Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/aob

Masticatory efficiency and bite force in individuals with normal occlusion

Rogério Alexandre Modesto de Abreu [a], Max Domingues Pereira [a,*], Fabianne Furtado [a], Gabriela Pereira Ribeiro Prado [a], Wilson Mestriner Jr. [b], Lydia Masako Ferreira [a]

[a] Division of Plastic Surgery, Universidade Federal de São Paulo (UNIFESP), São Paulo, Brazil
[b] Department of Clinical Pediatrics and Preventive and Sanitary Dentistry, College of Dentistry, Universidade de São Paulo, Campus Ribeirão Preto (USP-RP), SP, Brazil

ARTICLE INFO

Article history:
Accepted 5 May 2014

Keywords:
Bite force
Dental occlusion

ABSTRACT

Objective: The aim of the study was to evaluate and correlate masticatory efficiency (ME) and maximum bite force (MBF) in adult individuals of both genders with normal occlusion.
Design: The study was conducted in a university research centre. ME and MBF were evaluated in 55 adults (27 men and 28 women) with normal occlusion. All subjects chewed four fuchsin capsules (two on the right and two on the left molar region) for 15 chewing cycles with a 3-min interval between capsules. The concentration of fuchsin in the capsules was determined by spectrophotometry and stratified by gender and chewing side. Bite force (BF) was measured three times on both the left and right molars; the highest value of the three measurements on each side was taken as the MBF.
Results: ME was higher in women (right side, 1.17 ± 016 μg/mL; left side, 1.20 ± 0.15 μg/mL) than in men (right side, 0.92 ± 0.24 μg/mL; left side, 0.89 ± 0.24 μg/mL). The MBF was higher in men (right side, 632 ± 174 N; left side, 627 ± 170 N) compared with women (right side, 427 ± 140 N; left side, 420 ± 112 N). No significant differences in chewing efficiency and BF were found between sides for both genders.
Conclusions: Women showed the highest ME, while men had the highest MBF, with no correlation between these two parameters among genders.

1. Introduction

Maximum bite force (MBF) measurement can be used as a parameter indicating the functional condition of the masticatory system.[1,2] For those working in the field of oral and maxillofacial surgery, it can also be used as a parameter of normality.[3]

Masticatory efficiency (ME), also referred to as masticatory or chewing performance,[4] is the ability of an individual's masticatory system to reduce food to small particles to be swallowed. It is a complex task affected by many factors including bite or occlusal forces, occluding teeth, mandible kinematics, tongue work, and salivary activity.[2–4]

ME has been recognized as having a direct impact on the quality of life and previous studies have used a number of

* *Corresponding author.*: Division of Plastic Surgery, Rua Napoleão de Barros 715, 4° andar, CEP 04024-002, São Paulo, SP, Brazil. Tel.: +55 11 5576 4118; fax: +55 11 5575 8265.
E-mail address: maxdp@terra.com.br (M.D. Pereira).
http://dx.doi.org/10.1016/j.archoralbio.2014.05.005
0003–9969/

methods to determine to what degree the study participant's masticatory system could grind the study chewing material.[2–4]

ME has been most frequently determined using solid hard food, such as carrots,[5] peanuts,[6] and coconut.[7] After these materials are chewed for a period of time[3] or chewing cycles,[5,6] the resulting ground product is collected and usually separated in size ranges using sieves with different, calibrated openings. The separated portions, referred to as fractions, of the ground material are weighed and the rates determined are recorded for analysis.[5–7]

Attempts to improve ME determination in order to provide higher levels of reproducibility by eliminating influencing factors such as salivation activity, which makes grinding more effective by softening and/or dispersing the material chewed, and by controlling for the variability of hardness of the natural materials used led to the introduction of artificial materials for chewing such as Optosil™, Cuttersil™, and Optocal™.[4,8–12]

Further improvement was carried out aiming at replacing the sieving and weighing of the material chewed by a more convenient way to evidence the grinding ability of a study participant. The use of rubber capsules containing pigment-coated granules as a test material was introduced by Nakasima et al.[14] Other colorimetric and spectrophotometric methods have also been used to assess ME.[3,7,13]

