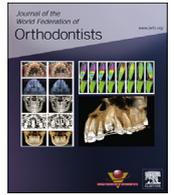


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Research Article

Masticatory performance between individuals with good overbite and patients with anterior open bite



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ABSTRACT

Objectives: To evaluate masticatory performance through the colorimetric method in individuals with good overbite, in comparison with patients who present with anterior open bite.

Materials and methods: The sample consisted of 16 individuals, divided into two groups: G1 (good overbite group, the control group), with $n = 8$; and G2 (anterior open bite group, the experimental group), $n = 8$. The masticatory performance tests started with the use of masticatory capsules. Statistical analysis of the obtained data was performed using the Mann-Whitney test, with a significance level of $U \leq 0.05$, to be compared with the fuchsine levels released.

Results: Masticatory performance showed higher absolute values for G1 than G2; however, from the Mann-Whitney nonparametric statistical test, it was shown that, for $U \leq 0.05$, no statistically significant differences were found between the two groups. Although G1 (control group) presented absolute mean values higher than those of G2, no statistically significant differences were observed in relation to the values of masticatory performance between the groups.

Conclusion: Patients with anterior open bite might have no impairment in masticatory efficiency.

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1. Introduction

Chewing is the act of biting, grinding, and masticating food through the efficient function of occlusal surfaces, regulated by neuromuscular control [1]. It represents the first step of the digestive process, and its quality is related to efficient digestion [2,3].

The size reduction of food particles is one of the elements of the masticatory function, with lubrication provided by saliva, which, through enzymatic action, acts in the initial digestion process.

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When the final chewing result is not adequate, the individual starts to swallow larger particles, or even avoids foods that require greater effort, as a compensatory or defense mechanism [4].

Some factors that influence masticatory performance have been mentioned in previous studies, including the number and area of occlusal contacts [5,6], the maximum bite force, the amount of lateral excursion during the masticatory function [3,7], the individual's physical stature, the bite force [1], the number of teeth [8], the decrease of salivary flow [9], the presence of malocclusions [10], the severity of malocclusions, the number of functional dental units [11], and age [12].

Occlusal factors may explain the decrease in chewing effectiveness, and the types of malocclusions presented by individuals may contribute to the quality of the masticatory function [13]. More severe malocclusions provide less efficient mastication [14,15].

Masticatory performance (MP) is a method for analyzing chewing, and is widely used in research [16,17]. It can be determined from clinical examinations with the chewing of natural foods or artificial test materials.

The MP parameter is the number of chewing cycles necessary to reduce food to a certain particle size, thus corresponding to the degree of food crushing [18].

There are several methods available for assessing MP; however, they are not feasible in clinical practice [19]. An important limiting factor is the test material, which is responsible for errors in such studies [16].

From this, various alternatives have emerged, such as the measurement of the chewed particle sizes by means of a scanner [20], optical scanning [21], and visible spectrophotometry [16].

The visible spectrophotometry method, also called the colorimetric method, was adopted in MP determination herein, using masticatory capsules. These capsules are made of a special type of granule that is used as a food simulator for testing. This food simulator consists of lactose (20.60 g), crystallized cellulose (36.85 g), maize starch (17.10 g), sucrose (17.10 g), hydrogenated oil (8.05 g), basic fuchsin (0.16 g), and water (60 mL), and is coated with Eudragit E-100 5% and acetone 50 mL (Rohm Pharma GmbH, Darmstadt, Germany). It also receives an external coat of polyvinyl acetate (PVA) [16].

MP determination using the colorimetric method and the standardized masticatory capsules provides greater convenience with reliability of results [10,19].

Thus, the objective of this study was to evaluate MP using the colorimetric method in good overbite individuals, and compare the results with those from individuals with anterior open bite.

2. Materials and methods

2.1. Sample selection

This study was approved by the Ethics and Research Committee under protocol number 2012/0380. The individuals who comprised the sample were people willing to participate in the research, and it was not necessary for them to have had any kind of relationship with the institution mentioned. All individuals were informed about the study's objectives and methods, and signed the Terms of Free and Informed Consent.

The sample was selected from 525 volunteers, 12 to 19 years old, who were invited to participate. The final sample consisted of 16 volunteers, divided into two groups: G1 (good overbite group, the control group), with $n = 8$; and G2 (anterior open bite group, the experimental group), with $n = 8$. Eight boys and eight girls participated in the study, four in each group.

To determine the number of individuals in G2 (experimental group), the sample was calculated by adopting a 95% confidence level and a maximum allowed error of 20%. As the incidence of anterior open bite in 14-year-olds is 2.5% [22], the ideal calculated sample for this group was eight individuals.

