

Electromyographic characteristic of orbicularis oris in patients with dental crowding in permanent occlusion

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ABSTRACT

Introduction: electromyographic indices were developed for complex analysis of functional condition of orbicularis oris.

Aim: to study electromyographic indices of orbicularis oris in patients with dental crowding in permanent occlusion.

Materials and methods: thirty four patients with malocclusion and a severe degree of severity of dental crowding (15 males, 19 females, aged 16-29 years) who underwent orthodontic examination. The treatment group was divided into three: Group Ia comprised 11 subjects with mandibular crowding (mean age $19,27 \pm 1,08$ years); group Ib, 10 patients with maxillary dental crowding (mean age $20,10 \pm 1,60$ years) and group Ic, 13 subjects with both maxillary and mandibular crowding (mean age $20,15 \pm 1,45$ years). The control group consisted of 10 patients with malocclusions but without dental crowding (mean age $20,70 \pm 1,32$ years). The findings were compared with similar indices in subjects with normal occlusion (mean age $21,3 \pm 1,25$ years). The index of orbicularis oris activity (ACTIV,%) was determined for each patient. A Student's t-test was used to analyze statistical difference between different groups.

Results: patients having crowding of maxillary teeth showed greater activity of muscles of the upper lip during maximum voluntary clenching (ACTIV= $0,99 \pm 7,44\%$). Activity of the muscles of the lower lip in patients with crowding of mandibular teeth (ACTIV= $20,52 \pm 4,22\%$) and crowding of maxillary and mandibular teeth (ACTIV= $17,93 \pm 4,33\%$) is prevailing.

Conclusions: activity of the orbicularis oris in patients with malocclusion, complicated by dental crowding depend on clinical localization of crowding.

Key words: malocclusion, dental crowding, orbicularis oris, electromyographic indices.

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INTRODUKTION

In spite of the development of new technologies the problem of diagnostic procedures optimization and improvement of orthodontic treatment efficiency of patients with malocclusion, complicated by dental crowding in permanent occlusion is a matter of topical interest [1, 2].

Electromyographic study of masticatory and facial muscles [3-6] is of great importance in functional dentistry. A number of studies show a positive correlation between the activity of the masticatory and facial muscles and bite morphology [5-7].

However, there are not enough data in literature about the importance of violations of electromyographic activity of orbicularis oris in diagnostic process and complex treatment of patients with dental crowding in permanent dentition. Orthodontic treatment of this disease need to be improved to suit the individual morphological and functional features of the maxillofacial area.

THE AIM OF THE STUDY

The aim to study electromyographic indices of orbicularis oris in patients with dental crowding in permanent occlusion.

MATERIALS AND METHODS

Fifty four patients (24 male and 30 females) at the age of 16-29 years old (mean age $20,28 \pm 0,59$ years) underwent orthodontic examination. Basic group comprised 34 patients with malocclusion

complicated by severe degree of severity of dental crowding. The control group consisted of 10 patients with malocclusions but without dental crowding (mean age $20,70 \pm 1,32$ years). In order to determine the degree of functional disorders the findings were compared with similar indices in subjects with normal occlusion (mean age $21,3 \pm 1,25$ years).

Dental crowding complicated malocclusion of Class I (accord. to Angle) in 23 (67,65%) patients and malocclusion of Angle Class II in 11 patients (32,32%). Thus from the standpoint of evidence-based medicine comparative analysis between EMG indices with malocclusion of I and II Angel Classes was carried out. According to its results statistically significant difference ($p > 0,05$) wasn't revealed, therefore later on basic group was divided into three subgroups depending on the localization of dental crowding. Group Ia comprised - 11 subjects with mandibular crowding (mean age $19,27 \pm 1,08$ years); group Ib, 10 patients with maxillary dental crowding (mean age $20,10 \pm 1,60$ years) and group Ic - 13 subjects with both maxillary and mandibular crowding (mean age $20,15 \pm 1,45$ years).

The study was conducted according to the method described by V.F.Ferrario [8]. Firstly electromyographic activity was recorded at the state of physiological rest with closed lips, and during performing a functional test - at the maximum voluntary clenching of lips (five seconds). Quantitative analysis of electromyograms provided determining for each patient of several offered by us (copyright

Dimitrenko M.I. №45342 from 27.08.2012.) electromyographic indices (microV / microV × 100%). Asymmetric index (ASIM,%) of orbicularis oris (OM) was measured in each patient, as well as asymmetric index was determined separately for the upper lip muscles (ASIM OM upper lip,%) and the lower lip (ASIM OM lower lip,%) and the index of orbicularis oris activity (ASTIV OM, %) in accordance with designed formulas.