The method developed by Escudeiro-Santos et al.[13] combines colorimetric indication of grinding efficiency with teeth crushing work. Artificial granules (beads) manufactured with natural components designed to have a controlled level of hardness are encased in a resistant, leak-proof polyvinyl acetate (PVA) capsule. Chewing on this capsule crushes the beads in a fashion similar to that regular hard food is crushed. When the beads are reduced to smaller particles, a dry colouring substance (fuchsin) is exposed on the surface of these particles. As it occurs with food, which after chewing becomes more exposed to digesting body secretion, the breaking down of the beads makes the colouring material more easily extractable by using a convenient solution. The exposed dye incorporate in the liquid means proportionally to the size of the crumbled particle, thus indicating to what degree the beads were ground.

The chewing capsules developed by the team of Escudeiro-Santos should fulfil three major research requirements: first, the elimination of bias in experimental reproducibility introduced by the variability in the level of salivation and saliva activity; second, the elimination of bias in experimental reproducibility introduced by the variability in the level of hardness of the material chewed; and finally, the reduction of costs and laboratory workload by using a cheaper and less demanding method of determining ME.

Studies using Escudeiro's capsules are few. These have determined reproducibility[3,7] and equivalence with other methods of assessing ME.[13] None of them have investigated the correlation between ME and other parameters of masticatory function. On the other hand, the literature includes many studies focusing on the association between mean values of MBF and ME.[8,15–17]

An aspect common to the studies retrieved is that they have found an association between bite force (BF) and ME in terms of mean values obtained for comparing groups (intergroup comparisons).[5,9,11,8,15–17] They have not explicitly reported on the variation of BF and ME in a same group. They also show some controversy regarding BF and ME. Despite reporting higher levels of BF in male groups[18–23] as compared with female counterparts, some found higher masticatory performance in men's groups,[8,15] whereas other studies reported similar rates for male and female participants.[5,9,11,16,17]

The aim of the present study was to determine whether an association between MBF and ME in healthy dentate individuals with normal occlusion could be evidenced using PVA capsules developed by the research team of Escudeiro-Santos et al.[13] to assess ME.

2. Materials and methods

The study was approved by the Research Ethics Committee of the Universidade Federal de São Paulo (UNIFESP), Brazil (approval number CEP 0472/10) and performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all participants prior to their inclusion in the study, and anonymity was ensured.

A total of 55 volunteers (27 men and 28 women) without dentofacial deformities, with normal occlusion and mean age of 28.05 ± 4.04 years (range, 18–40 years), were consecutively recruited in the Cranio-maxillofacial Surgery Unit of the Plastic Surgery Outpatient Clinic at UNIFESP. The volunteers included medical students, resident physicians, and postoperative patients who had not undergone cosmetic or any surgical procedure related to the maxillofacial topology.

The study included adults with at least 14 permanent teeth in each arch, Class I first molar and canine relationships (Angle Classification),[24] and Class I facial pattern, according to Capelozza Filho.[25]

Exclusion criteria were

- changes in the temporomandibular joint (TMJ), such as pain, limited oral opening, TMJ sounds (clicking or popping), bruxism, and dental restorations affecting occlusion
- use of fixed or removable prostheses
- orthodontic treatment in the past 3 years
- prior orthognathic surgery
- traumatic or congenital facial deformities, or tumours of the maxilla and mandible

All volunteers were clinically examined and completed a questionnaire assessing their demographic characteristics (age, gender, and ethnicity), medical history, and chewing side preferences. Individuals who reported any pain on clinical examination and those with any TMJ sounds, such as popping or clicking, were not included in the study.

2.1. Procedures

Facial photographs of all participants were taken in standardized views (frontal view and right and left lateral views), as well as intraoral photographs (frontal view, right and left buccal views, and upper and lower occlusal views). The photographs were evaluated by an orthodontist, who assessed