

## Lower Lip Activity during Clenching in incompetent lips subjects.

Kazunori Yamaguchi, DDS , PhD\*/ Yuko Morimoto, DDS, PhD\*\*/ Ram S. Nanda DDS, MS, PhD\*\*\*/ Kazuo Tanne, DDS , PhD\*\*\*\*

\* Associate Professor of Orthodontics, School of Dentistry, University of Hiroshima.

\*\* Assistant Professor of Orthodontics, School of Dentistry, University of Hiroshima.

\*\*\* Professor of Orthodontics, School of Dentistry, University of Oklahoma,USA.

\*\*\*\* Professor of Orthodontics, School of Dentistry, University of Hiroshima.

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### Introduction:

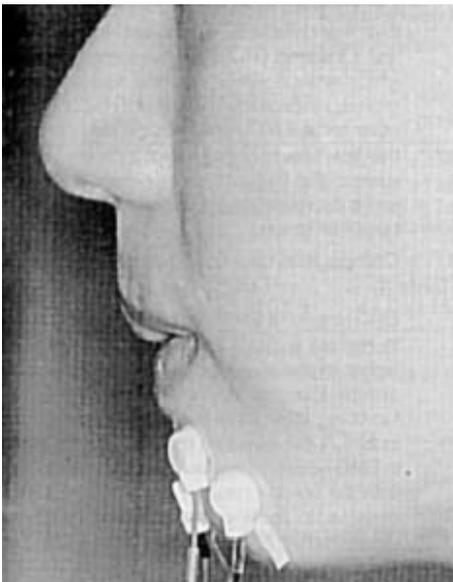
There seems to be a general consensus that both static and functional lip pressures are important factors affecting the stability of occlusion. Patients with incompetent lips hold the lips apart at rest and show an excessive activity of the lower lip when holding the lips in contact. Therefore, the lip incompetence should be treated to retain the corrected dentition after orthodontic or orthognathic treatment. However, there are two questions; whether lip competence can be identified at an initial examination and whether it can be improved by treatment. We have to get an answer to the first question before getting down to the second one.

In previous EMG studies on lip competence, it was visually determined based on whether the lips were in contact or apart at rest, although visual observation is less reliable and more variable. In our previous study, we selected the subjects who had positive incisal overjet and overbite without any visual consideration on lip competence. The difference in EMG activity of the lower lip at rest positions was evaluated to differentiate lip competence. The subjects that had positive value of difference were classified as the incompetent lips group. It was found that axial inclination of the maxillary and mandibular incisors and the mandibular plane angle were greater in the incompetent lips group. The proclined maxillary and mandibular incisors make lip closure difficult and higher EMG activity of the lower lip

is needed to close them. However, it is not clear why the incompetent lips group had a greater anterior facial height than the competent lips group.

It is known that higher masticatory muscle activity is correlated with less anterior facial height or vertical position of the mandible. Bakke and Michler reported on the temporalis and masseter muscle activities in patients with anterior open bite. They concluded that long-face morphology was associated with weak elevator muscle activity. Throckmorton et al. explained biomechanics of differences in facial height using a two-dimensional model. The model suggested that surgical correction of the facial disharmonies may have a significant effect on the mechanical advantage of the jaw muscles. Other studies also showed a negative correlation between two variables. On the other hand, Lowe et al. stated that low orbicularis oris muscle amplitude during clenching was correlated with high lower face height in the subject with Class II Division I malocclusion. Pancherz and Anehus-Pancherz reported on the muscle activity in the patients with Class II, Div. I malocclusion. They found that lower facial height, mandibular molar height and anterior dental height were significantly correlated with orbicularis oris muscle activity during clenching. Accordingly, the muscular activity of the lower lip possibly has some effect on the masticatory muscle activity in the incompetent lips subjects. In this study, EMG activities of the lower lip during clenching with the lips in contact or apart were measured to define lip incompetence.

