com DP possuem poucos dentes remanescentes e bom ISB. Entretanto, possuem autopercepção mais negativa da sua saúde bucal do que idosos sem DP;

2) Similar aos idosos saudáveis, aqueles com DP foram capazes de reduzir a presença de biofilme na prótese removível em resposta às instruções verbais e reforço positivo;

3) A DP está associada ao comprometimento da função mastigatória;

4) A reabilitação oral por meio de próteses dentárias removíveis melhora a QVRSB e a EM em idosos com DP. Após a reabilitação, embora os idosos com DP tenham mostrado pior EM quando comparado ao controle, ambos os grupos demonstraram impacto positivo em sua QVRSB.

REFERÊNCIAS*

1. Adachi K, Kobayashi M, Kawasaki T, Yokoyama C, Waddington JL, Sakagami H,*et al.*Disruption of programmed masticatory movements in unilateral MPTP-treated monkeys as a model of jaw movement abnormality in Parkinson's disease. J Neural Transm (Vienna). 2012 Aug;119(8):933-41. doi:10.1007/s00702-012-0768-0.

2. Atchison KA, Dolan TA. Development of the Geriatric Oral Health AssessmentIndex. J Dent Educ. 1990 Nov;54(11):680-7.

3. Bakke M, Larsen SL, Lautrup C, Karlsborg M. Orofacial function and oral health in patients with Parkinson's disease. Eur J Oral Sci. 2011 Feb;119(1):27-32. doi:10.1111/j.1600-0722.2010.00802.x.

4. Campos CH, Gonçalves TM, Garcia RC. Implant-Supported Removable Partial Denture Improves the Quality of Life of Patients with Extreme Tooth Loss. Braz Dent J. 2015 Oct;26(5):463-7. doi: 10.1590/0103-6440201300097.

5. Chaudhuri KR, Odin P, Antonini A, Martinez-Martin P. Parkinson's disease: the non-motor issues. Parkinsonism Relat Disord. 2011 Dec;17(10):717-23. doi:10.1016/j.parkreldis.2011.02.018.

6. Clifford T, Finnerty J. The dental awareness and needs of a Parkinson's disease population. Gerodontology. 1995 Dec;12(12):99-103.

7. Committee on Health and Behavior: Research, Practice, and Policy. Individuals and Families: Models and Interventions. In: Health and Behavior: The Interplay of Biological, Behavioral, and Societal Influences [internet]. Washington National Academies Press; 2001 [acesso 2016 jan 14] Disponível em: http://www.nap.edu/catalog/9838/health-and-behavior-the-interplay-of-biological-behavioral-and-societal.

8. da Silva SR, Castellanos Fernandes RA. [Self-perception of oral health status by the elderly]. Rev Saude Publica. 2001 Aug;35(4):349-55. Portuguese.

9. de Lau LM, Breteler MM. Epidemiology of Parkinson's disease. Lancet Neurol.2006 Jun;5(6):525-35.

10. Dirks SJ, Paunovich ED, Terezhalmy GT, Chiodo LK. The patient with Parkinson's disease. Quintessence Int. 2003 May;34(5):379-93.

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11. Einarsdóttir ER, Gunnsteinsdóttir H, Hallsdóttir MH, Sveinsson S, Jónsdóttir SR, Olafsson VG, *et al.* Dental health of patients with Parkinson's disease in Iceland. Spec Care Dentist. 2009 May-June;29(3):123-7.

12. Fontijn-Tekamp FA, Slagter AP, Van Der Bilt A, Van 'T Hof MA, Witter DJ, Kalk W, *et al.* Biting and chewing in overdentures, full dentures, and natural dentitions. J Dent Res. 2000 Jul;79(7):1519-24.

13. Friedlander AH, Mahler M, Norman KM, Ettinger RL. Parkinson disease: systemic and orofacial manifestations, medical and dental management. J Am Dent Assoc.2009 Jun;140(6):658-69.

14. Fukayo S, Nonaka K, Shimizu T, Yano E. Oral health of patients with Parkinson's disease: factors related to their better dental status. Tohoku J Exp Med. 2003 Nov;201(3):171-9.

