ARCHIVES OF ORAL BIOLOGY 53 (2008) 199–205

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/arob

Variations in activities of human jaw muscles depend on tooth-tipping moments

S. Uchida [a], *L.R. Iwasaki* [b,c,*], *D.B. Marx* [d], *Y. Yotsui* [e], *H. Inoue* [a], *J.C. Nickel* [b,c]

[a] *Department of Removeable Prosthodontics, Osaka Dental University, Temmabashi Campus, 5-17 Otemae 1-chome, Chuo-ku, Osaka 540-0008, Japan*

[b] *Department of Orthodontics and Dentofacial Orthopedics, School of Dentistry, University of Missouri – Kansas City, 650 East 25th Street, Kansas City, MO 64108-2784, USA*

[c] *Department of Oral Biology, School of Dentistry, University of Missouri – Kansas City, 650 East 25th Street, Kansas City, MO 64108-2784, USA*

[d] *Department of Statistics, University of Nebraska – Lincoln, 340 Hardin Hall North, Lincoln, NE 68583-0963, USA*

[e] *Department of Oral Maxillofacial Radiology, Osaka Dental University, Temmabashi Campus, 5-17 Otemae 1-chome, Chuo-ku, Osaka 540-0008, Japan*

ARTICLE INFO

Article history:
Accepted 5 October 2007

Keywords:
Human
Jaw muscle
EMG
Bite force

ABSTRACT

Static mechanical analyses of the masticatory apparatus often assume that jaw muscle activity, as measured using electromyography (EMG), is linearly and constantly related to magnitude of bite force during biting, regardless of bite force-induced tooth-tipping moments. The objective of this study was to test the hypothesis that the relationship between EMG of the jaw muscles and bite force varies with the magnitude and sign of tooth-tipping moments. Seven healthy male subjects produced unilateral static occlusal forces at five biting positions, resulting in sequential changes from buccal (+) to lingual (−) tipping moments on the mandibular first molar. Jaw muscle activities were recorded bilaterally using surface (for temporalis and masseter muscles) and indwelling (for lateral pterygoid muscles) electrodes. Bite forces were recorded and controlled using custom devices. EMG versus bite force data were plotted and regression relationships were calculated for each subject, muscle and biting position. Linear regression analysis, analysis of variance and Bonferroni adjusted least significant difference tests were used to determine the effects of muscle, side (ipsilateral, contralateral) and biting position within subjects. It was found that the relationship between EMG and bite force for different tipping moments differed significantly within a subject and muscle. This was most common in the lateral pterygoid and temporalis muscles (all $P \leq 0.042$), where slopes of the EMG:bite force relationship varied between 3:1 and >25:1. In the masseter muscle, the EMG:bite force relationship for different tipping moments differed significantly in one subject ($P < 0.008$); slopes varied up to 4.6:1. In conclusion, the relationship between EMG and bite force was linear. However, the slopes of the relationship changed significantly depending on sign (+, −) and magnitude of tipping moments acting on the molars.

© 2007 Elsevier Ltd. All rights reserved.

* *Corresponding author at*: Department of Orthodontics and Dentofacial Orthopedics, School of Dentistry, University of Missouri – Kansas City, 650 East 25th Street, Kansas City, MO 64108-2784, USA. Fax: +1 816 235 5472.
E-mail address: iwasakil@umkc.edu (L.R. Iwasaki).
0003–9969/$ – see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.archoralbio.2007.10.002

1. Introduction

It is often assumed that there is a constant linear relationship between muscle activity, as measured by electromyography (EMG), and bite forces. This is considered to be a useful circumstance that allows mathematical modelling to determine, a priori, muscle forces during static biting tasks and, thus, to calculate the magnitudes of temporomandibular joint (TMJ) forces. However, EMG:bite force data for the masseter, temporalis[1–7] and lateral pterygoid[5,6] muscles suggest that the constant of proportionality (slope) between EMG from the jaw muscles and bite force may vary. The variation depends on the position and direction of the bite force, and whether or not a muscle is ipsilateral or contralateral to the side of biting.

