Evaluation of Complete Denture Quality and Masticatory Efficiency in Denture Wearers

Jaiane Augusta Medeiros Ribeiro, DDS, MSc[a]/Camila Maria Bastos Machado de Resende, DDS, MSc[a]/
Ana Lílian Correia Lopes, DDS[b]/Wilson Mestriner Júnior, DDS, MSc, PhD[c]/
Ângelo Giuseppe Roncalli, DDS, MSc, PhD[d]/Arcelino Farias-Neto, DDS, MSc, PhD[e]/
Adriana da Fonte Porto Carreiro, DDS, MSc, PhD[d]

Purpose: This study aimed to investigate *(1)* the influence of complete denture quality and years of denture use on masticatory efficiency and *(2)* the relationship between complete denture quality and years of use. ***Materials and Methods:*** A cross-sectional study was conducted with 93 edentulous patients (mean age: 65.6 years) wearing both mandibular and maxillary dentures. Patients were classified into two categories according to years of denture use: ≤ 2 years and ≥ 5 years. Masticatory efficiency was evaluated via the colorimetric method with beads as the artificial test food. A reproducible method for objective evaluation of the technical quality of complete dentures was employed. The association between denture quality and years of denture use was analyzed using chi-square and Fisher exact tests. The results of masticatory efficiency testing were analyzed using two-way analysis of variance (with the Tukey post hoc test) in terms of years of denture use (≤ 2 years, ≥ 5 years) and denture quality (poor, average, good). ***Results:*** A significant relationship was found between denture quality and years of denture use ($P < .05$). Masticatory efficiency differed significantly ($P < .05$) between patients with ≤ 2 years of denture use (0.101 ± 0.076 absorbance) and ≥ 5 years of use (0.068 ± 0.076 absorbance). Masticatory efficiency was not influenced by denture quality. ***Conclusions:*** Complete denture quality and masticatory efficiency significantly decreased over time. However, complete denture quality did not influence masticatory efficiency. *Int J Prosthodont 2012;25:625–630.*

Edentulism is a common disability that frequently affects patients' quality of life. The major functional limitations of edentulism can include reduced eating and speaking abilities. The success of complete denture (CD) treatment has been subjectively evaluated regarding patients' comfort and mastication,[1,2] but these results may have been influenced by the examiner.[3] Thus, objective factors should be investigated, such as denture retention, stability, vertical dimension of occlusion, and esthetics, all of which are commonly associated with patient complaints following treatment.[3] Vervoorn et al[4] stressed the importance of standardized criteria for evaluation of CD quality in scientific research. In light of this requirement, Sato et al[2] proposed an index to perform reproducible and evidence-based quantitative analysis of denture quality.

Deficient retention and stability are among the primary complaints of CD wearers regarding mastication. Studies have found that various oral conditions and CD quality may affect masticatory efficiency in denture wearers.[1,5,6] According to Yoshizumi,[1] the quality of CDs tends to decrease substantially over time. From the fourth year on and particularly after the eighth year of use, a larger number of patients with CDs present chewing problems.[1] Replacement of worn dentures with new ones that offer balanced occlusion and satisfactory retention and stability seems to significantly increase masticatory efficiency.[7] However, the results reported by Gunne et al[8] were inconclusive regarding the improvement in masticatory efficiency following fabrication of high-quality CDs.

While it is obvious that the provision of new CDs should improve the general health of the stomatognathic system for elderly patients, little is known about the influence of CD quality on masticatory

[a]*Graduate Student, Department of Dentistry, Federal University of Rio Grande do Norte, Natal, Brazil.*
[b]*Undergraduate Student, Federal University of Rio Grande do Norte, Natal, Brazil.*
[c]*Professor, Ribeirão Preto Dental School, University of São Paulo, São Paulo, Brazil.*
[d]*Professor, Department of Dentistry, Federal University of Rio Grande do Norte, Natal, Brazil.*
[e]*Professor, Health School, Potiguar University, Natal, Brazil.*

Correspondence to: *Jaiane Augusta Medeiros Ribeiro, Rua da Saudade, 996 - Lagoa Nova, Natal/RN, Brazil 59056-400. Email: jaiaugusta@gmail.com*

efficiency. Therefore, the purposes of this study were to evaluate *(1)* the relationship between CD quality and years of use, *(2)* the influence of CD quality on masticatory efficiency, and *(3)* the influence of years of denture use on masticatory efficiency. The research hypotheses were that *(1)* CD quality decreases over time, *(2)* CD quality positively influences masticatory efficiency, and *(3)* masticatory efficiency decreases over time.

