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EMG evaluation of masseter muscle during maximum clenching in complete denture wearers after reducing the occlusal vertical dimension

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Abstract
The rehabilitation of masticatory function, which made by natural teeth, one of the most goals of the treatment of complete dentures patients, Studies indicate that the change in occlusal vertical dimension (OVD) affects the patient's biting force.
Purpose: This study aimed to evaluate the Electromyography (EMG) of masseter muscle during maximum clenching after reducing the OVD in complete dentures wears.
Materials and Methods: Seven completely edentulous subjects, 2females and 5 males, their ages were between (45 -70) years precipitated in this study. One upper and two lower complete dentures were fabricated for each subject, the first set of upper and lower complete dentures was made with an appropriate OVD, while the second set of complete dentures were made with reduced OVD (about 3 mm). The EMG of the master, in both sides during maximum tooth clenching were performed two months after the patient delivered the first complete denture. The same procedures were repeated for the second set of complete denture wears after two weeks.
Results: The mean value of the EMG of master muscle during maximum clenching for complete denture wearers with an appropriate OVD was (435.35) uV, while for the patients, who wear complete dentures with reduced OVD was (299.25) uV.
Conclusions: There are statistically significant differences in the mean value of the EMG between the two groups at the confidence level of 95%. The value of the EMG in dentures with reduced OVD was smaller than that of appropriate OVD in the research sample.

Keywords: Occlusal vertical dimension (OVD), electromyography (EMG), complete denture

Introduction
Occlusal Vertical Dimension (OVD) is the distance measured between two points when the dental arches are in occlusion at maximum intercuspation. (Researches and Supervision 2005) [15] Determination of the correct OVD for edentulous patients is one of the most important steps in making dentures with adequate esthetics and function. (Heartwell 1986) [9]
According to Sharry determining VDO is not a precise process, and many experts will come to this dimension using different methods.
Different methods have been proposed for determining VDO (Atwood 1958; Swerdlow 1964; Van Willigen *et al*. 1985) [21], All of these methods are inaccurate in determining the vertical occlusal dimension that may result in a plus or a low dimension.
A decreased OVD can lead to the appearance of lesions, such as angular cheilitis, facial disharmony, and temporomandibular disorders; meanwhile, an increased VDO may lead to the onset of joint and muscle pain, tension in functional speech, difficulty in swallowing, impaired chewing, pathologic bone resorption, abnormal wearing of teeth, the appearance of an elongated face, and a facial expression of fatigue (Discacciati *et al*. 2013) [6].
Many edentulous patients have adapted to a vertical dimension which has decreased due to bone resorption and posterior tooth wear. Restoring the proper vertical dimension is further complicated because the rest position may be subject to change. Swerdlow found that the vertical dimension of rest varies after natural tooth contacts are lost.

Also, the rest vertical dimension can undergo a reduction comparable to the loss of occlusal vertical dimension (Toolson and Smith 1982) [19]. Niswonger observed that the patients whose vertical dimension of occlusion was excessive complained that they could not use the dentures because of continual soreness on the residual ridges. Tenth felt that nature may shorten muscles, but rarely, if ever, is their functional length increased. There are conflicting reports in the literature regarding the effects of decreasing the OVD. Some authors have suggested that the stomatognathic system naturally adapts to decreases in OVD, for example in cases of tooth loss or severe dental attrition. Conversely, other authors have suggested that a decrease in OVD can predispose the patient to TMD. Nevertheless, there is no strong evidence in the literature supporting either of these statements (Moreno- Hay and Okeson 2015) [14]. McGee found that patients tend to register a reduced vertical dimension of occlusion because they feel more comfortable in this position (Mc 1947) [13].

The aim of this study was to assess the EMG of masseter muscle during maximum tooth clenching after reducing the OVD in complete dentures wears

Material and Methods

Seven completely edentulous subjects, 1females and 6 males, their ages were between (45 -70) years precipitated in this study. One upper and two lower complete dentures were fabricated for each subject, the first set of upper and lower complete dentures was made with an appropriate OVD, while the second set of complete dentures were made with reduced OVD (about 3 mm), fig **(**1,2,3**).** The maxillary cast of each patient was mounted in a semi adjustable articulator **(**Hanau H2) using Hanau face bow**.**OVD was established using the physiological rest positions associated with phonetic and esthetic techniques, Centric relation was established according to dynamic records based on physiological movements of the jaws, including opening, closing, and lateral movements performed by the patient.(Zarb *et al*. 2013) [22] These records were performed to position the mandibular casts on the articulators. Artificial teeth were selected, and bilateral balanced occlusion was obtained (Al- Ali *et al*. 1999) [2] Extreme care was taken to ensure that the experimental mandibular dentures occluded correctly with the conventional maxillary denture because any occlusal errors would lead to changes in activity levels in function, The dentures were waxed, processed, finished, and polished for insertion and follow-up.

The EMG of the master, in both sides during maximum clenching were performed two months after the patient delivered the first complete denture. The same procedures were repeated for the second set of complete denture wearers after two weeks.

