Psychometric Analysis and Masticatory Efficiency of Elderly People with Single-Implant Overdentures

Camilla Fraga do Amaral, DDS/Mayara Abreu Pinheiro, DDS, MS/Márcio de Moraes, PhD/Renata Cunha Matheus Rodrigues Garcia, PhD

Purpose: The aim of this paired clinical study was to evaluate psychometric parameters (patient satisfaction and masticatory ability) and masticatory efficiency in elderly people before and after oral rehabilitation by a single-implant overdenture. Materials and Methods: This study included elderly individuals with residual alveolar bone height classified as Class III or IV according to the American College of Prosthodontics, and who wore clinically unsatisfactory complete dentures. Subjects first received new maxillary and mandibular conventional complete dentures. After 2 months of patient adaptation to the new complete dentures, subjective and objective variables were measured. Satisfaction with the new complete dentures was verified by applying a visual analog scale to rate patient satisfaction with stability, comfort, ability to chew, ability to speak, ease of cleaning, esthetics, and general satisfaction of their new complete dentures. Masticatory ability was assessed by asking participants to rate on a visual analog scale their ability to chew foods with different roughness and consistencies. Masticatory efficiency was measured by the sieving method using a silicone-based artificial test food. After evaluations were completed, each participant received one implant, which was placed in the symphysis region. After 3 months of implant osseointegration, the conventional complete dentures were transitioned to mandibular single-implant overdentures through placement of a low-profile attachment on the intaglio surface of the prostheses. Subjects used the single-implant overdentures for 2 months, and then all variables were reevaluated. Parametric t test and nonparametric Wilcoxon statistical tests were used to analyze data. Results: Participants reported increased satisfaction with stability of their mandibular single-implant overdentures compared with their new conventional complete dentures. However, satisfaction with the esthetics decreased when the new complete denture was converted into the single-implant overdenture (P < .05). Masticatory ability with the rehabilitation was not different between the new conventional complete dentures and the single-implant overdentures; however, transition to the single-implant overdenture greatly increased masticatory efficiency (P < .0001). Conclusion: Single-implant overdentures changed the patient perceptions, improving their satisfaction with stability, although decreasing satisfaction with esthetics. Despite that, masticatory efficiency of elderly individuals with decreased residual bone height was greatly improved after single-implant overdenture use. INT J ORAL MAXILLOFAC IMPLANTS 2018;33:1383–1389. doi: 10.11607/jomi.6557

Keywords: edentulous mandible, implant, mastication, overdenture, patient satisfaction

In recent years, the development of simple, low-cost implant therapies for edentulous elderly patients has been a major goal of the dental research community.1–4 The two-implant overdenture has been the standard of care for edentulous elderly patients with resorbed residual ridges because of the poor stability and retention of conventional complete dentures.5–8 To reduce cost and chairside management time, researchers have proposed the use of the mandibular single-implant overdenture opposing a conventional maxillary complete denture.9–14

Patient self-perceptions of different types of prostheses are widely considered when evaluating clinical outcomes, as such perceptions reflect the true advantages and effects of treatment on the patient’s
life.\textsuperscript{5} Questionnaires using a visual analog scale to detect differences between prosthetic treatments have been conducted to evaluate the patient’s ability to chew specific foods or to predict levels of satisfaction throughout the entire oral rehabilitation process.\textsuperscript{15,16} Several reports\textsuperscript{10,17,18} showed improvements in patient perceptions about single-implant overdenture treatment and its positive influence on their quality of life.

In this sense, it is known that after a long-term assessment, the overall satisfaction of patients using overdentures attached to one or two implants is similar.\textsuperscript{17} In addition, the subjective chewing ability of hard food was improved after only 4 weeks of overdentures retained by a single-implant overdenture.\textsuperscript{10} However, no consideration was given to the levels of loss of the denture-supporting structures, mainly in the posterior mandible region, which can influence denture retention and stability.