15. Gazewood JD, Richards DR, Clebak K. Parkinson disease: an update. Am Fam Physician. 2013 Feb 15;87(4):267-73.

16. Hanaoka A, Kashihara K. Increased frequencies of caries, periodontal disease and tooth loss in patients with Parkinson's disease. J Clin Neurosci. 2009 Oct;16(10):1279-82. doi: 10.1016/j.jocn.2008.12.027.

17. Haralur SB. Clinical strategies for complete denture rehabilitation in a patient with Parkinson disease and reduced neuromuscular control. Case Rep Dent. 2015;2015:352878. doi: 10.1155/2015/352878.

18. Hatch JP, Shinkai RS, Sakai S, Rugh JD, Paunovich ED. Determinants of masticatory performance in dentate adults. Arch Oral Biol. 2001 Jul;46(7):641-8.

19. Heckmann SM, Heckmann JG, Weber HP. Clinical outcomes of three Parkinson's disease patients treated with mandibular implant overdentures. Clin Oral Implants Res. 2000 Dec;11(6):566-71.

20. Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. Neurology. 1967 May;17(5):427-42.

21. Kanli A, Demirel F, Sezgin Y. Oral candidosis, denture cleanliness and hygiene habits in an elderly population. Aging Clin Exp Res. 2005 Dec;17(6):502-7.

22. Karlsson S, Persson M, Johnels B. Levodopa induced ON-OFF motor fluctuations in Parkinson's disease related to rhythmical masticatory jaw movements. J Neurol Neurosurg Psychiatry. 1992 Apr;55(4):304-7.

23. Kennedy MA, Rosen S, Paulson GW, Jolly DE, Beck FM. Relationship of oral microflora with oral health status in Parkinson's disease. Spec Care Dentist.1994 Jul-Aug;14(4):164-8.

24. Locker D, Jokovic A, Clarke M. Assessing the responsiveness of measures of oral health-related quality of life. Community Dent Oral Epidemiol. 2004 Feb;32(1):10-8.

25. Lorefält B, Granérus AK, Unosson M. Avoidance of solid food in weight losing older patients with Parkinson's disease. J Clin Nurs. 2006 Nov;15(11):1404-12.

26. Lund JP. Mastication and its control by the brain stem. Crit Rev Oral Biol Med. 1991;2(1):33-64.

27. McGrath C, Bedi R. The importance of oral health to older people's quality of life. Gerodontology. 1999 Jul;16(1):59-63.

28. Movement Disorder Society Task Force on Rating Scales for Parkinson's Disease. The Unified Parkinson's Disease Rating Scale (UPDRS): status and recommendations. Mov Disord. 2003 Jul;18(7):738-50.

29. Müller T, Palluch R, Jackowski J. Caries and periodontal disease in patients with Parkinson's disease. Spec Care Dentist. 2011 Sep-Oct;31(5):178-81. doi:10.1111/j.1754-4505.2011.00205.x.

30. Nakayama Y, Washio M, Mori M. Oral health conditions in patients with Parkinson's disease. J Epidemiol. 2004 Sep;14(5):143-50.

31. Nussbaum RL, Ellis CE. Alzheimer's disease and Parkinson's disease. N Engl J Med. 2003 Apr 3;348(14):1356-64. Erratum in: N Engl J Med. 2003 Jun 19;348(25):2588.

32. Packer M, Nikitin V, Coward T, Davis DM, Fiske J. The potential benefits of dental implants on the oral health quality of life of people with Parkinson's disease. Gerodontology. 2009 Mar;26(1):11-8. doi:10.1111/j.1741-2358.2008.00233.x.

33. Paranhos HF, Silva-Lovato CH, Souza RF, Cruz PC, Freitas KM, Peracini A. Effects of mechanical and chemical methods on denture biofilm accumulation. J Oral Rehabil. 2007 Aug;34(8):606-12.

34. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century--the approach of the WHO Global Oral Health Programme. Community Dent Oral Epidemiol. 2003 Dec;31 Suppl 1:3-23.

35. Pinheiro JES. Doença de Parkinson e outros transtornos do movimento. In: Freitas EV, Py L, Neri AL, Cançado FAX, Gorzoni ML, Rocha SM. Tratado de Geriatria e Gerontologia. 3.ed. Rio de Janeiro: Guanabara Koogan; 2011. p.285-91.