Previously reported effects of bite force direction on masseter and temporalis muscle activation patterns[7] differ substantially from validated numerical model predictions.[8] Previous studies provided subjects with visual feedback of bite force magnitudes or muscle activities and splints linking multiple teeth. It is possible that control of muscle behaviour was affected by input from the visual cortex, variable and unknown input from periodontal mechanoreceptors, or both. This may have produced the reported patterns and variations in the slopes of the EMG:bite force regression relationship. It remains unknown whether or not the patterns and variations in the EMG:bite force relationship would be affected by eliminating feedback to subjects and by more discrete localization of activation of periodontal ligament mechanoreceptors associated with the molar teeth.

The main aim of this study was to test the hypothesis that the slope of the EMG from the jaw muscles and bite force varies as a function of magnitude and sign of the tipping moments acting on the molars. A secondary aim was to test whether or not the EMG:bite force relationship measured during static biting without feedback produced data similar to that from validated computer models. By addressing these aims, clinical EMG data are expected to be interpreted predictably and will therefore be useful to studies of the mechanics and function of the human jaw system.

2. Materials and methods

Seven adult male subjects gave informed consent to participate in this study. The study was approved by the Institutional Review Boards of Osaka Dental University and University of Nebraska Medical Centre.

Unilateral static biting tasks were performed on the right and left first molars to determine if muscle activities varied according to magnitude and sign of molar tipping moments. Static biting occurred on a small steel ball, 5 mm in diameter, between custom acrylic crowns cemented to maxillary and mandibular right and left first molars. A precalibrated electrically resistant film (TekScan Flexforce), positioned between the steel ball and acrylic crown, measured the magnitude of the bite force. The bolus position relative to the centre of resistance of the loaded mandibular molar was known through the use of five small depressions on each mandibular molar crown (Fig. 1). The depressions were spaced 5 mm apart and parallel to the mediolateral axis. The maxillary molar crown had a flat occlusal surface without depressions. Each subject was asked to produce a static bite force for 5 s, five times at each of five positions on the mandibular molar, with approximately 5–20 s between biting positions. Subjects were asked to produce a range of comfortable magnitudes of bite force at each position. No visual or auditory feedback was provided, in order to reduce the likelihood of influence from higher centres that enable

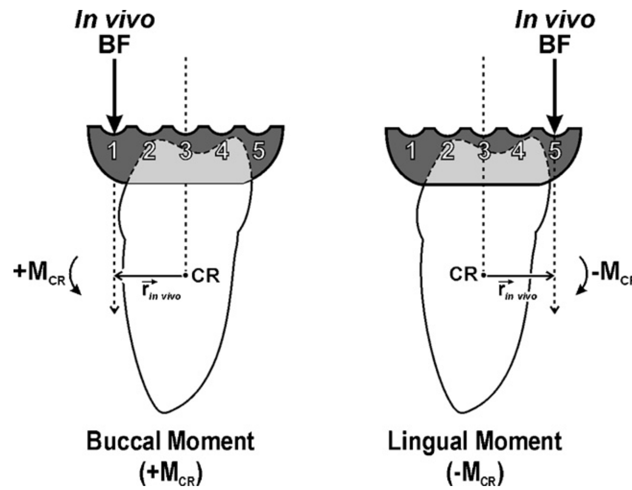

Fig. 1 – Mesial of right mandibular molar with acrylic crown in place showing the extreme buccal tipping moment ($+M_{CR}$, on left) resulting from an applied bite force (BF) at Position 1, the extreme lingual tipping moment ($-M_{CR}$, on right) resulting from an applied BF at Position 5, the centre of resistance of the tooth (CR) and the vector arm of the moment ($\vec{r}$) (adapted from previous work[9]). Positions 2–4 are labelled and corresponded to medium buccal, approximately zero and medium lingual tipping moments, respectively, when a bite force was applied.

Fig. 2 – Verification of electrode placement by computed tomographic imaging. Horizontal slice showing anterior (A), left (L), right (R) and posterior (P) aspects, and fine-wire electrode tips (circled) within inferior head of right and left lateral pterygoid muscles in one subject.

Download English Version:

https://daneshyari.com/en/article/3121195

Download Persian Version:

https://daneshyari.com/article/3121195

Daneshyari.com