Materials and Methods

Study Design

This cross-sectional study was conducted at the Department of Dentistry, Federal University of Rio Grande do Norte, Natal, Brazil. The study was approved by the Research Ethics Committee (no. 48/2010). Edentulous patients treated at the Prosthodontics Clinic between 2004 and 2009 were invited to join the sample. After a preliminary examination, patients wearing both maxillary and mandibular dentures were selected. Exclusion criteria were presence of polyarthritis or other rheumatic diseases, xerostomia, severe oral manifestations of systematic diseases, and psychologic or psychiatric conditions that could influence data collection.

The sample comprised 93 edentulous patients (17 men, 76 women; mean age: 65.6 ± 9.2 years) wearing both mandibular and maxillary dentures. After providing informed consent, patients filled out a personal-information questionnaire (name, address, phone number, age, sex). Patients were classified into one of two categories according to years of denture use: up to 2 years of use (n = 41) and 5 or more years of use (n = 30). Patients who did not fit into one of these categories were excluded for this variable. All dentures had been constructed according to the classic two-step procedure. Preliminary impressions were made using stock edentulous trays (Tecnodent) and irreversible hydrocolloid impression material (Jeltrate, Dentsply). The final impression was taken using a custom tray with border-molded impression compound (Impression Compound, Kerr) followed by a zinc oxide–eugenol impression (Horus, Dentsply). Dentures were made in centric occlusion with balanced articulation and anatomically shaped acrylic resin teeth (cuspal inclination: 33 degrees; Trubyte Biotone, Dentsply).

Assessment of Denture Quality

The criteria used for evaluation of the technical quality of CDs were established in accordance with Sato et al.[2] This is a reproducible method for quantitative clinical examination of CDs. This evaluation involved assessment of seven factors relevant to the technical quality of CDs:

1. Anterior teeth arrangement: First, it was verified that the height of the anterior teeth and the inclination of the anterior occlusal plane were in harmony with the patient's face. The height of artificial teeth was analyzed according to the smile line to ensure that the cervical region of the maxillary central incisor coincided with that line. For the smile curve, it was determined whether the incisal border of the maxillary central incisors touched the line of the moist part of the lower lips through the pronunciation of "F" and "V" sounds. Finally, patients were asked to smile in order to check the harmony of the smile curve. Score 1 = all factors were satisfactory, score 2 = only one satisfactory factor, and score 3 = all factors were unsatisfactory.
2. Interocclusal distance: The patient was seated in a comfortable position with his or her back away from the backrest and instructed to relax and bring the lips together lightly in an unstrained and relaxed manner. The distance that the mandibular incisal edge moved from this position to intercuspation was estimated with the lips carefully parted. Score 1 = distance between 1 and 4 mm, score 2 = distance between 5 and 7 mm, and score 3 = distance greater than 7 mm or smaller than 1 mm.
3. Stability of the mandibular denture: First, manual pressure was applied simultaneously on both first premolars. Next, pressure was applied separately on the right side and then the left side of the denture, supplemented by pressure in an oblique direction on each side. Score 1 = denture movement within a normal tissue pattern (from 1 to 2 mm), score 2 = some instability occurred (denture moved but did not shift), and score 3 = denture shifted.
4. Occlusion: The presence of correct intercuspation and simultaneous bilateral contacts between maxillary and mandibular dentures was verified. Occlusal contacts were checked using a carbon film (AccuFilm II, Parkell). Patients were asked to repeat the operation at least three times to verify the correct position and increase the reliability of the examination. Score 1 = correct intercuspation, score 2 = only one side presented correct intercuspation, and score 3 = incorrect intercuspation on both sides.
5. Articulation: The denture was checked for bilateral balanced occlusion in excursive movement. Patients were asked to perform jaw movements to the right and left sides while occlusal contacts were

Fig 1 Capsule containing the test food for the masticatory efficiency test.

Fig 2 Capsule after mastication.

checked with a carbon film (AccuFilm II). Score 1 = both sides articulated correctly, score 2 = one side (working or balancing side) articulated correctly, and score 3 = no balanced occlusion.

