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Research Article

TO INVESTIGATE GENDER DIFFERENCES IN EMG ACTIVITY OF SKELETAL CLASS I NORMAL OCCLUSION

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ABSTRACT

Effects of activity of facial and masticatory muscles on facial morphology is important to understand the normal growth and morphological abnormalities If muscle function plays a role in the development, abnormal muscle function explain certain abnormalities of facial morphology. The present study is designed to know sEMG activity of various muscles in normal skeletal Class I subjects with average growth pattern. The purpose of the study was to make an electromypgraphic comprasion of the action potentials of the Mentalis, Masseter, Upper and Lower orbicularis oris muscles between male and female as well as right and left sided activity.60 subjects were selected based on Angle's classification who have Class I normal occlusion with average growth pattern. Action potential of Mentalis, Masseter and Upper and Lower fibers of orbicularis muscles were carried out during rest position and isotonic contraction (Non habitual masticatory activity) by RMS EMG.EP MARK II [AN ISO 9001 COMPANY), VERSION – (i)] with 4 channels surface electrode There was no significant difference of EMG activity between male and female during rest position and isotonic contraction. Activity of right and left side have not differed much during rest position and also during isotonic contraction.

INTRODUCTION

Muscles of head are distinguished by their great variability. Muscles are variable not only to their strength but to their shape as well. It is important to know whether the activity of the facial and masticatory muscles has any effect on facial morphology in understanding the normal growth and possibly of morphological abnormalities. If muscle function plays a role in the development, abnormal muscle function explains certain abnormalities of facial morphology and certain forms of malocclusion.[1]

The influence of perioral musculature on the position of the teeth has been widely discussed in the orthodontic literature.[2]Perioral musculature and lip position are determinant factors in the position of the teeth and shape of the dental arch because of their moderate yet continuous activities. The forces resulting from the resting position of the lips help to define and maintain the occlusion. Patients with lip incompetence are unable to achieve habitual lip sealing without effort, a condition that favors dental protrusion by the reduction of lip pressure that acts on them, generating facial imbalance. The synergic patterns of muscle behavior differ with regard to the anomalies of occlusion and are correlated to the existence or lack of efficiency of the masticatory mechanism.

Electromyographic analysis of the muscles constitutes an important complementary instrument in orthodontic diagnosis. The present study made an electromyographic evaluation of the action potentials of the mentalis, masseter, upper and lower orbicularis oris muscles in Class I normal occlusion subjects during rest position and isotonic contraction by surface electrode to verify whether or not there were differences in electrical activity of this muscles between male and female and with right and left sided activity.

To determine the influence of this craniofacial muscles, we utilized surface electromyography (sEMG) to characterise role of jaw muscles. Surface electrode was utilized for EMG, though being less accurate than needle counterpart, - owing to its simplicity, non – invasiveness, it is painless and patient shows good cooperation due to absence of needle prick on facial muscles.

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Aim and Objectives

- To investigate gender differences in EMG activity of Mentalis, Masseter (superficial fibers), Upper and Lower fibers of orbicularis oris muscles in normal Class I occlusion group during rest position and isotonic contraction (Non habitual masticatory activity).
- To determine differences in right and left side muscle activity during rest position and isotonic contraction (Non habitual masticatory activity).

MATERIALS AND METHOD

The present study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Govt. Dental College & Hospital, Ahmedabad. An ethical approval was taken from Institutional Ethical committee. Total 60 subjects underwent clinical examination after their informed consent.

Selection criteria

Inclusion criteria

- Age group of the selected subjects were in the range of 17 to 30 years. (Mean age – 23.5 years).
- Subjects with CVMI stage 6 (Hassel and Farman method, completion of growth).
- All permanent teeth should be present except third molars.
- No previous history of orthodontic treatment, surgery and trauma.
- Angle's classification was followed to define Class I normal occlusion.

Exclusion criteria

- Clinically significant facial asymmetry.
- Signs or symptoms of temporomandibular joint disorder.
- Myopathy or any congenital deformities, syndromes.
- Habit of unilateral chewing.

For all the subjects, standardized lateral cephalometric radiographs were taken to classify samples. 120 subjects were found to meet the criteria for sampling from the cephalometric tracing.

Variables were measured viz. ANB, Beta angle and wits appraisal after following Angle's classification for saggital Class I normal occlusion and Jaraback's ratio for average growth pattern.Equal numbers of male (n=30) and female (n=30) subjects were selected to make a total sample size.

EMG Examination Method

Equipment

For electromyographic recording RMS EMG.EP MARK II (Recorders and Medicare System, AN ISO 9001 COMPANY), VERSION – (i) was used, consisting of 4 channel with power requirement 220 $\pm$ 10 V A.C, Minimum Watts 650 W.

Figure 1 RMS EMG.EP MARK II [AN ISO 9001 COMPANY), VERSION – (i)] with 4 channels

The EMG examination was performed by a single experienced and well trained clinician and orthodontist. This has been done to eliminate any investigator bias.

The participants were asked to sit on a chair with back supported and head unsupported in natural head position.

EMG Recording

The disc type silver chloride surface electrodes were attached to the skin as follows. The skin was shaved in the corresponding area (if necessary) and cleaned with alcohol wetted swab to reduce skin-electrode impedance.

Ground electrode was attached to the wrist for the recording of all the muscles. Out of the 4 channels present on the device, channel 1 and channel 2 were utilized for performing study.