Fig 1: Appropriate OVD

Fig 2: Reduced OVD

Fig 3: Two lower complete denture, one with an appropriate OVD, and the other was reduced by 3 mm than the first OVD

EMG recordings and measurements

Surface electrodes were used for EMG recording, The electrodes were fixed on the left and right masseter muscle. To reduce skin impedance, the skin was carefully cleaned prior to electrodes placement Fig (3).

During the recording procedure, the patient was seated in a dental chair in an upright but relaxed position with the head unsupported, and in its natural balance. Muscle activity was recorded in maximal clench in centric occlusion. the subject was instructed to bite hard for 10 seconds in maximum intercuspation without causing pain. EMG was recorded after 2.5 seconds of maximum clenching time of the masseter on both two sides, and the recording was continued for 5 seconds Fig (4). the subject was invited to clench as hard as possible, and to maintain the same level of contraction for all the tests. Three times of EMG recordings were made, A resting period of 5 minutes between clenching was allowed to avoid muscular fatigue. During maximal clenching the peak of EMG activity was measured Fig (4).

Fig 3: Bipolar surface electrodes positioned on the masseter (MM) muscle

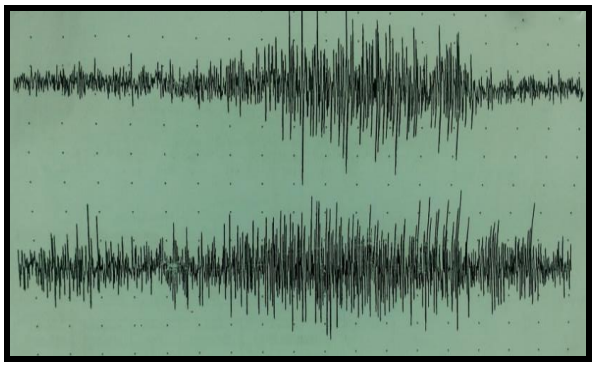

Fig 4: Shows the Max amplitude of EMG

Results

Mean EMG potentials of Max amplitude computed in the two groups were compared by using Student's t -test for independent samples.

All the EMG potentials recorded during maximum voluntary clench in the reduced OVD were lower than that recorded in the appropriate OVD, with statistically significant differences for all four analyzed muscles (p<0.05). The mean EMG potentials of both left and right master was 435.35 at patients with appropriate Occlusal vertical dimension. But the patients with decreased Occlusal vertical dimension was 299.25 Table (1).

By conventional criteria, this difference is considered to be statistically significant.

Table 1: Max ampl.,uV in left and right sides of master muscle

Max ampl.,uV				times	patient
Left side		Right side			
Reduced	appropriate	Reduced	appropriate		
192	348	208	276	1	*1*
175	221	301	316	2	
209	247	226	224	3	
205	220	230	240	1	*2*
299	295	280	290	2	
210	230	322	355	3	
470	537	371	669	1	*3*
450	668	454	631	2	
305	541	295	518	3	
420	499	310	530	1	*4*
466	512	355	455	2	
399	577	340	599	3	
69.8	101	311	93.1	1	*5*
59.5	143	335	320	2	
53.8	138	362	530	3	
168	499	315	534	1	*6*
255	598	325	612	2	
365	611	370	620	3	
389	520	311	534	1	*7*
415	599	399	620	2	
320	605	295	610	3	
278.755	414.7143	319.7619	456.0048	Mean	
Right and Left sides					
Reduced OVD		Appropriate OVD			
299.2585		435.3596			

Discussion

The present study used the EMG to examine how VDO can affect in maximum bite at complete denture wearers. (Matsuda *et al*. 2014) [12]

In this study, The mean electrical activity values of the muscles analyzed in the maximum tooth clenching with the complete dentures with reduced OVD were lower in comparison with those of patients with the complete dentures of appropriate OVD, There are statistically significant differences in the mean of the EMG between the two groups. The EMG activity during maximal clenching in complete dentures in the present study agrees with other authors who have reported that The change in VDO, either increase or decrease has many disastrous effects on stomatognathic system. The increased OVD can lead to constant strain of muscles of closure leading to masticatory inefficiency,

excessive resorption of the residual ridge, unacceptable appearance. When the OVD was reduced, the muscles of closure would not be extended to their full capacity, resulting in loss of muscle tone and efficiency. (Gosavi *et al*. 2015) [8],

As a result, a lower bite force is developed by the muscles. Several authors state that the main cause of reduction in masseter muscle electrical activity during maximum tooth clenching, also found in the patients of the present study, may be related to the patient's lack of muscular capacity and ability to adapt to the new state of OVD. values vary from one patient to another, it may be due to the different of muscular capacity and ability in compete denture wears (Brills 1957) [5].

In the present study, Increased in electrical activity in the masseter muscle during the maximum tooth clenching tests (Table 1) with appropriate OVD is in agreement with the results of Licona and Lindauer *et al*, who found that after 30 days of putting the new dentures in place, the electrical activities were significantly greater. According to the authors, this increase in electrical activity occurred as a result of reestablishing the suitable OVD. Clinically, the use of complete denture with an appropriate OVD will allow the muscle to work in natural length producing extra activity during maximum clenching and therefore greater occlusal bite (Goiato *et al*. 2007) [7].

Conclusion

This Study Showed significant decrease in muscles activity in complete denture wearers with reduced OVD. The bite force in appropriate OVD was greater than reduced OVD.

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