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Does a mandibular RDP and new maxillary CD improve masticatory efficiency and quality of life in patients with a mandibular Kennedy class I arch?

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Abstract

Objectives To evaluate the change in masticatory efficiency and quality of life of patients treated with mandibular Kennedy class I removable partial dentures (RPDs) and maxillary complete dentures at the Department of Dentistry of the Federal University of Rio Grande do Norte.

Materials and methods A total of 33 Kennedy class I patients were rehabilitated with maxillary complete dentures, and mandibular RPDs were selected for this non-randomized prospective intervention study. The patients had a mean age of 59.1 years. Masticatory efficiency was evaluated by colorimetric assay using fuchsin capsules. The measurements were conducted at baseline and 2 and 6 months after prosthesis insertion. Quality of life was evaluated using the Oral Health Impact Profile (OHIP-14) at baseline and 6 months after denture insertion. The Kolmogorov-Smirnov normality test was applied. Masticatory efficiency was evaluated by repeated measures ANOVA. Oral health-related quality of life was compared using the paired *t* test.

Results There was no statistically significant difference in masticatory efficiency after denture insertion ($p=0.101$). Significant differences were found ($p=0.010$) for oral health-related quality of life. A significant improvement in psychological discomfort ($p<0.01$) and psychological disability ($p<0.01$) was observed. Mean difference value (95 % confidence interval) was 6.8 (3.8 to 9.7) points, reflecting a low impact of oral health on quality of life, considering the 0–56 range of variation of the OHIP-14 and a Cohen's *d* of 1.13.

Conclusion According to the results of the present study, rehabilitation with Kennedy class I RPDs and complete dentures did not influence masticatory efficiency but improved oral health-related quality of life.

Clinical relevance The association between the patient's quality of life and the masticatory efficiency is important for treatment predictability.

Keywords Mandible · Mastication · Quality of life · Partially edentulous arch · Dental prosthesis

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Introduction

The oral rehabilitation of edentulous patients aims to restore masticatory function, impairment of which can restrict nutrition and digestion, and improve esthetics [1]. Walls et al. [2] stated that dentition is a significant factor for efficient chewing, which is important for the maintenance of bodily nutrition as well as systemic, psychological, and physical functions. However, other studies have suggested that nutrition does not improve after the fitting of new dentures [3–5]. Awad et al. [3] suggested that implant overdentures do not have a more positive post-treatment effect on the nutritional state of elderly edentate individuals than new complete dentures. Similarly, Khoo et al. [4] demonstrated that the insertion of mandibular implant-supported overdentures did not cause an improvement in body mass index (BMI), serum albumin value, or nutritional status. Muller et al. [5] found no difference in chewing efficiency between an implant overdenture group and a mandibular complete denture group, in terms of BMI, nutritional assessment, and blood markers, reflecting the fact that nutritional intake is complex and not solely determined by dental condition.

Several methods of evaluating the masticatory performance of Kennedy class patients, with or without free-end removable partial dentures, have been suggested. However, no significant difference was found when comparing patients who used RPDs and those who did not. Those studies that found a difference in terms of gender and occlusal units employed inaccurate methods of evaluation [6, 7]. In addition, chewing force has at times been evaluated as a single, isolated factor, despite the fact that other factors, such as craniofacial dimensions, may also influence the chewing force [8]. A reduction in masticatory function may also be related to reduced occlusal contact [9], which deteriorates after the loss of posterior teeth.

According to evaluations of oral health-related quality of life, the lack of rehabilitation after tooth loss affects quality of life. In this sense, partial edentulism represents a negative factor, as it causes pain and influences chewing, phonetics, and esthetics [9, 10].

Oral health-related quality of life (OHRQoL) is the patient's perspective of his or her oral health. Several questionnaires have been developed to evaluate the association between quality of life and oral health. According to Locker's conceptual model, the Oral Health Impact Profile (OHIP) has verified satisfactory psychometric properties and has been demonstrated to be the most sensitive method of detecting dissatisfaction with prosthetic rehabilitation [11–13]. The OHIP-14 is a concise questionnaire showing similar results to the original, and longer, OHIP-49 [14, 15].