36. Pringsheim T, Jette N, Frolkis A, Steeves TD. The prevalence of Parkinson's disease: a systematic review and meta-analysis. Mov Disord. 2014 Nov;29(13):1583-90. doi: 10.1002/mds.25945.

37. Rajeswari CL. Prosthodontic considerations in Parkinson's disease. PJSR. 2010 Jul; 3(2): 45-7.

38. Reichmann H. Clinical criteria for the diagnosis of Parkinson's disease.Neurodegener Dis. 2010;7(5):284-90. doi: 10.1159/000314478.

39. Ribeiro DG, Pavarina AC, Giampaolo ET, Machado AL, Jorge JH, Garcia PP. Effect of oral hygiene education and motivation on removable partial denture wearers: longitudinal study. Gerodontology. 2009 Jun;26(2):150-6. doi:10.1111/j.1741-2358.2008.00272.x.

40. Robertson LT, Hammerstad JP. Jaw movement dysfunction related to Parkinson's disease and partially modified by levodopa. J Neurol Neurosurg Psychiatry. 1996 Jan;60(1):41-50.

41. Schwarz J, Heimhilger E, Storch A. Increased periodontal pathology in Parkinson's disease. J Neurol. 2006 May;253(5):608-11.

42. Silva PF, Biasotto-Gonzalez DA, Motta LJ, Silva SM, Ferrari RA, Fernandes KP, *et al.* Impact in oral health and the prevalence of temporomandibular disorder in individuals with Parkinson's disease. J Phys Ther Sci. 2015 Mar;27(3):887-91. doi: 10.1589/jpts.27.887.

43. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health. 1994 Mar;11(1):3-11.

44. van der Bilt A, Fontijn-Tekamp FA. Comparison of single and multiple sieve methods for the determination of masticatory performance. Arch Oral Biol. 2004 Mar;49(3):193-8.

45. van der Bilt A, Olthoff LW, Bosman F, Oosterhaven SP. Chewing performance before and after rehabilitation of post-canine teeth in man. J Dent Res. 1994 Nov;73(11):1677-83.

46. van der Bilt A, Tekamp A, van der Glas H, Abbink J. Bite force and electromyograpy during maximum unilateral and bilateral clenching. Eur J Oral Sci. 2008 Jun;116(3):217-22. doi: 10.1111/j.1600-0722.2008.00531.x.

47. van der Bilt A. Assessment of mastication with implications for oral rehabilitation: a review. J Oral Rehabil. 2011 Oct;38(10):754-80. doi:10.1111/j.1365-2842.2010.02197.x.

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 **"Saúde bucal e função mastigatória em pacientes com doença de Parkinson"**, protocolo nº 097/2012, dos pesquisadores Renata Cunha Matheus Rodrigues Garcia, Camila Heitor Campos e Giselle Rodrigues Ribeiro, satisfaz as exigências do Conselho Nacional de Saúde - Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 01/11/2012.

The Ethics Committee in Research of the Piracicaba Dental School - University of Campinas, certify that the project **"Oral health and chewing function in patients with Parkinson's disease"**, register number 097/2012, of Renata Cunha Matheus Rodrigues Garcia, Camila Heitor Campos and Giselle Rodrigues Ribeiro, 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 on Nov 01, 2012.

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

ANEXO 2 - Protocolo de submissão do artigo 2.2 (Removable prostheses hygiene in elders with Parkinson's disease) no periódico *Gerodontology.*

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Gerodontology - Manuscript ID GER-15-OA-1668

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15-Oct-2015

Dear Prof. Rodrigues Garcia:

Your manuscript entitled "Removable prostheses hygiene in elders with Parkinson's disease" by Ribeiro, Giselle; Campos, Camila; Rodrigues Garcia, Renata, has been successfully submitted online and is presently being given full consideration for publication in Gerodontology.

Co-authors: Please contact the Editorial Office as soon as possible if you disagree with being listed as a co-author for this manuscript.

