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Comparative Study of VDR and the Electrical Activity of the Anterior Temporal and Masseter Muscles using Physiologic *rest* Position, *Phonetics* and *Swallowing* methods

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ABSTRACT

Vertical dimension of rest (VDR) or physiologic rest position (VDR) is defined as a stage of prosthetic treatment for edentulous patients. Mandibular rest position is used to record VDR which is fulfilled via common methods such as Physiologic rest position, Phonetics and Swallowing methods. This study aims to compare the rate of VDR and electrical activity of the anterior temporal and masseter muscles using physiologic rest position, phonetics and swallowing methods. This is a clinical trial conducted in the Rehabilitation faculty of Ahvaz Jundishapur University of Medical Sciences during 2009-2010. The statistical population consists of 30 individuals (15 men and15 women; age range 18-30 years old). The conditions for inclusion to this study is having 28 natural teeth with the Class I (Class I molar relationship), normal range of overjet and overbite, without anterior and posterior crossbites. Mean of VDR was recorded after swallowing (7/48$\pm$0.012), phonetics (8.14 0.19) and physiologic rest position (8.22 0.19). Mean of voltage of anterior temporal muscles was recorded after swallowing (7/360.216), phonetics (6.19 0.095) and physiologic rest position (6.19 0.119). it can use all the mentioned methods to acquire precise distance for VDR in clinic and it can use mean of acquired sizes under any difference.

Key words: VDR, Electromyography, phonetic voltage.

INTRODUCTION

The person is exposed to impairment with the loss of tooth, under which a change occurs in structure and functions of facial muscles; in addition, edentulous is a threat to health of masticatory system. Different components in masticatory system include teeth, neuromuscular system and cranial and facial structures [1]. In edentulous state due to needing to perfect teeth to retrieve masticatory system, knowing functional anatomy of the masticatory system and how the components of this system associate to each other is required [2]. The lost function and beauty can be returned to the patient by means of dental prosthesis, helping for health of remaining oral tissue. Recording jaw relations in these patients is made for alignment between dental prosthesis and masticatory system so as to provide occlusal contacts well suited with activity of masticatory muscles and temporomandibular joints by providing a suitable VDO [3]. The studies by Harris and Hight indicated that the vertical height of the face depends on occlusal contacts. Vertical height of the face reduces by means of teeth wear, loss of posterior teeth, ridge deterioration underneath the removable prosthesis, and dental wrong actions, deducing that the vertical height of the face depends must be reconstructed by considering these cases [4]. Starting edentulous is followed by occlusal contacts, and subsequently the vertical height of the face changes. This change continues during the next years [5]. Under loss of vertical height, neuromuscular system adapts with the changes and causes the patient does not face

much problem as these changes are gradual and just faces tangible changes in his face and reduction in his masticatory system by the passage of years [6]. Access to vertical height at the state of vertical dimension of occlusion (VDO) has been mentioned as one of the important principles to heal the patients who need the methods for mouth reconstruction [7]. When the person's natural teeth exist, there will be Vertical dimension of occlusion by these teeth [8]. In all the patients without teeth and patients who have lost their posterior teeth or have lost their VDO due to teeth wear, acquisition of methods to record the best result for VDO seems difficult [7]. Vertical height of face in the status of Vertical dimension of rest position is used to record VDO, which this is under influence of different factors such as loss of teeth, age of person and bone loss after edentulous; this method is used to determine the patient's position[9, 10, 11]. Formula VDO= VDR – FWS is used to record VDO. FWS refers to a distance between upper or lower teeth when mandible is in physiological rest position, mentioned that the distance at the premolar region is between 2-4 mm [12]. To set mandible at rest position and record VDR, there are a variety of methods such as phonetics and swallowing methods [7]. Further, it has been suggested to repeat measurement for several times regardless of the used methods and use mean of obtained sizes in case of difference [13]. This is because some studies have shown that this organ cannot be considered as an authentic reference point in determining VDO due to no constant mandible [14]. Further, cephalometric examination indicates that rest position of toothless jaw changes even in short time [15]. It seems that there is no certain rule to determine vertical dimension of occlusion from scientific perspective [14]. In general, a variety of methods to determine VDO have been suggested including mechanical methods such as Anthropometric measurements (16), cephalometric (17), records before pulling teeth (18) , the patient profile (19) , and face and physiological measurement (21,20) such as beauty , swallowing and speaking. In some cases, Computer programs based on the person's personal judgment is used to determine VDO used (22). Results of several studies indicated that use of denture alters the electrical activity of muscles by increasing VDO, which it can determine denture replacement time by recording EMG of masseter and temporal muscles [23, 24, 25]. Unsuitable VDO causes several orofacial disorders such as bruxism, masticatory muscle pain and temporomandibular joint problems (TMJ Disorders)[26]. On the other hand, increase or decrease of VDO in the area around the mouth and the face has been followed by substantial effects including beauty and masticatory force [9, 27]. Ambramicheltali(1998) compared size of vertical distance in rest position in clinic and vertical distance in rest position by means of Electromyographi and deduced that there is a millimeter difference in the distance between two vertical resting position at the clinic (phonetics and swallowing) and EMG[28]. Further, Frenso(2007) evaluated activity of temporal muscles using EMG, Phonetics and Swallowing methods and deduced that there is no significant difference between measured VDR via different methods[29].