### **Material and methods**



The positive overbite group consisted of 49 subjects with positive overjet and overbite, including Class I and Class II malocclusions (mean age: 24y and 2m), and the open bite group consisted of 17 skeletal open bite subjects (mean age: 26y and 2m) (Table I). Subjects were selected without any visual consideration of lip incompetence. The EMG recording was taken with the subject sitting in an upright position, with Frankfort-Horizontal plane parallel to the floor, in the dental chair, placed in an electrically sealed room.

Lips and mandibular positions.

At first, subjects were asked to swallow saliva to hold a clinical rest position. Then they were asked to hold the following positions:

Position1. Holding the lips in light contact at clinical rest

position for 15 seconds (Fig.1).

Position2. Holding the lips apart at clinical rest position for 15 seconds (Fig.1).

Position 3. Clenching with the lips in contact for 5 seconds.

Position 4. Clenching with the lips apart for 5 seconds.

EMG recording proceeded 3 times in the following sequence: positions 1,3,1 and the positions 1,2,4,2,1.

Placement of bipolar electrodes.

Two bipolar surface electrodes (8.0mm in diameter, Nihon Kohden, Tokyo) were attached to the skin overlying the left mentalis, masseter and anterior frontalis muscles according to the anatomical orientation. The distance between the two electrodes was approximately 10mm. EMG activity was recorded at 0.03 time second into a microcomputer via an A/D convertor with 40-Hzs sampling frequency. With the biological data analysing system (MacLab, ADInstrument, Australia), EMG amplitude of lower lip activities at 4 positions were integrated for 5 seconds and mean values were obtained for 3 trials. The integrated EMG activities at the position 1,2,3,4 were named as EMLC, EMLA, clenchLC, and clenchLA. The differences (EMLC - EMLA, clenchLC - EMLC, clenchLA - EMLA) in EMG activities were also calculated by simple subtraction. When the EMG activity increased when taking 4 lip positions,



EMG record on a display monitor was shown to subjects to get feedback to relax, so that they could make less of excessive action and be familiar with the positions.

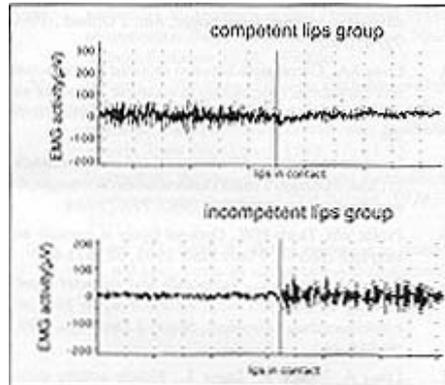
As previously reported, the subjects were divided into 2 groups based on positive or negative values of difference (EMLC - EMLA) in the lower lip activity at rest between two lip positions. The subjects that had positive values of EMG difference were classified as the incompetent lip group and those whose values were negative were considered as the competent lips group.

Electrodes were symmetrically attached to the skin about 20mm apart above the vermilion border of the upper lip. For the lower lip, they were placed about 15mm apart over the mentalis and depressor of lower lip.

Roentgen Cephalometric measurements.

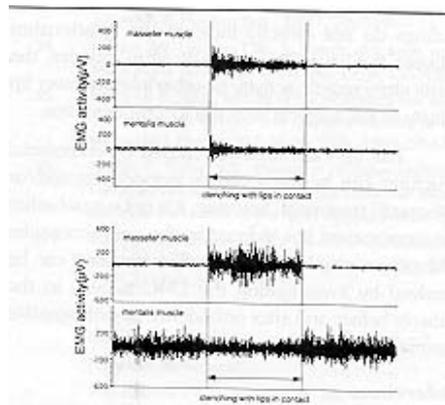
Six skeletal and 13 dental measurements were done for the lateral roentgen cephalometric analysis (Fig.2) Ar: Articulare, Ui: the edge of the upper central incisor, Ui': the foot of the perpendicular line from Ui to Ar-A plane, Ui to AB: distance from Li to AB plane, U1

axis to AB: axial inclination of the upper central incisor to AB plane, L1 axis to AB: axial inclination of the lower central incisor to AB plane. EMG activities of the lower lip and cephalometric measurements were statistically compared between the competent and incompetent lips groups using analysis of variance (ANOVA). The coefficient correlations among the electromyographic activities were also studied.