Aside from the negative psychosocial effects of edentulism, the masticatory function of edentulous individuals is impaired compared with that of the dentate population.\textsuperscript{19} Accordingly, it is important to evaluate psychometric variables alongside objective analyses, such as masticatory efficiency. Reports on clinical outcomes, such as bone loss and masticatory function, have endorsed the use of the single-implant overdenture rehabilitation for elderly patients as a conservative and simplified implant-based oral rehabilitation.\textsuperscript{20–23} Some authors\textsuperscript{24,25} found masticatory improvements for single-implant overdenture–rehabilitated elderly patients. However, those studies\textsuperscript{24,25} used natural foods to evaluate mastication, whereas no study to date has analyzed masticatory efficiency with an artificial test material, such as OptoCal. This artificial material does not undergo structural changes when exposed to the salivary environment.\textsuperscript{26} In addition, the cited studies\textsuperscript{24,25} used a paired design to evaluate edentulous patients before and after single-implant overdenture placement, but they did not evaluate their findings with respect to the quality of the complete denture used by their subjects before the implant treatment. This choice could lead to performance bias if the complete denture prostheses were not constructed in a standardized manner.

Therefore, the purpose of the present study was to evaluate psychometric parameters in terms of patient satisfaction according to the prosthetic treatment received, as well as the subjective masticatory ability of edentulous elderly patients with loss of residual bone height before and after oral rehabilitation by a single-implant overdenture. In addition, masticatory efficiency was objectively verified by a sieving method using artificial test material.

**MATERIALS AND METHODS**

**Study Design and Patient Selection**

This paired clinical trial was approved by the Ethics Committee of Piracicaba Dental School, University of Campinas under protocol #087/2015. The study was registered in the Brazilian Registry of Clinical Trials (#RBR-3kgjtw), a spinoff of the International Clinical Trials Registration Platform (ICTRP/World Health Organization).

Participants were recruited from a population of completely edentulous elderly individuals who were seeking prosthetic treatment at the dental clinic of the Piracicaba Dental School, State University of Campinas, Brazil. Participants signed a consent form according to the 1964 Helsinki Declaration.

A sample size calculation was done based on a previous study,\textsuperscript{27} and a total of 12 elderly subjects were indicated to obtain statistical differences with 80% power and 5% error probability. In view of the expected loss rate of 25%, the final sample included 15 participants.

Selection criteria were as follows: patient age of 60 years or older; good general health or adequately medication-controlled systemic disease, such as hypertension or diabetes; completely edentulous, classified as Class III or IV according to the American College of Prosthodontics\textsuperscript{28}; and current use of a clinically unsatisfactory complete dentures. Type IV subjects must present enough bone in the mandibular midline region for an implant length of 11 mm. Subjects presenting signs and symptoms of temporomandibular disorders, uncontrolled systemic diseases, or osteoporosis, smokers, and alcoholics were excluded.

Determination of whether the patient’s current complete denture was clinically unsatisfactory was made according to the Rise Index.\textsuperscript{29} This prosthetic quality assessment method analyzes several denture characteristics, such as retention, stability, presence of defects, denture material, presence of soft tissue injury, and occlusion, to generate a score reflecting whether the prosthesis is clinically satisfactory. The complete denture is classified in four degrees (0, I, II, or III) according to its score (range: 0 to 13), with lower degrees indicating better prosthetic quality. Two researchers (C.F.A., M.A.P.), who had been previously calibrated for the assessment (Cohen’s Kappa inter- and intrarater agreements of 1.00), evaluated characteristics of the maxillary and mandibular complete dentures in use by subjects at the beginning of the study.

**Complete Denture Process**

Recruited participants were submitted to anamnesis, including a medical history questionnaire and a clinical examination. Participants received new conventional maxillary and mandibular complete dentures,
which were constructed in accordance with standard techniques\textsuperscript{30} and adjusted to a bilaterally balanced occlusal scheme. A cobalt-chromium framework was inserted in the acrylic denture base at the anterior region of the mandibular denture, to dissipate forces and prevent early fracture of the prosthesis.\textsuperscript{31} Immediately after the conventional complete denture placement, the subjects were given verbal and written instructions on how to use and clean their new prostheses. During the next 3 weeks, and according to individual needs, they were instructed to return to the clinic for denture adjustments. After the subject was free of any complaint about their new conventional denture, a period of 2 months of using the new prostheses was allowed, and variables related to patient satisfaction, masticatory ability, and masticatory efficiency were assessed.

