

Clinical assessment of masticatory efficiency in the rehabilitation of edentulous patients

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Abstract

Rehabilitation of edentulous patients has been a constant concern in dentistry. Several studies have reported a reduction in the masticatory function in these patients. Osseointegrated implants have been used in order to obtain better masticatory efficiency, but more studies are needed to confirm these results. **Aim:** To evaluate the masticatory function of patients with conventional dentures and implant-supported dentures. **Methods:** A double-blinded controlled clinical study was conducted. The sample was composed of 60 patients divided into three groups: G1 with 20 patients with conventional upper (maxillary) and lower (mandibular) complete dentures, G2 with 20 patients with mandibular overdentures and upper (maxillary) complete dentures, and G3 with 20 patients with lower fixed implant-supported complete dentures (protocol). Objective data were collected through the masticatory efficiency test performed by the colorimetric method with the beads, in which capsules of a synthetic material enclosing fuchsine-containing granules were used. **Results:** A statistically significant difference was found for masticatory efficiency between groups G1 and G2 ($p < 0.05$) and between G1 and G3 ($p < 0.05$), and there was no statistically significant difference between G2 and G3 ($p > 0.05$). **Conclusions:** The results suggest that placement of osseointegrated implants in complete denture wearers improves their masticatory efficiency.

Keywords: complete dentures, complete dentures over implant, masticatory efficiency, edentulousness.

Introduction

Reestablishing the masticatory function is fundamental to preserve the stomatognathic system's health. The purpose of rehabilitating completely edentulous patients by replacing lost teeth is to provide adequate physical, functional and psychological rehabilitation.

Good performance of mastication is related to the dental conditions. Individuals with complete natural dentition show high masticatory performance rates, while edentulous individuals show minimal performance. However, according to the type of dentition and rehabilitation procedure performed, there are intermediate rates between the extreme ones¹.

Mastication is therefore considered one of the most important functions of the stomatognathic system for it is the initial stage of the digestive procedure. On

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the other hand, ingested food bolus properties may be affected by the oral conditions².

Before the advent of osseointegrated implants, there were no rehabilitation options for completely edentulous patients other than the mucosa-supported complete dentures. Several patients did not feel safe with this treatment due to the poor retention of the mandibular denture in comparison with the maxillary one. A previous study has shown that 22% of the examined patients were unsatisfied with their maxillary complete dentures and 55% with their mandibular dentures³.

At present, completely edentulous patients may be rehabilitated by conventional complete dentures (CD) or implant-supported complete dentures (overdentures or protocol). The use of implants to support dentures significantly improves the masticatory performance of these individuals.

The assessment of the masticatory function is undoubtedly a method to determine the effectiveness of rehabilitation procedures mentioned for edentulous patients by using objective tests that measure masticatory efficiency through artificial test materials⁴⁻⁸.

There are several studies that show a reduction in the masticatory efficiency of edentulous patients rehabilitated with bimaxillary complete dentures⁹⁻¹⁰. However, few studies have compared the different types of rehabilitations for this group of patients by assessing their masticatory efficiency.

The aim of this study was to compare clinically the masticatory efficiency of edentulous patients rehabilitated with conventional complete dentures and implant-supported complete dentures, seeking scientific evidences of the benefits for the masticatory function of these types of prosthetic rehabilitations.

Material and methods

The clinical study protocol was submitted to the Ethics Committee of the Potiguar University (Laureate International Universities) and approved in accordance with the report No n^o156/2009.

Sixty volunteers of both sexes were selected from the patients treated at the Study Center of Osseointegrated Implants of the Department of Dentistry at the Federal University of Rio Grande do Norte (UFRN) and the Dental Research and Study Center of Paraiba (COESP), Brazil. The volunteers were included in the study if they had bimaxillary conventional complete dentures or maxillary conventional complete dentures, but not implant-supported complete mandibular dentures. Those who did not have good general health, intraoral conditions, and dentures in satisfactory conditions and minimum time of use from 3 to 6 months were excluded. An informed consent form was signed by all the participants before the beginning of the study.

The volunteers were divided into 3 groups. The first group was composed of 20 completely edentulous volunteers, 17 women and 3 men (mean age of 65.55 ± 10 years), rehabilitated with conventional bimaxillary complete dentures. The second group was composed of 20 volunteers, 18 women and 2 men (mean age of 62.60 ± 8.88 years),

rehabilitated with mucosa-implant-supported complete mandibular overdentures (MISCOD) and maxillary conventional complete dentures. The third group was composed of 20 volunteers, 14 women and 6 men (mean age of 64.07 ± 10.30 years), rehabilitated with mandibular fixed implant-supported dentures and maxillary conventional complete dentures.

Assessment of the masticatory function

The masticatory function of the groups studied was assessed by the colorimetric method. The beads were the artificial test-food used to measure masticatory efficiency⁸. They are composed of a PVC capsule with an internal diameter of 7.6mm and external diameter of 8.95mm. Inside each capsule, there is approximately 250mg of standardized beads which contain violet fuchsin as the pigment of choice mixed and crushed with a small amount of crystalline cellulose, lactose, starch and other substances. Each pigmented bead was covered with a coat of the substance Eudragit E100[®] (Rohm Pharma GmbH, Germany), in a standardized size of approximately 1 mm in diameter.