Partial edentulism affects chewing and the quality of life of patients. There are some limitations with the use of a removable partial denture due to the supporting structures. A clasp-retained RPD, a low-cost rehabilitation, can contribute to the

restoration of some oral functions lost after tooth loss, and studies have shown that such treatment often leads to an improvement in OHRQoL [16]. Arabi et al. [17] found that the effects of prosthodontic interventions on patient perception seem to last for at least 2 years, including in a group treated with a RPD. While better quality of life results have been obtained with fixed dentures, additional studies are required to evaluate the effect of conventional fixed and removable dentures in a global context [16, 17]. Little data is available from randomized controlled clinical trials (RCTs) of treatment options. Most of the studies evaluating oral health-related quality of life applied the test within the 5 years following rehabilitation [18].

The recent increase in the number of publications focusing on the long-term effects of prosthodontic interventions on patient perceptions implies a steadily increasing interest in this information [17, 19]. However, although OHRQoL is expected to be an important outcome of prosthodontics therapy, cross-sectional and longitudinal data, according to John et al. [16], is available mainly for patients treated with complete dentures or implant-supported overdentures, such as in the studies of Allen et al. [19] and Heydecke et al. [20]. Furthermore, evaluation of masticatory performance and quality of life together can contribute to improved choice of treatment and positively influence the prognosis. Therefore, the aim of this study was to evaluate the influence of new free-end removable partial dentures and maxillary complete dentures on masticatory function and quality of life in Kennedy class I patients. The hypothesis was that RPD would have a positive effect on masticatory efficiency and on oral health-related quality of life.

Materials and methods

Setting and participants

A non-randomized prospective intervention study (2 and 6 months) was conducted. Kennedy class I patients were rehabilitated with maxillary complete dentures and mandibular RPDs. The treatment was conducted at the Department of Dentistry of the Federal University of Rio Grande do Norte (UFRN). Preexisting dentures were replaced due to poor quality. The mean number of remaining mandibular teeth was 6 (± 1.1), ranging from 4 to 8 at baseline for the group without RDP. The mean number of remaining mandibular teeth was 5 (± 1.5), ranging from 2 to 7 at baseline for the group with RDP. The occlusal units (OUs) ranged from 0 to 2, with a mean of 0.54 (± 0.7) OU at baseline for the group without RDP, and ranging from 0 to 2, with a mean of 0.56 (± 0.7) OU for the group with RDP. The study was approved by the Research Ethics Committee of University Hospital Onofre Lopes (protocol #60244).

In order to determine the socioeconomic profile of the research subjects, participants answered a questionnaire on health care, education level, and monthly individual income, categorized by the number of minimum wages, which is defined as the lowest wage that a company can pay an employee, established by law and reassessed every year based on the cost of living of the population. Table 1 shows the socioeconomic information of the patients. Of the patients, 57.5 % had health insurance coverage, while 51.5 % had not finished secondary education, and 60.6 % had a monthly individual income 0–2 times the minimum wage.

A total of 30 patients were evaluated in each period, revealing a 50 % difference in masticatory efficiency between baseline and 6 months afterward, with a 95 % level of confidence and 80 % power.

The inclusion criteria were that all patients should wear a maxillary complete denture (CD) or a mandibular Kennedy class I RPD. Temporomandibular disorders, facial deformities, and reduced occlusal vertical dimension were considered exclusion criteria.

New prostheses were fabricated for all the patients in the present study. The patients were treated by predoctoral students at the Dental School of the Federal University of Rio Grande do Norte under the mentoring of the prosthodontics professor (Adriana da Fonte Porto Carreiro). Six clinical steps were conducted according to the procedures suggested by Carr et al. [21]. The first step involved gathering patient information, while the second stage comprised treatment planning. The third step was functional impression, while the fourth stage consisted of occlusal relation and tooth distribution. The fifth step included denture insertion and occlusal adjustment. Bilateral balanced occlusion was established, and acrylic resin artificial teeth Biolux and Trilux (Dental Vipi Ltd., São Paulo, Brazil) were used.

Table 1 Sample distribution according to socioeconomic profile: absolute values (*n*) and percentage

Socioeconomic profile		
Health insurance coverage	Number	Percent
Covered	19	57.5
Not covered	14	42.4
Level of education		
Elementary education	4	12.1
Secondary school	17	51.5
Higher education	12	36.3
Individual monthly income		
0–2 minimum wages	20	60.6
3–4 minimum wages	11	33.3
5 or more minimum wages	2	6.0
Total	33	100

Brazilian currency standard (BRL \$724.00)

Each denture was designed with an occlusal rest in the mesial surface of the posterior tooth, a cingulum rest in composite resin far from the edentulous area, a T-bar clasp in the posterior and anterior teeth adjacent to the free-end area, a lingual bar (8 mm between the free gingival margin and the mouth floor), or a lingual plate as major connectors. The metallic framework was fabricated in cobalt-chromium (Co-Cr) alloy. Recall appointments were conducted at 24 h; 7, 15, 30, and 60 days; and 6 months after denture insertion.