**Patient Satisfaction**

Patient satisfaction related to the prosthetic treatment was determined according to Awad and Feine.\textsuperscript{32} Subjects were asked about their general satisfaction with the new conventional denture. They were also asked to rate their prosthesis stability, comfort, ability to chew, ability to speak, ease of cleaning, and esthetic appearance of their maxillary and mandibular new complete dentures.\textsuperscript{32} Participants rated each item on a 100-mm visual analog scale, where the anchor words were “totally dissatisfied” for zero and “completely satisfied” for 100. Participants drew a vertical line at the point on the scale that best reflected their response, for which higher scores indicate greater satisfaction.

**Masticatory Ability**

A questionnaire based on a visual analog scale was also applied to rate the ease of chewing seven types of food with different roughness and consistencies,\textsuperscript{33} such as bread, hard cheese, sausage, peanuts, raw apples, and carrots.\textsuperscript{15} Participants rated their ability to masticate these foods by placing a dot on a scale ranging from “very easy” to “very difficult”. Lower scores represented greater masticatory ability.

**Masticatory Efficiency**

Masticatory efficiency was evaluated quantitively by using Optocal, a standardized artificial chewable test material.\textsuperscript{34,35} Subjects were asked to chew portions of 17 cubes, with an edge size of 5.6 mm, for 40 chewing strokes in the manner of the completely edentulous population. Chewing strokes were counted by a trained researcher.\textsuperscript{27} Using the fractional sieving method, the chewed material was separated through eight sieves with decreasing mesh aperture from 5.6 to 0.5 mm. Masticatory efficiency was calculated as the weight percentage of material that was passed through the 2.8-mm sieve, representing the initial particle size suitable for swallowing.\textsuperscript{36}

**Single-Implant Overdenture Process**

After 2 months of new conventional complete denture use and variable assessment, each participant received one osseointegrated implant. All surgeries were performed by two dental surgeons at the Piracicaba Dental School Surgery Center, using tomographic guides and computed tomography images. Through a conventional two-stage technique\textsuperscript{37} under local anesthesia, one implant with an 11-mm length and 3.75-mm width (Titamax-ticortical, Neodent) was placed in the central symphysis region of the edentulous mandible. The conventional mandibular denture was relined with resilient soft lining material (Dencril), and it was used during the 3-month osseointegration period.

Periapical radiographs using a long-cone paralleling technique were taken to evaluate the osseointegration process, and once osseointegration was complete, the new mandibular conventional denture was converted into an overdenture over the implant. The hexagon platform of the implant was exposed, and a low-profile abutment patrrix (Locator, Neodent) was attached, using 32 Ncm of torque, according to the manufacturer’s instructions. The central region of the mandibular denture base was relieved, and the matrix was intraorally captured by using a self-curing acrylic resin (Vipi). The acrylic base was polished, and adjustments were made to maintain an occlusion that was bilaterally balanced with the single-implant overdenture, similarly to how it was with the conventional denture.

Participants received verbal and written instructions about implant cleaning and overdenture maintenance, such as its insertion and removal, as well as hygiene. Once it was adjusted and the subjects showed no complaints about their overdentures, a period of 2 months was released for its use. Subsequently, all variables were reassessed.

**Statistical Analysis**

Data were evaluated using SAS 9.3 (SAS Institute). Exploratory statistical analysis by the Shapiro-Wilk test was used to verify the Gaussian distribution. Student’s tests were used to analyze normally distributed data, including questions 3, 4, 6, 10, and 11 from the patient satisfaction questionnaire, chewing ability, and masticatory efficiency. The remaining questions of the satisfaction survey were not normally distributed and were analyzed by the nonparametric Wilcoxon signed-rank test. All analyses were carried out at a significance level of 5%.
Fifty-seven patients were initially recruited for possible inclusion in this study. After anamnesis and clinical and radiographic exams, 19 subjects were excluded due to the presence of residual alveolar bone height classified as Class I or II; four subjects presented osteoporosis, three presented uncontrolled type 2 diabetes mellitus, two were partially dentate, two presented mandibular implants already placed, and finally, one patient was less than 60 years of age, and therefore, these subjects were also excluded. In addition, 11 patients refused to participate. Thus, 15 subjects were selected to participate; however, three of them could not conclude the study due to personal problems. Consequently, the final sample was composed of 12 volunteers, for which sociodemographic data are presented in Table 1. A typical panoramic radiograph of the subjects is presented in Fig 1.