With regard to difference in the results of the mentioned studies, this study aims to examine amount of VDR by means of three Physiologic *rest* position, *Phonetics* and *Swallowing* methods and examine electrical activity of the anterior temporal and masseter muscles under mentioned conditions.

MATERIALS AND METHODS

This research is an experimental study and Lab Trial, conducted in *Rehabilitation* faculty of Ahvaz Jundishapur University of Medical Sciences during 2009-2010. The statistical population consists of 30 individuals including 15 men and15 women at the age group 18-30 years old. The conditions for inclusion to this study is having 28 natural teeth with the Class I (Class I molar relationship), normal range of overjet and overbite, without anterior and posterior crossbites. During clinical examination, mesiobuccal cusp of the maxillary first permanent molar should have been in Mesiobuccal groove of the mandibular first molar. None of the subjects had received orthodontic therapy and consumed chemotherapy which affects facial muscle activity. In beginning each one sat on the chair in a vertical position and he/she was asked to press his teeth together and then masseter and temporalis muscles in anterior muscles were specifie*d by the physical therapist.*

For anterior temporal muscle, one of the electrodes is *placed* in 1 cm above the zygomatic arch and 1.5 cm behind the border of the orbit. The other electrode is placed 1.5 cm below the first electrode. Masseter muscle electrode is placed in the middle of the right muscle. Number of muscle channel includes channel by channel (2) and (4): temporal muscle masseter muscle, respectively. After ensuring the safety and soundness of device, the person was asked to practice phonetics which contains pronunciation of the letter (M) and the electrical activity of muscles was recorded in 15 seconds(3 seconds of rest, 5 seconds of muscle contraction, 7 seconds of rest after function). After pronunciation of the word and relaxation of muscles by EMG during record time, VDR distance between two points on the nose and chin that was already marked, measured and recorded. Then saliva was swallowed at 15 seconds and again VDR distance was measured and recorded at rest after the function. In the third function, the person was asked to press his/her teeth for 2 seconds and then he/she stopped pressing and the technician placed mandibular muscles in the position of rest using touch, ensured on total rest of anterior temporal and masseter muscles via EMG, during which VDR distance was measured and recorded. After recording data of all the individuals, the information was analyzed via Myo-Dat program.

RESULTS

Analysis of variance with repeated measures displayed that there is a significant difference between phonetics, swallowing and rest methods in the average voltage of the temporal muscle ($p < .001$). Furthermore, Tukey's *HSD test* indicated a significant difference between 'swallowing' and 'phonetics and rest methods' in the average voltage of the temporal muscle ($p < .001$), but there is no significant difference between phonetics and rest methods in the average voltage of the temporal muscle ($p > .0.05$)(Table 1).

DISCUSSION AND CONCLUSION

The present study was conducted to examine the levels of VDR measured via physiologic *rest* position, *phonetics* and *swallowing* methods; in this study, electrical activity of the anterior temporal and masseter muscles in the right side of subjects was recorded via device EMG. A number of previous studies mentioned lack of electrical activity of muscles during rest [30, 31], but most of studies believed in little electrical activity of muscles during rest of muscles [32, 33, 34], that the present research confirms these investigations. In this study, mean of voltage of anterior temporal muscles was recorded

Table 1: Comparison of the temporal muscle voltage in physiologic *rest* position, *phonetics,* and *swallowing* methods. The letters a, b, and c indicate statistically significant difference ($p<0.05$).

Confidence level Upper bound	Confidence level Lower bound	Standard error	Standard deviation	Mean of voltage of the temporal	Methods
	7.287	.039	.216	7.368[bc]	[a] *Swallowing*
6.233	6.161	.017	.095	6.197[a]	[b] *Phonetics*
6.239	6.150	.021	.119	6.194[a]	[c] Physiologic *rest* position

Analysis of variance with repeated measures displayed that there is a significant difference between phonetics, swallowing and rest methods in the average voltage of the masseter muscles ($p < .001$). Further, Tukey's *HSD test* indicated that there is a significant difference between 'swallowing' and 'phonetics and rest methods' in the average voltage of the temporal muscle ($p < .001$), but there is no significant difference between phonetics and rest methods in the average voltage of the temporal muscle ($p > .0.05$)(Table 2).

after *swallowing* (7/36±0.216), *phonetics (6.19 0.095) and* physiologic *rest* position (6.19 0.119).