6. Retention of the mandibular denture: The patient was asked to slightly open his or her mouth, and it was determined whether the denture moved under a vertical opposite force applied on the mandibular central incisors after being dried with gauze. Score 1 = no displacement, score 2 = displacement with difficulty, and score 3 = easy displacement.
7. Border extension of the mandibular denture: The presence of the following denture characteristics were verified: *(1)* half of the right retromolar pad was covered, *(2)* half of the left retromolar pad was covered, *(3)* the right mylohyoid line was properly contoured to anatomical form, *(4)* the left mylohyoid line was properly contoured to anatomical form, *(5)* the length and form of the anterior lingual flange were appropriate, and *(6)* the length and form of the entire flange were contoured to anatomical form. Score 1 = all criteria satisfied, score 2 = one to five criteria satisfied, and score 3 = no criteria satisfied.

After the clinical examination, category scores for each factor were calculated and converted into an integer, which could range from 0 (score 3 attributed to all factors) to 100 (score 1 attributed to all factors).[2] From this calculation, the quality of the CDs was classified as follows: poor (0 to 55), average (56 to 75), or good (76 to 100).

Masticatory Efficiency Test

Objective evaluation of masticatory function was performed using the colorimetric method with beads as the artificial test food (Fig 1).[9,10] They were obtained by ionotropic jellification of an aqueous dispersion of 2% pectin containing 50% solids and fuchsin dye in a 1.0-mol/L calcium chloride solution. After preparation, the beads were coated with Eudragit E 100 solution (Eudragit) in a solvent mixture of 10% acetone in absolute ethanol. Next, 250 mg of the beads were packed in polyvinyl acetate capsules in rectangular form (0.70 × 0.51 inches) and sealed.

For the masticatory test, subjects were asked to chew the capsules in their habitual manner, without any additional instructions given on how to chew. Patients were seated on a chair with a back and with both feet resting on the ground. The test stopped after 20 seconds, and the beads were collected into a container identified by subject and test number (Fig 2). The test was then repeated two more times. At no point did the polyvinyl acetate capsules rupture, allowing the beads to escape. After chewing, the capsule shell was cut open, and the beads were placed in a 20-mL test tube, dissolved in 5 mL of distilled water, and shaken mechanically in a rotary shaker (Certomat, B.Braun Biotech) for 30 seconds. The solution was then filtered through qualitative filter paper, and the extracted dye was quantified in nanometers (nm) using a Beckman DU-640 UV-Visible Spectrophotometer (Ultrospec 2100 Pro UV/Visible Spectrophotometer, GE Healthcare). This allowed for the measurement of masticatory efficiency based on the concentration of extracted fuchsin, which was expressed in absorbance (abs). Analysis of the beads was carried out at the Biochemistry Laboratory of the Health Sciences Center at the Federal University of Rio Grande do Norte.

Statistical Analysis

Data were collected by a single examiner to avoid interexaminer variability. Prior to the clinical examinations, the examiner participated in the calibration process, which was divided into theoretical

Table 1 Complete Denture Quality According to Years of Use*

	≤ 2 y		≥ 5 y	
Denture Quality	n	%	n	%
Poor	7	17.1	12	40.0
Average	18	43.9	13	43.3
Good	16	39.0	5	16.7

*A significant association was found between denture quality and years of denture use ($P < .05$).

Table 2 Influence of Denture Quality and Years of Use on Masticatory Efficiency (abs)*

Denture quality	≤ 2 y		≥ 5 y	
	n	Mean (SD)	n	Mean (SD)
Poor	7	0.080 (0.050)	12	0.049 (0.025)
Average	18	0.125 (0.102)	13	0.052 (0.073)
Good	16	0.089 (0.020)	5	0.095 (0.088)
Total	41	0.101 (0.076)	30	0.068 (0.076)

SD = standard deviation.
*Masticatory efficiency was significantly affected by years of denture use ($P < .05$) but not by denture quality.

discussions regarding the codes and criteria for the study as well as practical activities. Data were processed using SPSS software version 17.0 for Windows (IBM). The masticatory efficiency of each subject was calculated as the mean value of the three tests. The reliability of the masticatory test was analyzed using one-way analysis of variance (ANOVA) with the Tukey post hoc test ($P < .05$). The relationship between denture quality and years of denture use was analyzed using chi-square and Fisher exact tests. The results of masticatory efficiency testing were submitted to two-way ANOVA (Tukey post hoc test) in relation to years of denture use (≤ 2 years or ≥ 5 years) and denture quality (poor, average, good). Shapiro-Wilk and Levene tests were used to observe normality and variance homogeneity, respectively. The confidence level was set at 95%.