For fabrication of the maxillary CD, first the anatomical impressions were made, and the study models obtained. Secondly, the preparation and adjustment of the orientation plans were performed. After the mounting had been made in the semi-adjustable articulator, the proof of the artificial teeth was made. Finally, installation and control were carried out.

Measuring took place at baseline and 2 and 6 months after prosthesis insertion. Quality of life was evaluated using the OHIP-14 at baseline and 6 months after denture insertion. Baseline was characterized by patients requiring treatment regardless of the presence of previous dentures. All patients had a maxillary complete denture (*n*=33), and some of the patients had a mandibular RPD (*n*=11).

Assessment of masticatory function

Masticatory efficiency data was based on the ability to chew natural or artificial food tested using a colorimetric assay, as suggested by Santos et al. [22]. In the present study, rectangular (50 mm×35 mm) capsules (Laboratory JP-Farmacêutica, Ribeirão Preto, Brazil) with a PVC external layer (0.2 mm in thickness) containing 250 g of fuchsin beads were used. Each bead was coated with Eudragite E100® (Rohm Pharma GmbH, Weiterstadt West, Germany) and standardized to 1 mm in diameter. The beads exhibited resistance to kneading, as was previously established using a universal testing machine (Dental School of Ribeirão Preto, University of São Paulo, São Paulo, Brazil) [22].

The patients were asked to chew the capsules for 20 s during masticatory efficiency testing. No additional information was provided to simulate habitual chewing. All patients were comfortably seated with their feet flat on the floor. At the end, the capsules were evaluated in the laboratory of the Department of Biochemistry at the Center of Health Science of UFRN.

The capsules were opened by a technician with no knowledge of the rehabilitation process of the patients. The capsule content was dissolved in 5 ml of distilled water, and the solutions were mechanically mixed (Mechanical Shaker Certomat MV, B. Braun Biotech International, Melsungen, Germany) for 30 s.

The solution was filtered in a gray filter paper-0.007 (Quantitative filter paper Quanty, J. Prolab®, São José dos Pinhais, Brazil) to remove the beads that were not triturated.

Masticatory efficiency was calculated based on the absorbance of the fuchsin solution measured in a spectrophotometer (Ultrospec 2100 pro UV/Visible Spectrophotometer, GE Healthcare, Piscataway, New Jersey, USA). The higher the absorbance values, the better the masticatory efficiency of the patient.

Assessment of OHRQoL

Oral health-related quality of life was assessed using the OHIP-14 questionnaire, which is a simplified form of the OHIP-49 questionnaire. The OHIP-14 has been tested and validated in its Portuguese language version [23]. This questionnaire contained a total of 14 questions, with two questions for each of the following parameters: functional limitation, pain, psychological discomfort, physical disability, psychological disability, social disability, and inability. Responses were given on a five-point scale (0=never, 1=hardly ever, 2=occasionally, 3=fairly often, and 4=very often). Higher scores implied poorer OHRQoL, as the OHIP index measures the frequency of problems. The OHIP-14 variation range is 0–56. The patients answered the questionnaire without any interference from the researchers. The OHIP-14 questionnaire was applied before and 6 months after RPD rehabilitation, as the Portuguese version asks the patient to provide information about the preceding 6 months, representing the minimum period for a new evaluation [23]. The results were evaluated using the additive method, representing the sum of the points (0–4) assigned to the responses to each item.

Statistical analysis

Data was inserted into an Excel 2007 (Microsoft, Redmond, Washington, USA) spreadsheet and transferred to the SPSS® statistics 17.0 for Windows (SPSS Inc., Chicago, Illinois, USA) program for comparison of all variables. The Kolmogorov-Smirnov normality test was applied. Since data fitted normal distribution, masticatory efficiency was evaluated by repeated measures ANOVA. Oral health-related quality of life was compared using the paired *t* test. In this phase, the mean differences between groups and the effect size (ES) of Cohen's *d* were also calculated to determine the strength of the difference between the baseline and follow-up [24]. All analyses were conducted at 5 % level of significance.

Results

The sample included 33 patients (7 males and 26 females) with a mean age of 59.2 (± 10.1) (39–82) years. Of the patients, 57.5 % had health insurance, 51.5 % had concluded secondary school, and 60.6 % reported a monthly income of 0 to 2 minimum wages (Table 1).

