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Interferential effect of the over-erupted third molar on chewing movement

Shaoxiong Guo[1], Baoyong Li[1], Kun Qi[1], Mian Zhang, Han Zhang, Donghui Guo, Xiaodong Liu, Meiqing Wang*

State Key Laboratory of Military Stomatology & National Clinical Research Center for Oral Diseases & Shaanxi International Joint Research Center for Oral Diseases, Department of Oral Anatomy and Physiology and TMD, School of Stomatology, The Fourth Military Medical University, Xi'an, China

A R T I C L E I N F O

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A B S T R A C T

Objective: To clarify whether over-eruption of the mandibular third molar can disturb chewing movement.
Methods: Eighteen patients with a unilateral mandibular over-erupted third molar confirmed by both study cast observation and T-scan occlusal detection were selected from a sample of patients with complaints of temporomandibular disorder (TMD) symptoms. A unilateral gum-chewing trace was recorded separately for left and right side chewing by an electrognathography system. The average chewing pattern (ACP) was created based on segments from the recorded chewing trace to represent the chewing movement characteristics of each individual. Two factors, the TMD symptomatic side and the over-eruption side, were analysed for their effects on values of difference in the parameters (Δvalue) regarding the ACP between chewing with right and left side. Three-dimensional amplitudes of ACP and the cross point value of ACP with the vertical axis (termed the cross zero point value) which described the turning point of the chewing cycle from the balancing side to the working side, were compared between sides.
Results: The over-eruption side had an effect on the Δvalue of the medial amplitude, the lateral amplitude, and the cross zero point ($P < 0.05$), but the symptomatic side didn't ($P > 0.05$). When chewing on the over-eruption side, the medial amplitude was shorter, the lateral amplitude was larger, and the cross zero point value was smaller than those when chewing on the other side ($P < 0.05$).
Conclusion: The present data indicate an effect of the over-erupted mandibular third molar on the chewing pattern while that from the symptom(s) is limited.

1. Introduction

Occlusion is defined as the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues (The glossary of prosthodontic terms, 2005). The main function of occlusion is the mastication of foods. Each of the particular contacts between the maxillary and mandibular dentitions may have more or less modifying effect(s) on chewing movements through peripheral modulation, such as periodontal feedback, which may influence the chewing cycle (Fueki, Yoshida, Okano, & Igarashi, 2013; Nishio, Miyauchi, & Maruyama, 1988; Pröschel & Hofmann, 1988), at least in the occlusal phase. Thus, to better comprehend the effects of occlusion on chewing function, such as those related to the temporomandibular joint (TMJ) and jaw muscles, it is helpful to analyse the relative quality of chewing movements in analogous groups of patients with certain classes of occlusions.

There are many morphological aspects of occlusion, such as overbite and over-jet in the labial-lingual or buccal-lingual direction and Angle's classification in the sagittal plane. The morphological features of occlusion vary greatly between individuals. Reports in the literature on the effect of occlusion on chewing movements are conflicting. For example, Slavicek et al. (2010) indicated that there were no relationships between Angle's classifications of malocclusion and chewing patterns. Skeletal Class III patients were reported to have no significant change in the duration of their chewing cycle after receiving surgical orthodontic treatment (Ueki et al., 2009). Pröschel, Hümmer, Hofmann, and Spitzer (1990) did not find regularly changes in the individual mastication modes in patients with mandibular prognathism after correction of their occlusal profiles. However, Rech, Santos, Maahs, and Vidor (2014) reported that participants with Class III relationships had a decreased chewing speed compared with Class I subjects. Using an occlusal registration strip, Shiga, Kobayashi, Arakawa, Yokoyama, and

* Corresponding author at: State Key Laboratory of Military Stomatology & National Clinical Research Center for Oral Diseases & Shaanxi International Joint Research Center for Oral Diseases, Dept. Oral Anatomy and Physiology and TMD, School of Stomatology, the Fourth Military Medical University, 145 West Changle Road, 710032, Xi'an, China.
E-mail address: mqwang007@aliyun.com (M. Wang).

[1] These authors contributed equally to this work and should be considered co-first authors.

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Tanaka (2009) reported that differences in occlusal contacts at 2 mm of lateral excursion of the mandible from the intercuspal position were associated with differences in chewing path patterns. However, three investigators who independently observed the chewing movement tracings failed to find any characteristic patterns in subjects with balancing side molar contacts (Nishigawa, Nakano, & Bando, 1997). Posterior scissor-bite and crossbite were most often reported to relate to chewing pattern, such as a significantly narrower chewing pattern (Tomonari, Kubota et al., 2014), a high frequency of reverse and reverse-crossing chewing types (Nie, Kanno, Xu, Lin, & Soma, 2010), the appearance of a figure "8" when viewed in the frontal plane (Piancino, Farina, Talpone, Merlo, & Bracco, 2009), and a shorter lateral deviation when chewing on the crossbite side (Sever, Marion, & Ovsenik, 2011). However, conflicting results have also been reported in the literature (Martín, Alarcón, & Palma, 2000). Patients with a first molar crossbite were reported to have the same cycle duration as subjects with normal occlusion (Tomonari, Ikemori, Kubota, Uehara, & Miyawaki, 2014). The heterogeneous nature of occlusion, such as the location and number of tooth pairs with a crossbite relationship, is one of the main explanations for these divergent conclusions and makes it difficult to compare the different reports. It is thus rational to enrol and investigate a group of patients with occlusions that show an analogous pattern. When the occlusion pattern is more analogous and identifiable, the likelihood that conclusive results will be achieved is greater.