ASIM OM:

$$\frac{(OM \text{ lower right} + OM \text{ upper right} - OM \text{ lower left} + OM \text{ upper left})}{(OM \text{ lower right} + OM \text{ upper right} + OM \text{ lower left} + OM \text{ upper left})} \times 100\%$$

ASIM OM (upper lip):

$$\frac{(OM \text{ upper right} - OM \text{ upper left})}{(OM \text{ upper right} + OM \text{ upper left})} \times 100\%$$

ASIM OM (lower lip):

$$\frac{(OM \text{ lower right} - OM \text{ lower left})}{(OM \text{ lower right} + OM \text{ lower left})} \times 100\%$$

ACTIV OM:

$$\frac{(OM \text{ lower right} + OM \text{ lower left} - OM \text{ upper right} - OM \text{ upper left})}{(OM \text{ lower right} + OM \text{ lower left} + OM \text{ upper right} + OM \text{ upper left})} \times 100\%$$

Absolute value of indicators asymmetry – modules of indicators (MASIM, %) – was determined for each index. Indicators of symmetry of orbicularis oris were calculated by the following formula: symmetry index (SIM, %) = 100 – absolute value of asymmetry index (MASIM, %). Significant differences of the results for different groups was detected by Student's t-test. Nonparametric U-Mann-Whitney test was calculated for semi-quantative and quantative indicators.

RESULTS

Before orthodontic treatment comparative analysis hasn't found significant difference between the groups according to age, gender, type of malocclusion in the vertical, sagittal and transversal planes, as well as the severity of dental crowding ($p > 0,05$).

When comparing the asymmetry index (ASIM) in a state of physiological rest in patients with dental crowding there was great activity of muscles of lower lip on the right (as it was indicated by positive values of lower lip orbicularis oris ASIM index), on the left there was great activity of the muscles of upper lip (negative values of ASIM index of orbicularis oris of upper lip) (Table 1). It may be a compensatory mechanism to balance orbicularis oris of the mouth. There was statistically significant difference of indices (ASIM%) of upper lip in the group of patients with dental crowding in mandibula compared to the group of individuals with normal occlusion ($p < 0,05$).

Patients with dental crowding on maxilla and mandibula have the lowest overall index of symmetry (SIM OM = $81,94 \pm 9,61\%$). Therefore, imbalance of orbicularis oris muscle was observed in this group during rest position, which probably is one of the pathogenetic mechanisms that determines and maintains dental crowding. Great activity of upper lip muscles (negative ACTIV index,%) was measured while comparing the index of orbicularis oris muscle activity (ACTIV CM, %) at rest in patients with dental crowding on upper jaw. Activity of the lower lip muscles predominated in patients with dental crowding of mandibular teeth (positive ACTIV OM = $12,99 \pm 36,55\%$). In majority of

experimental groups prevalence of lower lip muscles activity (positive ACTIV%), was revealed in clench while comparing indices ACTIV. The largest muscle activity of lower lip was observed in patients with mandibular dental crowding (ACTIV index = $20,52 \pm 4,22\%$). In clench upper lip muscles activity prevailed only in patients with maxillar dental crowding (negative ACTIV index = $-0,99 \pm 7,44\%$), which is significantly higher in comparison with those of groups Ib and Ic ($p < 0,05$) (Table I).

DISCUSSION

Thus, this study confirmed the relationship between the myofunctional disorders and orthodontic pathology [6-8, 9]. Previously, it was found [6] that in adult patients with dental crowding there is imbalance in proper masseter and temporal muscles. We identified imbalance in orbicularis oris muscle, what indicates the functional instability of occlusion.

Studies of Drogomiretska M.S., Sukhomlinova T.Ya, Yakimets A.V. et al (2011) [10] revealed abnormalities in the functional state of orbicularis oris muscle at distal occlusion. Electrical activity significantly increased during rest position, but in clench amplitude of orbicularis oris muscle was decreased in comparison with norma.