2.2. Inclusion criteria

All subjects needed to be between 12 and 19 years of age, presenting a complete permanent dentition, and giving no affirmative answers to the questionnaire of the European Academy of Cranio-mandibular Dysfunction (EACD). They were divided into two groups:

G1 (control group): subjects with Angle's Class I normal occlusion; and

G2: subjects with anterior open bite.

2.3. Exclusion criteria

Individuals giving affirmative answers to any questions in the EACD questionnaire were excluded, as were individuals undergoing orthodontic treatment, and also those who did not present complete permanent dentition (Fig. 1).

2.4. Material

To carry out this research, the Assessment System of MP (MP-mastig–FORP, FCFRP/USP) was adopted. One capsule was used for each test (right, left, and habitual chewing), totaling three capsules (Fig. 2) [18].

2.5. Clinical procedures

The evaluations and examinations were carried out in the following institutions: *Instituto de Educação Euclides Dantas*, *Centro Integrado de Educação Navarro de Brito* and *Colégio Orlando Leite*, all located in the city of Vitória da Conquista, State of Bahia. All the subjects were submitted to an anamnesis, involving the EACD questionnaire, a clinical examination of occlusion, and later analysis of MP using the masticatory capsules (MP-mastig) [4,16].

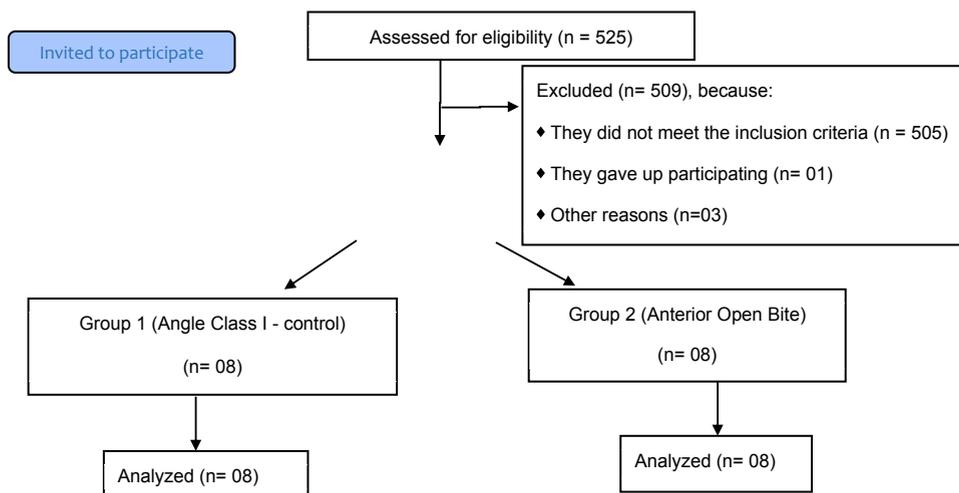


Fig. 1. Flowchart of participants (Consort 2010).



Fig. 2. Masticatory capsules for assessment of MP.

Seated in a chair, each volunteer was evaluated in a room with adequate natural light, and the environment remained calm and silent. The subjects sat in an upright chair, their feet resting on the ground, and their arms resting on their legs. The head was positioned having the Frankfort plan as a parameter. The volunteers did not receive any additional guidance when chewing to achieve and reproduce, as much as possible, their usual chewing habits.

Following this, the MP tests were started, using the masticatory capsules. In the first go, the individuals were asked to chew the first capsule in their habitual way. Then, the second capsule was used, to be exclusively chewed on the right side of the mouth; and, finally, the third capsule was exclusively chewed on the left side, totaling three capsules.

The chewing period was 20 seconds for each capsule, which is the time defined as corresponding to a masticatory cycle, with approximately 25 crunches on average. After each cycle, the capsule was collected and stored in a container with the volunteer identification number.

After the MP tests were completed, the capsules used in the evaluation were washed, dried, conditioned in an appropriate container, and sent to the Laboratory of Masticatory Performance of the Department of Child, Preventive and Social Dentistry, to obtain the MP value through the colorimetric method.

2.6. Laboratory procedures

For the MP test, PVA capsules, measuring 6.7 mm thick, 10 mm wide, and 20 mm long were used.

During the capsule chewing, the granules in the capsule are ground, and the fuchsine released is proportional to the energy used during this grinding. The capsule film coatings (PVA) were not damaged, and there was no escape of the beads to the oral cavity. After chewing each capsule, they were identified, contained, and then sent for laboratory analysis. The analysis was performed blind.

2.7. Evaluation of capsules by visible spectrophotometry

The capsule contents were dissolved in 5 mL of water, receiving constant stirring for 30 seconds. This solution was then filtered using qualitative filter paper, and the dye extracted was quantified by a visible UV spectrophotometer (Backman DU-640, Beckman Coulter Life Sciences, IN), at a wavelength of 546 nm. Finally, it was possible to determine the MP parameter from the extracted concentration of fuchsine.