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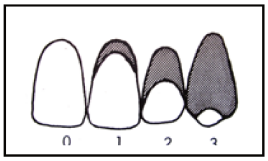
Sincerely,
Gerodontology Editorial Office

ANEXO 3 – Critérios para obtenção do Índice de Higiene Oral

Avaliação do biofilme e cálculos nas superfícies vestibulares e palatinas/linguais dos dentes superiores e inferiores presentes, exceto terceiros molares, sendo atribuídos escores de acordo com Greene e Vermillion (1960):

1. Escores para **biofilme**:



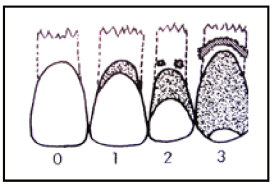
Escore 0 - ausência de biofilme

Escore 1 - biofilme cobrindo não mais de um terço da superfície do dente, ou a presença de manchas extrínsecas, sem outros resíduos, independentemente da superfície coberta

Escore 2 - biofilme cobrindo mais de um terço da superfície do dente, mas não mais que dois terços da coroa clínica do dente

Escore 3 - biofilme cobrindo mais de dois terços da coroa clínica do dente

2. Escores para **cálculo**:



Escore 0 - ausência de cálculo

Escore 1 - cálculo supragengival cobrindo não mais do que um terço da coroa clínica do dente

Escore 2 - cálculo supragengival cobrindo mais de um terço, mas não mais do que dois terços da coroa clínica do dente ou presença de manchas de cálculo subgengival ao redor da cervical do dente ou ambos

Escore 3 – cálculo supragengival cobrindo mais de dois terços da coroa clínica do dente ou presença de uma faixa densa de cálculo ao redor da cervical do dente ou ambos

Os Índices de biofilme e de cálculo foram obtidos por meio da soma dos escores totais atribuídos às superfícies vestibulares e linguais, divididos pelo número de dentes avaliados.

O Índice de Higiene Oral (IHO) foi obtido por meio da soma dos Índices de biofilme e cálculo (Greene e Vermillion, 1960).

ANEXO 4 – Critérios para avaliação das próteses totais e parciais removíveis

(Vigild, 1987)

1. Estabilidade:

Próteses totais: será exercida uma leve pressão dos dedos bilateralmente na região de pré-molares, na tentativa de inclinar, girar e deslocar a prótese total horizontalmente. A estabilidade será considerada satisfatória quando apenas leves movimentos forem provocados. *Próteses parciais:* será considerada satisfatória se não balançar através de pressão digital suave.

2. Retenção:

Próteses totais: será considerada satisfatória se a prótese permanecer no local durante abertura moderada da boca. *Próteses parciais:* será avaliada por uma tentativa de remover a prótese no sentido oposto ao da inserção. Se os grampos oferecerem resistência, a retenção será considerada satisfatória.

3. Oclusão:

Será avaliada apenas quando o voluntário possuir prótese total em ambas as arcadas.
A prótese total superior será pressionada firmemente nos tecidos de suporte e o voluntário será instruído a ocluir lentamente. Se a prótese mandibular movimentar-se no momento da oclusão, será registrada como insatisfatória.

4. Dimensão vertical:

Será avaliada apenas quando o voluntário possuir prótese total em ambas as arcadas.
Será registrada como *muito baixa, aceitável e muito alta,* através de um julgamento clínico baseado na harmonia facial dos voluntários.

5. Defeitos:

Os defeitos serão classificados como presentes ou ausentes e apenas principais defeitos serão registrados, como flanges quebradas, dentes perdidos ou fraturados e/ou perda de grandes pedaços da base da dentadura.

ANEXO 5 – Geriatric Oral Health Assessment Index – GOHAI (Atchison e Dolan, 1990; Silva e Castellanos Fernandes, 2001)

Componentes – Índice GOHAI			
Nos últimos três meses... Quantas vezes você...	**Sempre (1)**	**Ás vezes (2)**	**Nunca (3)**
1. Diminuiu a quantidade de alimentos ou mudou o tipo de alimentação por causa de seus dentes ou próteses?			
2. Teve problemas para mastigar os alimentos?			
3. Teve dor ou desconforto para engolir os alimentos?			
4. Mudou o jeito de falar por causa dos problemas de sua boca?			
5. Sentiu algum desconforto ao mastigar algum alimento?			
6. Deixou de encontrar com outras pessoas por causa de sua boca?			
7. Sentiu-se satisfeito ou feliz com a aparência de sua boca?			
8. Teve que tomar remédio para passar alguma dor ou desconforto na boca?			
9. Teve problemas na boca que o deixou preocupado?			
10. Chegou a se sentir nervoso por causa de problemas na sua boca?			
11. Evitou comer junto com outras pessoas por causa dos problemas na sua boca?			
12. Sentiu seus dentes ou gengivas ficarem sensíveis a alimentos ou líquidos?			
	Total:		
	Índice GOHAI **Alto:** 34 a 36 **Moderado:** 33 a 31 **Baixo:** <30 (Silva *et al.*, 2005)		