During treatment of patients with dental crowding in permanent dentition it is necessary to use complex methods. Functional elements should be used along with mechanical instrumental treatment. Combination of massage with miogymnastics is aimed at the balancing of maxillofacial area muscules state. Data of orbicularis oris electromyographic analysis indicate that relaxing massage of the upper lip muscles and activating massage of the lower lip muscles should be administered at presence of malocclusion complicated by maxillary dental crowding. Patients with mandibular dental crowding and those who are diagnosed both dental crowding of maxillar and mandibular teeth should use a relaxing massage of the lower lip and activating massage of the upper lip.

CONCLUSIONS

Electromyographic activity of the muscles of the upper lip (ACTIV = $-0,99 \pm 7,44\%$) is great in dental crowding of maxillary teeth. Activity of the lower lip muscles (ACTIV = $20,52 \pm 4,22\%$) predominates in dental crowding of mandibular teeth. In patients with dental crowding of maxillary and mandibular teeth the lowest overall index of muscle symmetry of orbicularis oris (SIM = $81,94 \pm 9,61\%$) and great electrical activity of muscles of the lower lip (ACTIV = $17,93 \pm 4,33\%$) have been determined. It is recommended to take into account the peculiarities of electromyographic activity of orbicularis oris muscle while planning orthodontic treatment of patients with dental crowding in permanent dentition.

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Table I. EMG indices of orbicularis oris muscle (OM) in groups (M ± m)

Index, %	Group				
	basic			control	healthy
	I			II	III
	Ia	Ib	Ic	II	III
maxillary dental crowding	mandibular dental crowding	maxillary and mandibular dental crowding	without dental crowding	normal occlusion	
During rest position					
ASIM OM	1,30±3,94	-0,86±5,93	5,32±5,65	0,71±5,26	6,69±6,22
MASIM OM	10,63±2,10§	14,66±3,38	18,06±2,67	13,58±2,70	14,36±4,55
SIM OM	89,37±2,10§	85,34±3,38	81,94±2,67	86,42±2,70	85,64±4,55
ASIM OM upper lip	-1,63±15,30	-9,00±22,99*	2,31±23,67	3,33±16,37	11,29±19,12
MASIM OM upper lip	11,79±2,77	20,97±3,60	18,72±3,79	10,34±4,02	17,01±4,31
SIM OM upper lip	88,21±2,77	79,03±3,60	81,28±3,79	89,66±4,02	82,99±4,31
ASIM OM lower lip	3,98±16,30	4,58±24,05	6,49±22,20	-1,12±21,76	4,97±21,90
MASIM OM lower lip	14,05±2,45	13,94±6,21	17,36±4,04	18,26±3,23	15,01±5,07
SIM OM lower lip	85,95±2,45	86,06±6,21	82,64±4,04	81,74±3,23	84,99±5,07
ACTIV OM	-19,61±13,03	12,99±11,56	-0,08±9,62	10,06±10,19	-6,35±8,50
During clenching					
ASIM OM	0,38±2,67	-1,28±5,16	-3,69±2,09	4,17±3,61	-2,93±2,54
MASIM OM	7,29±1,35	3,31±1,28#	5,79±1,64	9,50±2,23	7,13±1,32
SIM OM	92,71±1,35	96,69±1,28#	94,21±1,64	90,50±2,23	92,87±1,32
ASIM OM upper lip	1,70±4,33	-2,70±2,58	0,80±3,64	8,18±5,91	1,08±3,67
MASIM OM upper lip	10,91±2,66	6,54±5,23#	11,17±1,71	17,46±2,93α	8,69±2,28
SIM OM upper lip	89,09±2,66	93,46±1,65#	88,83±1,71	82,54±2,93α	91,31±2,28
ASIM OM lower lip	-1,19±2,70	-0,31±3,15	-6,34±2,80	-1,22±3,93	-5,39±3,67
MASIM OM lower lip	6,95±1,61	7,93±1,72	10,01±1,68	9,76±2,24	9,58±2,50
SIM OM lower lip	93,05±1,61	92,07±1,72	89,99±1,68	90,24±2,24	90,32±2,50
ACTIV OM	-0,99±7,44§	20,52±4,22□	17,93±4,33	3,21±9,48	7,85±7,17

* – Significant difference between the indices of the I and III groups at P<0,05.

α – Significant difference between the indices of the II and III groups at P<0,05.

– Significant difference between the indices of the I and II groups at P < 0,05.

§ – Significant difference between the indices of the Ia and Ic groups at P<0,05.

□ – Significant difference between the indices of the Ia and Ib groups at P < 0,05.

~ – Significant difference between the indices of the Ib and Ic groups at P < 0,05.

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