When making the comparison between the number of remaining teeth and groups of patients with or without PPR at baseline, no statistically significant difference was observed between the groups in terms of the number of remaining teeth ($p=0.122$).

No statistically significant difference ($p=0.101$) was observed in the masticatory efficiency variable for all periods, although there was a change immediately after the provision of the new dentures, and after 2 and 6 months, these values had again returned to baseline level (Table 2).

Table 3 shows improvement in oral health-related quality of life 6 months after installation of the new RPD, in terms of general OHIP-14 results and the evaluation of seven dimensions. The OHIP-14 results were reduced by 66 % (additive method) (baseline 10.2 and 6 months 3.4), showing a statistically significant positive impact of oral health on quality of life ($p<0.01$). Mean difference value (95 % confidence interval) was 6.8 (3.8 to 9.7) points, and Cohen's *d* was 1.13. According to Cohen, an effect size of $d=0.2$ is considered to be small, 0.5 medium, and 0.8 large [24]. Therefore, the effect sizes based on these changes were considered large. Significant improvement in psychological discomfort ($p<0.01$) and psychological disability ($p<0.01$) was also observed.

Discussion

There was no statistically significant difference in masticatory efficiency after denture insertion. However, significant differences in oral health-related quality of life were observed. It is important to highlight that the aim of this study was not to determine masticatory efficacy in RPD patients but to evaluate the effect of RPD on the masticatory efficacy of each patient, displaying results before and after rehabilitation.

Masticatory efficiency is an important statistic, but evaluating it is not an easy process. Several methods have been

Table 2 Values of absolute frequency, mean, and standard deviation of masticatory efficiency of all individuals at different periods of evaluation

Masticatory efficiency				
Period	<i>n</i>	Mean	SD	<i>p</i> ^a
Baseline	33	0.075	0.053	0.101
Insertion	33	0.054	0.030	
2 Month follow-up	33	0.068	0.039	
6 Month follow-up	33	0.077	0.029	

The higher the average value, the better the patient's masticatory efficiency

n sample size

^a Repeated measures ANOVA

Table 3 OHIP values of the respective dimensions in relation to time: baseline and 6 months after wearing an RPD

Dimension	<i>n</i>	Baseline		6-Month follow-up		Mean change score (95 % CI)	Cohen's <i>d</i> (ES)	<i>p</i> ^a
		Mean	SD	Mean	SD			
Functional limitation	33	2.03	2.63	1.12	1.55	0.9 (−0.1–1.9)	0.42	0.12
Physical pain	33	3.06	2.12	2.08	2.18	0.9 (−0.0–2.0)	0.45	0.91
Psychological discomfort	33	3.32	2.89	1.58	2.24	1.7 (0.4–3.0)	0.67	<0.01
Physical disability	33	2.77	2.83	1.73	2.30	1.0 (−0.3–2.3)	0.40	0.13
Psychological disability	33	3.06	2.44	1.42	2.08	1.6 (0.5–2.7)	0.72	<0.01
Social disability	33	1.16	1.79	0.73	1.11	0.4 (−0.3–1.1)	0.28	0.29
Incapacity	33	1.94	2.44	0.88	1.65	1.0 (0.0–2.0)	0.50	0.06
OHIP	33	10.25	7.23	3.44	4.48	6.8 (3.8–9.7)	1.13	<0.01

^a Repeated measures ANOVA test

suggested [25–28], most of which are based on the ability of food trituration measured by different graduated sieves. According to Nakasima et al. [29], these methods are not standardized as food may change due to pH alteration and saliva. In addition, these methods cannot easily be performed in clinical practice [30].

In the present study, there was no material loss by swallowing, something that is typically observed with chewing and swallowing food. Furthermore, the capsules were immediately evaluated, preserving their physical properties and avoiding dissolution in saliva. However, it is known that the use of standardized test materials based on silicon compounds during masticatory analysis with the sieving method neutralized saliva interference issues [31].

According to the results of the present study, Kennedy class I RPDs did not result in a positive effect on masticatory efficiency at the different evaluation times. However, the number of remaining mandibular occlusal unities may have influenced the results, as this factor was not standardized among the individuals. The absence of standardization of the number of remaining teeth and consequently the number of occlusal units influenced the uniformity of the sample, as the study included patients with different characteristics classed according to oral function, which included chewing ability [32].