ANEXO 6 – Critérios para avaliação do biofilme nas próteses removíveis

1. Enxaguar as próteses em água corrente por 5 segundos para remoção de possíveis resíduos alimentares.
2. Aplicação do corante vermelho neutro a 1% com um "swab" sobre a superfície das próteses.
3. Nas próteses totais (PT), serão avaliados oito locais das mesmas, sendo 4 na superfície labial/vestibular e 4 na superfície de assentamento das próteses (Ausberger e Elahi, 1982). Nas próteses parciais removíveis (PPR), como há diferentes classificações de Kennedy e modificações, será escolhida a maior área edêntula para avaliação. Se houver áreas edêntulas com mesmo número de dentes artificais, ambas áreas serão avaliadas. Desta forma, será avaliada a superfície labial/vestibular e a superfície de assentamento da maior área edêntula da PPR.

4. Os escores da PT e PPR serão atribuídos de acordo com a quantidade de biofilme revelada pelo corante em cada local (Augsburger e Elali,1982):

Escore 0: sem biofilme
Escore 1: biofilme leve (1% a 25% da superfície da prótese corada)
Escore 2: biofilme moderado (26% a 50% da superfície da prótese corada)
Escore 3: biofilme pesado (51% a 75% da superfície da prótese corada)
Escore 4: biofilme muito pesado (76% a 100% da superfície da prótese corada)

5. O índice final de biofilme de cada prótese total (PT) será obtido pela média dos oito escores. Nas próteses parciais removíveis (PPR), o índice final será obtido pela média dos escores da maior área edêntula.

6. O índice final de biofilme nas próteses será obtido pela média dos índices das próteses superior e inferior.

ANEXO 7 – Oral Health Impact Profile – OHIP-49 (Slade e Spencer, 1994; Pires eu al., 2006)

Marque a resposta que indique com qual freqüência cada um dos problemas ocorreu.

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

ANEXO – 8 - Figuras - Movimentos mandibulares, movimentos durante a mastigação e performance/eficiência mastigatória.

Figura 1 – Ímã posicionado por meio de um adesivo aos incisivos inferiores da prótese do voluntário.

Figura 2 – Dispositivo sensor magnético do Cinesiógrafo (JT-3D; BioResearch, Milwaukee, WI, EUA) acoplado à cabeça do voluntário - capta a amplitude de movimento da mandíbula e posteriormente os movimentos durante a mastigação de Optocal por 40 ciclos mastigatórios.

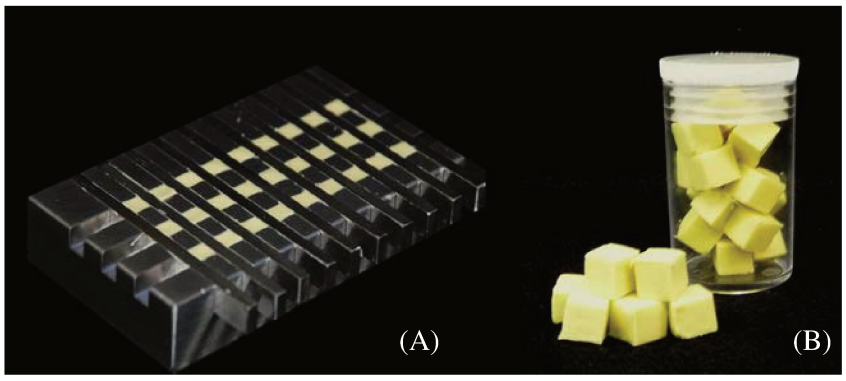


Figura 3- Confecção de cubos de Optocal com 5,6mm de aresta, utilizando-se matriz metálica (A) e porção contendo 17 cubos de Optocal em um total de 3,7g (B).