**Fig.3:** Electromyographic record of the mentalis muscle at rest. Upper: competent lips subject, Lower: incompetent lips subject. EMG activity of lower lip decreased in the competent lips subject when closing

lips, while it increased in the incompetent lips subject.



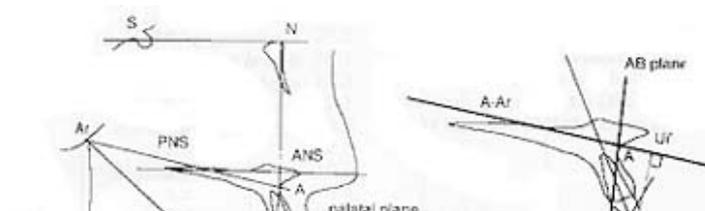
**Fig.4:** Electromyographic record of the mentalis during clenching with the lips in contact (clenchLC). Upper: competent lips subject, Lower: incompetent lips subject. In competent lips subject, EMG

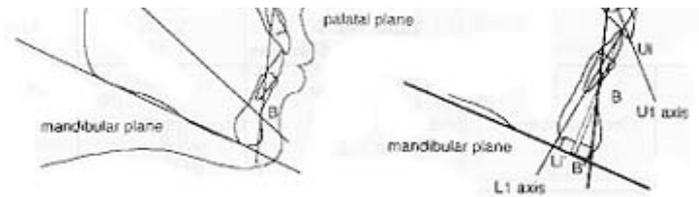
activity of mentalis muscle increased during clenching with the lips in contact. It decreased in an incompetent lips subject during clenching.

## Results

1. Distribution of the sample (Table 1).

In 34 (69.3%) of the positive overbite group and all subjects of the open bite group, EMG activity of the lower lip increased when holding the lips in contact (fig.3). Consequently, they were classified into the





incompetent lips group (Table 1). EMG activity during clenching with the lips in contact (EMLC) increased in 13 subjects (86.7%) of the competent lips group (Fig. 4 and Table 1). It decreased in 18 (52.9%) and 13 subject (76.5%) of the incompetent lips group with positive overbite and open bite groups, respectively (Fig. 3 and table 1). On the other hand, EMG activity during clenching with the lips apart (EMLA) also increased in 12 subjects (80.0%) in the competent lips groups, and it decreased in 13 subjects (76.5%) of the open bite group.

**Table No. 1**  
Classification of Samples

	Positive overbite group (N: 49)		open bite group (N: 17)	
	Competent lips group (N:15)	Incompetent lips group (N:34)	Competent lips group (N:0)	Incompetent lips group (N:17)
clenchLC				
-EMLC	+ 13 (86.7%)	16 (47.1%)	0	4 (23.5%)
	- 2 (13.3%)	18 (52.9%)	0	13 (76.5%)
clenchLA				
-EMLA	+ 12 (80.0%)	19 (55.8%)	0	4 (23.5%)
	- 3 (20.0%)	15 (44.2%)	0	13 (76.5%)

2. Comparison of Electromyographic activity (Table II). EMG activity of the lower lip at rest with the lips in contact (EMLC) was significantly ( $p < .05$ ) higher in the incompetent lips and open bite groups than in the competent lips group. However, there were no significant differences in EMLA between 2 groups. The difference in EMG activity of the lower lip during clenching with the lips in contact (clenchLC - EMLC) was negative in the incompetent and open bite groups, while it was positive in the competent lips group.