The participants were instructed to chew the beads for 20 s, without adding any other additional instruction on how to chew it with the purpose of reproducing habitual mastication. For this reason, they were seated in a chair with a backrest and both feet supported on the ground. With regard to mastication, the grains contained inside the capsule were ground and the pigment released in proportion to the energy used, and then collected in an identified receptacle.

In the laboratory, the capsule was opened and its content dissolved in 5 mL of distilled water and mechanically agitated (mechanical agitator - model Q.222.2 - Quimis Aparelhos Científicos Ltda, Campinas, SP, Brazil) for 30 s. Afterwards the solution was filtered using a 0.5% grey paper filter (Qualitative paper filter; Nalgon Equipamentos Científicos Ltda., Iyupeva, SP, Brazil) to remove the grains which were not ground. Thus, the masticatory efficiency was calculated by measuring the absorbance concentration of the color intensity of the fuchsin solution with the aid of a spectrophotometer (SP-22 UV, Biospectro Inc., Curitiba, PR, Brazil). Therefore, the higher the concentration of fuchsin in the solution, the higher was absorbance and masticatory efficiency. The analysis of the beads was carried out at the analytical chemistry laboratory of the Department of Pharmacy of the Potiguar University, RN, Brazil.

The absorbance values were compared with the different types of rehabilitation using the one-way analysis of variance (ANOVA) and descriptive statistics. The variables with significant differences ($p \leq 0.05$) were compared with Bonferroni's post test.

Results

There was a statistically significant difference between Groups 1 and 2 ($p \leq 0.05$) and Groups 1 and 3 ($p \leq 0.05$). However, there was no statistically significant difference between Groups 2 and 3 ($p \geq 0.05$) (Table 1).

Table 1 - Data for masticatory efficiency.

Groups (G)	N	Mean(Abs = absorbance)	Standard deviation*
Bimaxillary complete dentures (G1)	20	0.244	± 0.065 a
Overdentures (G2)	20	0.327	± 0.139 b
Protocol (G3)	20	0.301	± 0.073 b

*Different letters indicate statistically significant difference in accordance with the Bonferroni test (pd⁰0.05).

Discussion

The aim of this study was to assess if patients with implant-supported complete dentures had better masticatory efficiency than those with conventional complete dentures since there are no studies on this subject using the three methods of rehabilitation.

The term masticatory efficiency was defined in this study as a degree of fragmentation of a certain food-test after mastication for a pre-determined time¹¹⁻²¹. The predetermined mastication time in this study was 20 s, which is the time needed to breakdown the food⁵⁻¹².

Differently from other investigations that assessed masticatory efficiency using natural test food¹⁻¹¹, this clinical study used artificial test food. This method was used for being more reliable for testing masticatory efficiency, enabling greater standardization of the tests, while the physical properties of the natural food are variable and difficult to standardize, which may alter the final results⁵⁻¹³⁻⁹.

The obtained results showed a significant difference for the masticatory efficiency between G1 and G2 and G1 and G3, but no significant difference was found between G2 and G3.

The significant lower masticatory efficiency in patients rehabilitated with conventional bimaxillary complete dentures (G1) has been reported in other studies⁹⁻¹⁰, and a significant improvement was observed in the masticatory function after treatment with overdentures, irrespective of the retention modality (magnet, sphere and bar/clip)¹⁴. This was also found in other studies in which the masticatory efficiency was better for patients with overdentures in comparison with conventional complete dentures¹⁵⁻¹⁷. However, some studies have shown that patients with mean mandibular ridge height rehabilitated with bimaxillary complete dentures present masticatory performance similar to the ones rehabilitated with mandibular overdentures and maxillary complete dentures¹⁸. This suggests that the residual ridge height is a critical factor to assess masticatory efficiency.

Group G2 showed a higher masticatory efficiency mean than Group G3. This result is extremely important since overdentures are a simpler and cheaper treatment option when compared with implant-supported fixed dentures. Furthermore, they provide a significant improvement in terms of stability and retention for patients with severe adaptation problems to conventional mandibular dentures¹⁶. However, this unexpected result is probably due to the following factors: increase in retention and stability of overdentures using additional retentions fixed to implants, more favorable condition for mounting the teeth with a centralized occlusal

platform in the crest of the mandibular ridge and the presence of a conventional complete denture as an antagonist. No studies were found in the literature that compared masticatory efficiency with the above-mentioned groups.

It is also important to emphasize the diagnostic factor and previous planning before placing the implants. The human factor in planning and technical performance are decisive for the success of rehabilitations.

Mandibular complete overdentures and protocol dentures with conventional complete dentures as antagonists would bring more benefits for edentulous patients with great resorption of the ridges or difficulties in adapting to bimaxillary conventional complete dentures¹⁹ in addition to offering the possibility of overcoming some limitations of these dentures with regard to masticatory efficiency²⁰. Therefore, more scientific evidence must be found through clinical trials comparing these types of rehabilitation.

Based on the results, it may be concluded that the use of osseointegrated implants improves masticatory efficiency of patients with complete dentures.

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