Results

Of the 93 CDs evaluated, 24 (25.8%) were considered poor, 44 (47.3%) average, and 25 (26.9%) good. A significant association between denture quality and years of denture use was observed ($P < .05$) (Table 1). Mean masticatory efficiency was 0.085 ± 0.072 abs. When analyzed according to years of denture use, masticatory efficiency differed significantly ($P < .05$) between up to 2 years of denture use (0.101 ± 0.076 abs) and 5 or more years of denture use (0.068 ± 0.076 abs) (Table 2, Fig 3). Masticatory efficiency was not influenced by denture quality (Table 2, Fig 4).

Discussion

The results of this study support the first research hypothesis that CD quality decreases over time. The second research hypothesis (CD quality positively influences masticatory efficiency) was not supported. The third hypothesis (masticatory efficiency decreases over time) was confirmed.

Several methods have been used to objectively evaluate the technical quality of conventional CDs.[1,3,11–17] However, comparison among studies is difficult due to the differences in methodology, data collection, number of researched items, and classification method. Previous studies have used a wide variety of classification system, including those based on dichotomy scales,[1,11] three scales (good, average and poor),[3,12,13] four scales,[14] five scales,[15,16] or seven scales.[17] Thus, it is necessary to establish clear criteria for objective assessment of the function of a dental prosthesis. This study employed the method proposed by Sato et al[2] because it has been shown to be widely used, reliable, and reproducible.

In this study, statistical analysis revealed a significant association between denture quality and years of denture use ($P < .05$) (Table 1). Eighty-three percent of CDs with 5 or more years of use were considered poor or average, as opposed to 61% of dentures with up to 2 years of use. These results are in agreement with previous studies, in which a significant decrease in denture quality was found for dentures in use for more than 10 years.[2,14,18]

Reduced eating capacity is one of the major functional limitations of edentulism. Thus, masticatory efficiency is an important aspect of CD quality. In the present study, masticatory efficiency was measured using the colorimetric method with beads as the artificial test food.[9,10] With this method, the test material is promptly evaluated and has stable physical properties. Because the beads are packed in capsules, the material is fully contained within the mouth, with no danger of it being swallowed or dissolved by saliva. Laboratory processing is fast and effective and allows precise determination of the patient's masticatory efficiency. All granule components are listed in the Brazilian pharmacopoeia and can be reproduced.

Mean masticatory efficiency was 0.085 ± 0.072 abs. When analyzed according to years of denture use, mean masticatory efficiency differed significantly

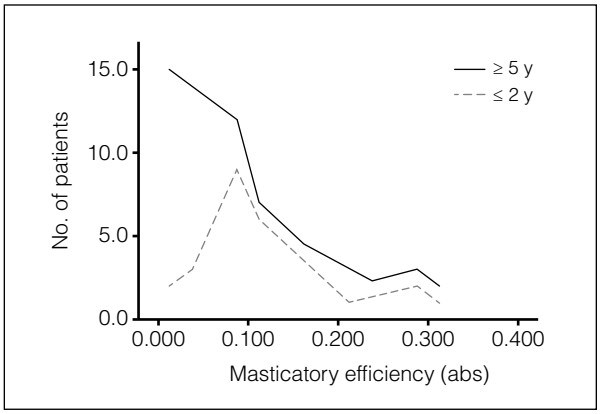

Fig 3 Histogram showing the masticatory efficiency of denture wearers according to years of use: ≤ 2 years of use (n = 41, mean: 0.101 ± 0.076 abs) and ≥ 5 years (n = 30, mean: 0.068 ± 0.076 abs). The difference between groups was statistically significant.

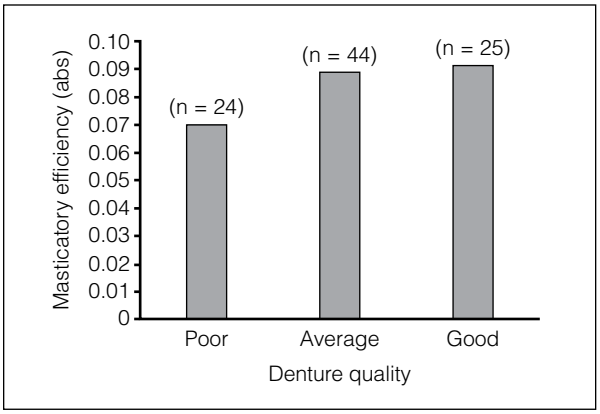

Fig 4 Masticatory efficiency according to complete denture quality.