The other possible explanation for these results could be related to the methodology applied. The colorimetric method seems to be less specific when detecting small differences between treatments. According to Silva et al. [33], the capsules are tough and hard to chew. These authors also pointed out that the sieve method might be more suitable for evaluating patients with posterior partial edentulism.

The lack of statistical significance in relation to the masticatory efficiency variable may be explained by the effect of a small sample size, which might be too small to detect the observed difference.

The masticatory efficiency values reported in the study are in accordance with those obtained by the study by Ribeiro

et al. [34], which used the same method to evaluate patients wearing complete dentures. Aras et al. [6] observed no significant improvement in masticatory efficiency over time when wearing RPDs, as was found in the present study.

Wolfart et al. [19] conducted a multicenter randomized controlled trial with 215 patients and did not find a statistically significant difference between treatments with shortened dental arches (SDAs) and RPDs after different periods of evaluation (before; 6 weeks, 6, and 12 months after treatment; and thereafter annually for 5 years). However, better quality of life was observed within each group using the OHIP-49 questionnaire, as was also found in the present research.

The mean values are directly proportional to masticatory efficiency, or in other words, the higher the average value, the better the masticatory efficiency of the patient (Table 2). It was noted that after the installation of new prostheses, there was a decrease in values of efficiency, indicating that during this period, the patient is adapting to the new condition, as he or she had been accustomed to the use of old dentures. Therefore, it is very important to maintain control and maintenance appointments after the installation of new prostheses. After 2 and 6 months of use, these values increased, indicating that it, a period of adaptation, is necessary for the patient to learn to chew satisfactorily with the new prosthesis.

According to Strassburger et al. [35], tools such as OHIPs have been widely used for evaluation of the impact of dental prosthesis on patient satisfaction and oral health-related quality of life. The OHIP-14 values declined 6 months after denture insertion, and a statistical difference was observed in comparison with the initial condition. McGrath and Bedi [10] reported that individuals with tooth loss and no dental rehabilitation exhibited a significant reduction in oral health-related quality of life.

The decrease in the standard deviation (SD) of the sum OHIP scores after 6 months was an indicator of the beneficial effect of the treatment in terms of the perception of quality of life of the patient. As the OHIP is a problem index and the

numbers of problems decrease after treatment, there was a decrease in variance in the scores and consequently a decrease in SD (Table 3).

The OHIP-14 questionnaire was selected as it presents similar properties to the original OHIP-49. As OHIP-14 is concise, it is a less time-consuming approach in evaluating oral health and quality of life [15].

The sample type was non-probabilistic and voluntary, in which participants were chosen by the criteria of availability and convenience. This type of sample was chosen because of the difficulty in finding patients with the same maxilla toothless and full arch Kennedy class I mandibular characteristics, and operational difficulties, as all these patients needed to be rehabilitated at the end of the study. This type of sample was chosen because of the difficulty in obtaining a probabilistic sample, which would have been the ideal approach. Therefore, one limitation of the study is an inability to generalize the results for other groups, as well as the possibility of selection bias.

Another limitation of the study was that it was not controlled and randomized. In addition, there was no standardization for the number of remaining occlusal unities.

The inclusion of patients requiring RPD rehabilitation was an additional limitation of this study as some characteristics (i.e., extensive free-end area) probably influenced masticatory efficacy results. Another limitation of the present study was the short follow-up period.

Although no statistically significant difference in masticatory efficacy was found before and 6 months after using a mandibular RPD, improvement in quality of life was observed 6 months after denture insertion. These findings probably resulted from the association between several factors related to well-being and quality of life measured by the OHIP-14. The functional limitation of chewing is only one of the OHIP-14 dimensions, while other results, including reduced psychological discomfort and disability, influenced the improvement in quality of life. Furthermore, while the applied test for masticatory function is an objective measure, OHRQoL is a subjective measure of the patient's perspective, and these two perspectives do not necessarily match. This highlights the fact that OHRQoL is the more important measure of oral function, as it presents the patient's perspective or, in other words, what a patient perceives, which is of uppermost importance.

Further studies are required to evaluate the effect of RPDs on masticatory efficiency and quality of life in Kennedy class I arches.

Conclusion

The results of the present study indicated that dental rehabilitation with mandibular Kennedy class I RPDs and maxillary complete dentures did not influence masticatory efficiency.

However, these forms of treatment had a positive impact on patient oral health-related quality of life.

Compliance with ethical standards

Ethical standards All procedures performed in studies involving human participants 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.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare that no conflicts of interest exist with regard to the present study.

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