Mean of voltage of anterior masseter muscles was recorded after *swallowing* (6/45 0.23), phonetics (5.52 0.062) and physiologic rest position (5.50 0.072). Difference in gender of participants (male and female) does not indicated a significant effect on electrical activity of anterior temporal and masseter muscles in physiologic rest position, phonetics and swallowing methods, which these results are consistent with the studies by Rugh & Michelotti. Results of this research indicated that there is a significant difference between mean of electrical activity of anterior temporal and masseter muscles after swallowing and mean of voltage of these muscles after physiologic rest position and phonetics($p>0.05$), but there is no significant difference between mean of voltage of these muscles in physiologic rest position and phonetics. With a study on function of muscles in physiologic rest position, phonetics and swallowing methods, anterior temporal and masseter muscles were specified as the major muscles serving in these motor patterns; more specifically, major part of activity associates to anterior temporal and masseter muscles in *swallowing*[35]. In neuropsychological studies, it has been specified that after activity of a muscle, rest potential of that muscle will be in a threshold that facilitates the next contraction called with post contraction facilitation, that is, muscle facilitation for next contraction after one contraction can be observed after a contractive activity of a muscle [36]. Recording activity potential after muscle contraction confirms this point. With regard to these findings, increasing contraction level of activity will cause preparing that muscle after activity for movement facilitation, indicating preparedness of a muscle with higher level of electrical activity and voltage of that muscle. Results

Table 2: Comparison of voltage of the masseter muscles in physiologic rest position, phonetics and swallowing methods. The letters a, b, and c indicate statistically significant difference ($p<0.05$).

Confidence level		Standard error	Standard deviation	Mean of voltage of the temporal	Methods
Upper bound	Lower bound				
.230	6.53	6.36	.042	6.450[bc]	[a] Swallowing
.062	5.55	5.50	.011	5.528[a]	[b] Phonetics
.072	5.52	5.47	.013	5.501[a]	[c] Physiologic rest position

Analysis of variance with repeated measures displayed that there is a significant difference between phonetics, swallowing and rest methods in mean of VDR ($p <.001$). Further, Tukey's HSD test indicated that there is a significant difference between 'swallowing' and 'phonetics and rest methods' in t mean of VDR ($p <.001$)(Table 3).

Table 3: Comparison of mean of VDR in Physiologic rest position, Phonetics and Swallowing method. The letters a, b, and c indicate statistically significant difference ($p<0.05$)

Confidence level		Standard error	Standard deviation	Mean of voltage of the temporal	Methods
Upper bound	Lower bound				
7.529	7.437	.022	.123	7.483[bc]	[a] Swallowing
8.215	8.071	.035	.192	8.143[ac]	[b] Phonetics
8.291	8.149	.034	.190	8.22[ab]	[c] Physiologic rest position

of this research indicate this point, that is, preparedness of muscle is expected more for movement facilitation *in swallowing* regarding high level of muscle activity. Mean of VDR was recorded after *swallowing* (7/48 0.012), phonetics (8.14 0.19) and physiologic rest position (8.22 0.19). A significant difference on VDR was seen in three methods (p>0.05) that the highest associates to physiologic *rest* position and the least vertical distance in physiologic *rest* position associates to physiologic *rest* position after swallowing. This result is consistent with the results of study by Michelotti & Frenso, indicating that VDR in rest position of muscle is greater than VDR after clinical tests of *swallowing* and phonetics, because after clinical tests, masticatory muscles must be placed in the least contraction for jaw maintenance *status* that the contraction causes reduction of VDR. On the other hand, these results can be justified with neuropsychological theory of post contraction facilitation [36], that is, since level of muscle activity is greater in closing the mouth in swallowing activity, preparedness of muscle will be greater in facilitation of next movement, causing more contraction and electrical activity of involved muscles for movement facilitation. Thus, it is expected that VDR followed by swallowing has the least rate and measured VDR in rest position has the highest rate. Each of three methods under study is used by the dentists to determine VDR, because each of three methods is simple. But results of this research indicate a significant difference in rate of VDR recorded by these three methods. Indeed, three VDR measurement methods can be justified, but none of them is more authentic than others [7]. Therefore, it is suggested that VDR has been measured via three methods and it is recorded as vertical height of face in rest position under any difference of mean. Further, it is suggested to examine effect of the factors including head, neck and body position, sleep, gender, age, excitement, pain, stress on VDR.

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