($P < .05$) between up to 2 years of denture use (0.101 ± 0.076 abs) and 5 or more years (0.068 ± 0.076 abs). Previous studies with the same methodology presented higher values for masticatory efficiency (0.186[9] and 0.162 abs[10]). In those studies, masticatory efficiency was evaluated 3 months after denture insertion, in contrast to 2 and 5 years after insertion in the present study. It is hypothesized that masticatory efficiency may decrease during the early years of denture use due to initial artificial tooth wear. Further studies are necessary to confirm this hypothesis.

The influence of technically inadequate CDs on diet, masticatory perception during chewing, and masticatory efficiency is not clear.[19] In the present study, no association was found between CD quality and masticatory efficiency (Table 2). These results are in agreement with previous studies[8,20,21] that showed no improvement in masticatory efficiency after the construction of new CDs. In contrast, Gunne and Wall[7] reported that replacing old CDs with new ones with appropriate retention, stability, and balanced occlusion significantly improved masticatory efficiency. Manly and Vinton[5] found a moderate correlation between masticatory performance and CD quality, while Renaud et al[6] reported a significant improvement in masticatory performance after surgical reconstruction of the mandibular alveolar ridge and fabrication of technically appropriate dentures. The lack of consensus regarding the influence of CD quality on masticatory efficiency is likely related to the different methodologies employed to evaluate CD quality.[5,6,9,19]

The hypotheses that both CD quality and masticatory efficiency decrease over time were confirmed; it is possible that studies with a larger sample size or different design may confirm the interaction between these variables. The method proposed by Sato et al[2] to assess denture quality has seven categories of equal weight; however, the influence of anterior teeth arrangement on masticatory efficiency is certainly lower than that of denture stability. This could have skewed the ratings for CDs that showed excellent esthetics but poor denture stability. In addition, the Sato et al[2] assessment does not consider artificial tooth wear, which is likely to be one of the most important factors in chewing. Finally, specific anatomical conditions that may influence CD retention and stability (eg, mucosal resiliency and alveolar ridge height and width) should be controlled to avoid potential bias. For example, it is possible that patients with poor anatomical conditions and a technically adequate CD would present similar masticatory efficiency to those with reversed anatomical conditions and CD quality.

While it is obvious that the provision of new CDs improves the general health of the stomatognathic system for elderly patients, the influence of the technical quality of CDs on masticatory function needs further investigation. Longitudinal studies with the same methodology for objective evaluation of masticatory efficiency, larger sample sizes, and different criteria for denture quality assessment may help to clarify the factors that influence masticatory efficiency in denture wearers.

Conclusions

Complete denture quality and masticatory efficiency significantly decreased over time; however, complete denture quality did not influence masticatory efficiency.

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Literature Abstract

Parathyroid hormone and its effects on dental tissues

In general, drugs used for the treatment of osteoporosis aim to either suppress bone resorption or enhance bone formation. Teriparatide, a human recombinant form of parathyroid hormone (PTH), is the first anabolic drug approved by the US Food and Drug Administration for the treatment of osteoporosis. Depending on when it is given, PTH has the ability to cause both bone formation and resorption. This review looks at the effects of PTH on dental tissues. PTH appears to influence bone formation by increasing the number of osteoblasts, inhibiting osteoblast apoptosis, and reactivating quiescent lining cells to resume matrix formation. When administered intermittently in therapeutic doses, PTH was able to increase bone strength and prevent bone fractures by increasing bone mineral density. However, when PTH was administered continuously, it led to bone loss. It was also noted that intermittent administration of PTH improved the initial fixation of implants and resulted in a high bone-implant sheer strength in rats. It is likely that in implant patients with advanced trabecular bone loss, PTH administered intermittently may increase the bone density around implants and improve clinical outcomes. While evidence suggests that PTH may be used in dentistry to improve dental outcomes, several studies are based on animal models, and further clinical trials are needed to determine the proper indications, safety, and efficacy.

Aggarwal P, Zavras A. *Oral Dis* 2012;18:48–54. **References:** 49. **Reprints:** Athanasios Zavras, Division of Oral Epidemiology and Biostatistics, Columbia University College of Dental Medicine, 601 W 168th Str., Suite 34, New York, NY 10032, USA. Email: az2256@mail.cumc.columbia.edu—*Clarisse Ng, Singapore*