Abnormality of the third molar is frequently found in clinics (Forsberg, Vingren, & Wesslén, 1989; Russell et al., 2013). This fact provides an opportunity to recruit participants with analogous occlusion, such as Angle's Class I first molar relationship, who have only one mandibular over-erupted third molar without the appearance of other kinds of malocclusion (as mentioned above). Over-eruption of the third molar due to the lack of an occlusal antagonist is often noted. The contact between the over-erupted third molar and the distal part of the opposing second molar is often strong enough to produce a wear facet with time. This type of occlusion, capable of producing facet between the over-erupted third molar and the opposing second molar, should be generally comparable between subjects when other sites of occlusion look normally arranged. Agreement on the diagnosis of this type of occlusion pattern is easy to achieve via observation of the tooth wear facet either directly in the mouth or on the cast study model; alternatively, it can be conducted via clinical examination with occlusal coloured paper or occlusion detectors, such as the T-Scan system (Li et al., 2015; Wang, Zhang, Xing, Xu, & Wang, 2013). It is then practical to assess the effect of that contact on the mandibular movement. In the present study, we created an average chewing pattern (ACP) in accordance with the manual to represent individual mean chewing patterns. The mean chewing pattern, represented by the ACP, was compared between the sides with and without the mandibular over-erupted third molar. We hypothesized that there is no consistent interfering effect of the over-erupted mandibular third molar on the chewing movement pattern.

2. Materials and methods

2.1. Subjects

Eighteen female patients (26.0 ± 4.74 years of age) with one over-erupted mandibular third molar volunteered to participate. All of them were patients complaining of the symptoms of temporomandibular disorders (TMD) that satisfied the diagnostic criteria of RDC/TMD (Dworkin & LeResche, 1992), and they presented at the Department of Orofacial Pain and TMD, Dental Hospital, Fourth Military Medical University. Six of the patients suffered from TMD symptoms bilaterally, while the other twelve suffered symptoms unilaterally. Fourteen patients complained of orofacial pain, ten complained of TMJ sounds, and four had joint locking (Table 1). The symptoms were confirmed by one of the authors, an experienced dentist (BY), via patient inquiry. All volunteers understood the details of the test and were asked to sign an informed consent form. Other inclusion criteria included the following: (i) Angle's Class I relationship, (ii) mouth opening range that was sufficient for chewing gum, and (iii) positive occlusal contact between the over-erupted mandibular third molar and the distal surface of its opposing maxillary second molar, diagnosed by the observation of faceting on the study cast. Positive interfering posterior contact during protrusive edge-to-edge or contra-lateral side contact during lateral clenching in the cusp-to-cusp position was confirmed by T-scan occlusal analysis as described below. The exclusion criteria were as follows: (i) history of restorations and orthodontics, (ii) missing teeth except some of the third molars, (iii) complaints of periodontal problems, and (iv) history of oral-facial trauma, orthognathic surgery, or periodontal treatment. The study protocol was approved by the Ethics Committee of the Fourth Military Medical University in accordance with the World Medical Association's Helsinki Declaration.

2.2. Confirmation of interferential occlusion contact

Tekscan's T-Scan III Computerized Occlusal Analysis system, a device for occlusal contact force and timing detection, was adopted according to the T-Scan user manual (Tekscan, Inc., South Boston, MA, USA). The 0.1-mm-thick sensor recorded the changes in relative pressure on the occlusal surfaces of the teeth, the many levels of which were then expressed as different colours on the screen (Fig. 1a, b). The sensor was placed on the mandibular dentition, and the patient was encouraged to clench in the protrusive edge-to-edge position as well as the lateral cusp-to-cusp position (separately at right and left side), with the aim of confirming the interferential contact of the over-erupted third molar at these eccentric positions.

2.3. Movement recording

Chewing movement was recorded using the JT-3D Electrognathograph (EGN) and BioPAK system software (Bioresearch Associates, Inc., Milwaukee, WI, USA), an instrument that uses a sensor array to dynamically track the position of a magnet attached to the gingival third of the patient's mandibular central incisors. Briefly, the upper edge of the magnet was positioned parallel to the inter-pupillary line. The magnet attachment was carefully performed to prevent the magnet from interfering with any movement of the mandible. The sensor array was fixed on the patient's head. The chewing cycles in three dimensions as well as the corresponding amplitudes were automatically calculated and displayed by the software (BioPAK software Version 8.1, BioResearch Associates, Inc., Milwaukee, WI, USA) (Fig. 1c–e). During the whole testing process, the patients were required to sit upright in a chair, keeping their eyes on a point at eye level two metres away. Before the chewing tasks, the range of mouth opening (ROM) was recorded by asking the patients to open as wide as possible to represent the mandibular function.

Prior to the chewing recordings, the patients were instructed to chew a piece of gum 22 × 12 × 7 mm (length × width × thickness) (Doublemint; Wm. Wrigley Jr. Company, Guangzhou, Guangdong, China) for one minute to ensure a uniform consistency of bolus quality. Before starting the formal test, the patients were asked to place the bolus on their tongue with their teeth slightly in contact at intercuspal position and to wait for the starting order. After the recording software and electrognathograph were calibrated, the recording button was pressed simultaneously with the request of unilateral gum-chewing. The sequence of left- vs right-side chewing recording was randomized by Excel 2007 software (Microsoft Office 2007; Microsoft Inc., Redmond, WA, USA) to eliminate any possible order effects. The"RANDBETWEEN" function of the Excel 2007 software was used.

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