Table 1  Sociodemographic Data of Subjects (n = 12)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD (y)</td>
<td>68.66 ± 5.22</td>
</tr>
<tr>
<td>Sex, frequency (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>25</td>
</tr>
<tr>
<td>Female</td>
<td>75</td>
</tr>
<tr>
<td>Monthly income, mean ± SD (BRL, minimum wage)</td>
<td>2.42 ± 0.87</td>
</tr>
<tr>
<td>Educational level, mean ± SD (y)</td>
<td>3.33 ± 1.15</td>
</tr>
<tr>
<td>Time using complete denture, mean ± SD (y)</td>
<td>22.75 ± 08.71</td>
</tr>
</tbody>
</table>

BRL = Brazilian Real.

Table 2  Mean ± SD of Patient Satisfaction and Masticatory Ability with New Conventional Complete Denture or Single Implant-Retained Overdenture Treatment (n = 12)

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Complete denture</th>
<th>Single-implant overdenture</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>General satisfaction</td>
<td>95.58 ± 5.21</td>
<td>96.83 ± 5.15</td>
<td>.7031*</td>
</tr>
<tr>
<td>Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>97.25 ± 5.61</td>
<td>98.42 ± 2.23</td>
<td>.6875*</td>
</tr>
<tr>
<td>Mandible</td>
<td>87.00 ± 12.53</td>
<td>98.75 ± 1.36</td>
<td>.0057†</td>
</tr>
<tr>
<td>Comfort</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>98.83 ± 2.48</td>
<td>98.17 ± 1.75</td>
<td>.3752†</td>
</tr>
<tr>
<td>Mandible</td>
<td>88.92 ± 18.32</td>
<td>95.58 ± 6.29</td>
<td>.333*</td>
</tr>
<tr>
<td>Ability to chew</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>97.58 ± 5.21</td>
<td>95.00 ± 5.62</td>
<td>.3191†</td>
</tr>
<tr>
<td>Mandible</td>
<td>84.67 ± 20.72</td>
<td>95.92 ± 4.81</td>
<td>.7539*</td>
</tr>
<tr>
<td>Ability to speak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>96.17 ± 8.96</td>
<td>98.83 ± 2.12</td>
<td>.675*</td>
</tr>
<tr>
<td>Mandible</td>
<td>90.92 ± 13.09</td>
<td>99.00 ± 1.54</td>
<td>.7266*</td>
</tr>
<tr>
<td>Ease of cleaning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>96.50 ± 5.74</td>
<td>97.67 ± 2.42</td>
<td>.5655†</td>
</tr>
<tr>
<td>Mandible</td>
<td>93.08 ± 11.15</td>
<td>96.58 ± 4.17</td>
<td>.35†</td>
</tr>
<tr>
<td>Esthetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>98.17 ± 3.43</td>
<td>98.83 ± 2.04</td>
<td>.9531*</td>
</tr>
<tr>
<td>Mandible</td>
<td>99.58 ± 1.44</td>
<td>98.67 ± 1.44</td>
<td>.0339†</td>
</tr>
<tr>
<td>Masticatory ability</td>
<td>51.65 ± 17.10</td>
<td>51.12 ± 13.44</td>
<td>.146†</td>
</tr>
</tbody>
</table>

*Wilcoxon or †Student t test, P < .05.

RESULTS

Psychometric analysis of patient satisfaction and masticatory ability with the new conventional complete denture and the single-implant overdenture are shown in Table 2. Comparisons of satisfaction scores between the new conventional denture and single-implant overdenture showed increased satisfaction with stability (P = .0057) but decreased satisfaction with the esthetics of the mandibular overdenture (P = .0339) after single-implant overdenture placement. No significant difference in masticatory ability was observed before and after single-implant overdenture rehabilitation.
Masticatory efficiency demonstrated a marked increase (P < .0001) after placement of the single-implant overdenture (Fig 2).

**DISCUSSION**

The purpose of this trial was to investigate patient satisfaction and masticatory function in elderly individuals following rehabilitation with a new conventional complete denture or single-implant overdenture. Elderly individuals presenting complete edentulism Class III or IV were selected because of their insufficient supporting structures, which shows the most debilitated edentulous condition with the least favorable status for complete denture insertion. The single-implant overdenture therapy improved satisfaction with stability of the mandibular prosthesis and improved masticatory efficiency. Despite the similar overall satisfaction and masticatory abilities with both types of prostheses, patients reported decreased satisfaction with esthetics of the single-implant overdenture.