**Table No. II**  
Comparison of EMG activities

	Positive overbite group		p	Openbite group	p1	p2
	Competent lips group	Incompetent lips group				
EMLC	78.2±32.0	254.1±238.0	*	582.2±526.5	*	*
EMLA	143.5±81.6	134.6±111.0	-	306.3±211.5	-	*
EMLC-EMLA	-65.3±71.7	119.5±174.1	*	275.9±490.9	*	*
clenchLC	94.8±50.3	236.1±236.0	*	471.9±360.9	*	*
clenchLC-EMLC	16.6±30.6	18.0±91.4	*	-110.3±225.4	*	*
ClenchLA	188.8±146.2	178.6±130.2	-	235.8±170.7	-	*
clenchLA-EMLA	45.3±103.9	44.0±115.2	-	-70.5±118.2	*	*

p1 : open bite group vs competent lips group

p2 : open bite group vs incompetent lips group in positive overbite group

\* :  $p < 0.05$

3. Comparison of Cephalometric measurements (Table

III).

U1 axis to AB, L1 axis to AB and mandibular plane angle to palatal plane (Mp to PP) were significantly ( $p < 0.05$ ) greater in the incompetent lips and open bite groups than in the competent lips group. L1 axis to MP and overbite were significantly ( $p < 0.05$ ) less in the open bite group than in the incompetent subjects of the positive overbite group, whereas mandibular plane angle to palatal plane was significantly greater ( $p < 0.05$ ) in the open bite group.

**Table No. III**  
Comparison of cephalometric measurements

	Positive overbite group		Openbite group	p1	p2	p3
	Competent lips group	Incompetent lips group				
SNA	82.4	81.5	82.5	-	-	-
SMB	79.0	77.8	79.3	-	-	-
ANB	3.4	3.7	3.3	-	-	-
AnsAB	95.4	94.3	96.3	-	-	-
Mp to PP	24.5	29.2	36.3	*	*	*
AA-B	25.3	26.1	28.2	-	-	-
A-U1'	12.1	12.3	12.4	-	-	-
B-Li	1.2	2.1	1.3	-	-	-
Li-U1'	23.9	23.3	22.8	-	-	-
Li-Li'	22.3	22.5	22.7	-	-	-
Li to AB	9.1	10.6	9.8	-	-	-
L to AB	5.2	6.4	7.6	-	-	-
U1 axis to AnsA	125.2	128.0	131.2	-	*	-
U1 axis to PP	115.7	115.9	117.3	-	-	-
U1 axis to AB	30.1	33.2	34.6	*	*	-
L1 axis to MP	54.5	54.6	59.4	-	-	*
L1 axis to AB	23.7	26.1	28.1	*	*	-
overjet	4.0	3.7	2.3	-	-	-
overbite	3.5	2.8	2.6	-	*	*

p1 - competent lips group vs incompetent lips group

p2 - competent lips group vs open bite group

p3 - incompetent lips group vs open bite group

\* :  $p < 0.05$

Correlation of the lower lip activity between at rest and during clenching (Table IV).

EMG activity of the lower lip during clenching with the lips in contact (ClenchLC) was positively correlated ( $r = 0.813, 0.890, 0.928$ ) with that at the rest position with the lips in contact (EMLC) in three groups. The difference between EMLC and EMLA (EMLC-EMLA) was negatively ( $r = -0.910, -0.980$ ) correlated with clenclC - EMLC in the incompetent lips and open bite groups, but not in the competent lips group. There were no significant differences in the EMG activity during clenching with the lips apart in three groups.

Table No. IV  
Correlation of EMG activity

		EMLC	EMLA	clenchLC	clenchLA	EMLC-ENLA	clenchLC-EMLC
clenchLC	positive overbite group	0.813*	0.43*	-			
	closed group	0.890*	0.662*	-			
	open group	0.928*	0.467*	-			
clenchLA	positive overbite group	0.203	0.748*	0.358	-		
	closed group	0.440*	0.557*	0.497*	-		
	open group	0.191	0.830*	0.358	-		
EMLC-EMLA	positive overbite group	-0.108	-0.922*	-0.125	-0.760*	-	
	closed group	0.898*	0.350	0.785*	0.256	-	
	open group	0.916*	-0.043	0.793*	-0.154	-	
clenchLC -EMLC	positive overbite group	0.275	0.131	0.795	0.381	-0.091	-
	closed group	-0.293	-0.198	0.084	-0.381	-0.910*	-
	open group	-0.886*	-0.899*	-0.841*	0.055	0.980*	-
clenchLA -EMLA	positive overbite group	-0.119	0.230	0.153	0.821*	0.323	0.384
	closed group	-0.218	-0.320	-0.210	0.550*	-0.075	-0.014
	open group	-0.374	-0.601*	-0.324	-0.055	-0.142	0.365