Figura 4- Porção contendo 17 cubos de Optocal sendo colocada sobre a língua do voluntário para avaliação dos movimentos durante a mastigação e performance mastigatória (A). Material teste triturado sendo dispensado sobre um filtro de papel (B).

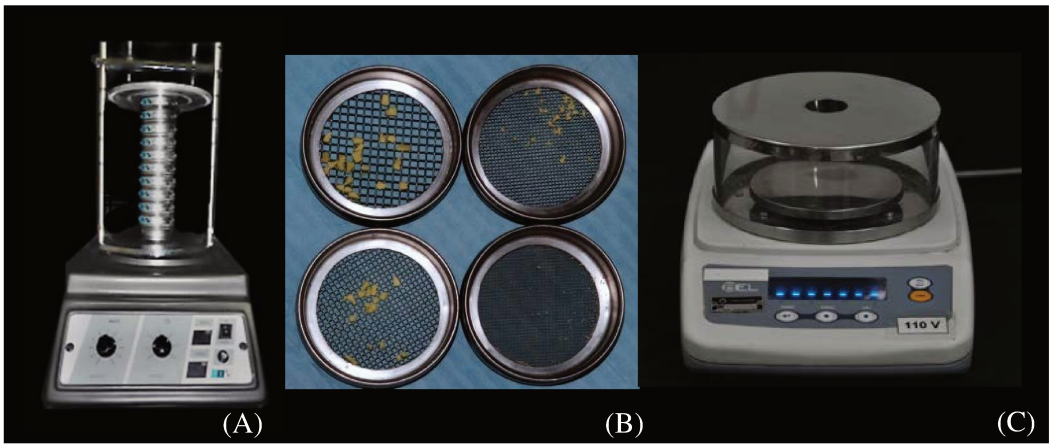


Figura 5 - Sistema de peneiras acopladas ao agitador (Bertel Indústria Metalúrgica Ltda., São Paulo, Brasil), material retido nas peneiras de diferentes tamanhos de abertura (B) e balança analítica 0,001 g (Marcos; BEL Engineering, Milão, Itália) utilizada para pesar o material retido nas peneiras (C).

ANEXO 9 – Figuras – Força máxima de mordida

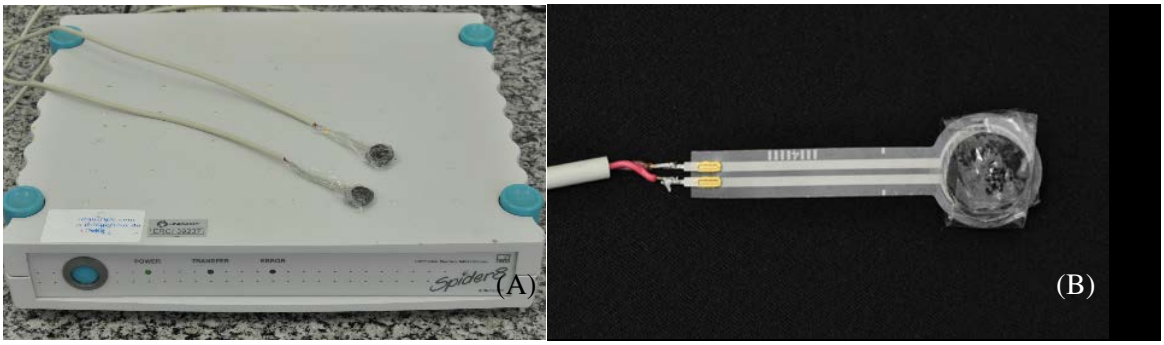


Figura 6 - Transdutor de força de mordida (Spider 8; Hottinger Baldwin Messtechnik GmbH, Darmstadt, Alemanha) (A). Sensores (FSR n.º 151.), com 12,7 milímetros de diâmetro e 0,25 mm de espessura (Interlink Electronics Inc., Camarillo, Califórnia, EUA), protegidos por discos de metal de 0,7 mm de espessura e envoltos por um filme plástico (B).

Figura 7 - Sensores (FSR n.º 151.) posicionados sobre a região de primeiros molares, bilateralmente.