The absorbance values were transformed into concentration of fuchsine dye using a standard curve, calculated by the equation $x =$

$(y + 0.0045)/0.167$, where y is the solution absorbance (546 nm) and x is the dye concentration ($\mu\text{g}/\text{mL}$).

Thus, for each chewed capsule, the fuchsine concentration ($\mu\text{g}/\text{mL}$), corresponding to the MP value, was obtained.

2.8. Statistical analysis

Normality was achieved using the Kolmogorov-Smirnov test. Statistical analysis of the obtained data was performed using the Mann-Whitney test, with a significance level of $U \leq 0.05$, for comparing the fuchsine levels released. The analysis also used the SPSS v.17 (SPSS, Inc., IBM Corp., Chicago, IL), Minitab 16, and Excel Office 2010 software packages (State College, Pensilvânia, EUA; Redmond, Washington, EUA).

3. Results

The average values of MP obtained from the groups are shown in Table 1, for habitual/free, right, and left chewing.

The obtained MP results showed higher absolute values for G1 compared with G2; however, from the Kolmogorov-Smirnov test, the results obtained did not show a normal distribution. The Mann-Whitney nonparametric test showed that, for a $U \leq 0.05$, no statistically significant differences were found between the two groups.

4. Discussion

Most previous studies on MP related to malocclusion have not included anterior open bite, possibly because of its low prevalence in the population [23,24], but have rather been based on Angle's Classes I to III malocclusion sagittal classification criteria. The evaluation of other malocclusions is of great importance, because one of the main functions of teeth is the correct chewing and processing of food.

A total of 525 volunteers, aged 12 to 19 years, were evaluated over a period of 11 months; each had complete permanent dentition and no signs or symptoms of temporomandibular disorder. Even with the low prevalence of open bite in this age group, 4.2% had presented an anterior open bite by 6 years of age, the prevalence having decreased to 2.5% [21] by 14 years of age. Then, it was possible to correctly select eight individuals to constitute the experimental group, surpassing the quantity determined by the sample calculation.

In studies, masticatory function can be evaluated objectively through clinical tests (masticatory efficiency or MP), or subjectively through questionnaires (masticatory ability). Most of the tests for efficiency or MP evaluate the size and distribution of chewed particles after a certain number of masticatory cycles [25].

In the present study, the selected methodology was the colorimetric system, with the use of masticatory capsules. This methodology has presented excellent intraexaminer reproducibility and good interexaminer reproducibility, demonstrating the reliability of results obtained from this method [26].

Table 1

Compares the groups in relation to the masticatory efficiency with fuchsine

Fuchsine	Mean	SD	n	P
Habitual				
Class I	0.1172904	0.0586673	8	0.600
Open Bite	0.1037425	0.0372824	8	
Right				
Class I	0.1437126	0.0575100	8	0.172
Open Bite	0.1005988	0.0620232	8	
Left				
Class I	0.1081587	0.0622425	8	0.600
Open Bite	0.0776946	0.0401941	8	

Through dynamic electromyography examinations, and comparing the behavior of masticatory capsules with materials of different textures during chewing tests, these devices have demonstrated behavior similar to food in tests [18].

Since the first studies using masticatory capsules [16], several studies have used them for evaluations in different areas of clinical practice, showing a broad applicability, including, for example, comparisons of MP and quality of life before and after the replacement of removable partial dentures [25]; the evaluation of supported implant rehabilitation [27]; comparing methods of prosthesis fabrication [28]; and evaluations in patients with temporomandibular disorders [29] and dentofacial deformities [30].

As previously stated, the number of studies involving anterior open bite and MP is not significant in the scientific literature. The authors of the first related study in the literature suggested that surgical correction of anterior open bite may improve bite force, but nothing was mentioned about MP [31].

The correlation in children of MP with malocclusion, and including anterior open bite, suggested that the control group had a better ability to crush the test material [22].

A more recent study involved children with their first dentition; among these, 15 presented an anterior open bite using the capsule methodology. The study concluded that, in the sample studied, anterior open bite in the first dentition had no influence on MP. This result resembles those obtained in this study, which showed that, although the control group presented mean values of MP higher than the group with previous open bite, no statistically significant differences were found between the groups.

5. Conclusion

From the results obtained in this study, it is possible to conclude that, although the control group (G1: good overbite) produced absolute mean values higher than the average of G2 (anterior open bite), no statistically significant differences were evidenced between the values of MP in both groups, indicating that individuals with anterior open bite may not have their MP compromised.

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