EMLC : EMG activity at rest with lips in contact  
 EMLA : EMG activity at rest with lips apart  
 clenchLC : EMG activity during clenching with lips in contact  
 clenchLA : EMG activity during clenching with lips apart  
 \* : p<0.05

## Discussion

Muscular activity of the lower lip at the rest position. As previously reported it was found that vertical position of the mandible was greater in the incompetent lips subjects of the positive overbite group. This study also showed that the skeletal open bite group had greater anterior facial height and were classified as the incompetent lips group. Thus, it is verified that the vertical position of the mandible or anterior facial height affect the muscular activity of the lower lip at rest position.

EM activity of the lips during clenching. It was well known that EMG activity of the elevating muscles of the mandible is related with the mandibular vertical position or lower facial height. The masseter muscle activity during masticatory function is less in the subjects with higher lower anterior facial height than in the subjects with lower one.

Therefore, we measured EMG activity of the lower lip during clenching with the lips in contact and apart, so that we can figure out the relationship between muscular activity of the lips and masticatory muscles in the competent and incompetent lips groups.

### 1. Competent lips group

Kawamura stated that main contraction of the lips occurred while the temporal muscles were passive during chewing cycle. Accordingly, the anterior oral sealing with the lips is maintained during normal mastication in the subjects with the competent lips, and lip function may cooperate with the masticatory musculature during mastication and swallowing. Weber

and Smith reported on the reflex responses in human jaw, lip and tongue muscles elicited by mechanical stimulation. They found that the stimulation of the lip and the tongue produced responses in masseter, but stimulation of jaw muscle spindle afferents and overlying cutaneous receptors had no observable effect on activity in the orbicularis oris inferior muscles. Other studies also showed stimulation to the lower lip produced reflex response in the masseter muscle. These findings indicated that masticatory muscle activity was dependent on lower lip activity and that muscular activity on the lower lip is independent to that of masticator muscle activity. In the competent lips group of our study, there was little or no increase in the EMG activity of the mentalis muscle during clenching with the lips in contact, and there was no significant correlation between EMG activity of the lower lip at rest with the lips in contact and that during clenching with the lips in contact. These findings show that masticatory function may be cooperated with anterior oral sealing in the competent lips subjects.

## **2. Incompetent lips group.**

Some parents complain that their children make noise during chewing food because they are chewing the food with their lips open. This is an example of distinct cooperation between lip and masticatory muscle function in an incompetent lips subject. Many studies have shown negative correlation between masticatory muscle activity and anterior facial height of vertical position of the mandible. Our previous study showed that EMG activity of the lower lip at rest with the lips in contact (EMLC) in the incompetent lips group was positively correlated with vertical position of the mandible or anterior facial height.

Therefore, negative correlation is expected between EMG activity of the lips and masticatory muscle. In this study, we observed the decrease in EMG activity of the lower lip at rest with the lips in contact and that during clenching with the lip in contact. Although these findings do not directly indicate the relationship between the lower lip and masticatory muscles, the masticatory muscle activity possibly inhibits lower lip activity in the subject with the incompetent lips.

The lip incompetence caused by dentofacial structures can be improved by orthodontic and/or orthopaedic treatment; however, it is not sure whether the incompetent lips induced by the neuro-muscular dysfunction may be improved. This question can be resolved by investigating the EMG activity in the patients

before and after orthodontic or orthognathic treatment.

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