As expected, most of the study participants were women. Studies have shown that women are more concerned and proactive with their health than men and tend to search for new treatments that could improve their quality of life. Despite their relatively low educational level, participants showed monthly earnings that were almost twice the average Brazilian income and were considered to belong to the middle class. This result was unexpected but should be considered as a random occurrence.

After single-implant overdenture therapy, patient satisfaction with mandibular stability improved, but satisfaction with esthetics decreased compared to satisfaction with the new conventional complete denture. Findings on mandibular stability agree with previous studies, which reported overall increases in patient satisfaction with parameters such as oral comfort and function after single-implant overdenture use. The increased stability of the single-implant overdenture is explained by the presence of the implant in the anterior region of the mandible, thereby providing retention and stability to the lower prosthesis.

On the other hand, the decreased satisfaction with esthetics of the single-implant overdenture was a totally unexpected result, and evidently, this finding is in contrast with some studies. Compared with the conventional complete prosthesis, the overdenture has no alteration in its external region of the denture base. However, the intaglio surface of the overdenture can show some metallic components, such as the matrix. Thus, even if the matrix does not appear when the overdenture is in its position in the mouth, the subjects can see this metallic component every time that they insert or remove their overdentures, and this is likely to negatively influence their esthetics perception.

Nevertheless, the decrease in satisfaction with esthetics did not seem to influence overall satisfaction with the new treatment, which remained high after overdenture insertion. Therefore, the authors believe that this finding has no clinical relevance and does not influence the success of the single-implant overdenture. In addition, the main complaint about the mandibular denture was the poor stability, and this aspect was improved.

An interesting finding is that, in spite of the improved satisfaction with stability after using their overdentures, subjects revealed similar satisfaction with their masticatory ability after using both types of prostheses. Thus, the individual's opinion about how difficult a food is to chew did not change after overdenture use. This finding is in contrast with Harder et al, who showed an improvement in masticatory ability after connection of the denture to the implant for hard foods. These opposing data may be explained by methodologic differences between studies. While the latter author selected patients already using technically acceptable complete dentures, the present study subjects were using old and unsatisfactory prostheses (Rise Index degrees II and III), which were replaced by new maxillary and mandibular conventional dentures. In addition, the absence of differences in masticatory ability after conventional complete denture and single-implant overdenture use could be because the present study subjects have experienced the greater masticatory ability when their old, unsatisfactory dentures were replaced by the new conventional ones. Consequently, when the single-implant overdenture was used, the subjects continued to be satisfied with their mastication as much as they were with the conventional complete denture use.

In spite of the absence of differences in most of the subjective masticatory parameters, masticatory efficiency values were at least seven times greater after single-implant overdenture placement than they were after conventional complete denture insertion. Although modest, Cheng et al also observed an improvement in masticatory efficiency. The higher masticatory efficiency improvement observed in the present study may be related to the differences in the test food material and sieve sizes that were used. Whereas Cheng et al used peanuts as a natural food, the present study used an artificial test food (Optocal) that does not undergo changes in its intrinsic properties due to contact with saliva. The distinct properties of natural foods and Optocal may explain the difference in the magnitude of improvement between the studies.

Considering the data of the present study, it is possible to conclude that single-implant overdenture...
treatment can be considered as a choice for the elderly population with loss of residual alveolar bone height. This rehabilitation improved patients’ satisfaction with their mandibular prostheses stability and objectively increased their masticatory efficiency, even though showing decreased esthetics satisfaction. However, it is important to mention that there are many other factors that can influence food choice, such as socioeconomic status, cultural beliefs, and personal preferences, and greater masticatory efficiency may not improve nutritional status. Thus, future studies on nutritional intake of elderly people using single-implant overdentures are important, and additional longitudinal clinical trials are needed to confirm the long-term success of this type of oral rehabilitation in terms of elderly individuals’ perceptions and masticatory function as well.

CONCLUSIONS

After 2 months of conventional complete dentures and single-implant overdenture use, elderly people with decreased residual ridge bone height were more satisfied with the esthetics of mandibular conventional dentures compared with the overdentures. Additionally, a significant increase in satisfaction with stability and objective masticatory efficiency was observed after single-implant overdenture use.

ACKNOWLEDGMENTS

The authors report no conflicts of interest related to this study. This study was supported by grant number 2015/21704-1 from the São Paulo Research Foundation (FAPESP).

REFERENCES