EMG recording was performed for Mentalis, Masseter (superficial fibers), Upper and Lower fibers of orbicularis oris muscles individually but simultaneously for right and left side during rest position, after that all muscles were again recorded in isotonic contraction (Non habitual masticatory activity).

Electrode fixation

Mentalis: Electrodes were placed over the most prominent part of thechin and 1 cm away from midline of the face.

Masseter muscle (superficial fibers): Electrode was attached on the superficial part of masseter muscle (at muscular belly 2 cm above and in front of gonial angle)

Upper fibers of Orbicularis oris: Electrode was attached 2 mm above the vermillion border of upper lip and 1 cm away from midline of the face.

Lower fibers of Orbicularis oris: Electrode was attached 2 mm below the vermillion border of lower lip and 1 cm away from midline of the face.

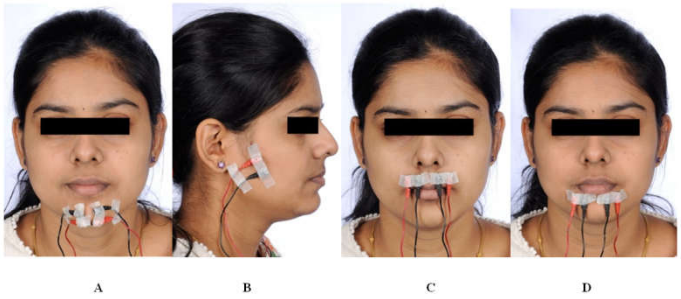
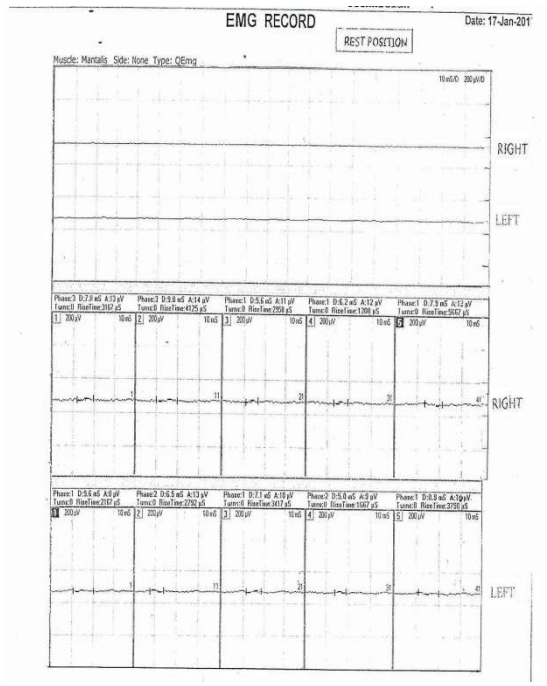


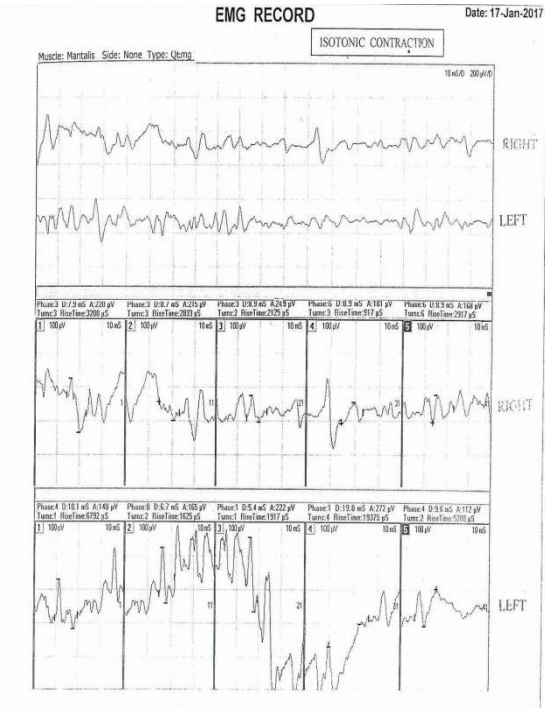
Figure 2 Placement of electrode for mentalis(A), maseter(B), upper(C) and lower(D) orbicularis oris muscles respectively.

The EMG recordings began with resting position after this during isotonic contraction (Non habitual masticatory activity). After fixing the electrodes on right and left side, while recording the resting position each subject kept the facial and masticatory musculature relaxed and lips in their habitual posture, with examiner using the following command: Relax, Relax, Relax….. The resting EMG potential was observed and recorded.

After this to record isotonic contraction activity the subject was asked to make continuous chewing movements by giving MENTOS chewing gum on both sides. Peak EMG potentials were recorded in the resting position and during isotonic contraction activity, 5 central intervals from the electromyographic tracing were selected, avoiding the initial and final intervals, as these may be affected by the subject's hesitation, or diminished muscle activity at the end of the movement. The mean values of the peak amplitude of the right and left muscles taken for the statistical analysis.

EMG of Mentalis Muscle of Right and Left Side during Rest Position and Isotonic Contraction





RESULTS: DATA TABLES AND GRAPHS

Collected data was analysed using SPSS version 22. Tests performed were Paired "t" test and independent "t" test.

Table 1 Group statistics for male and female during rest position for Class I normal occlusion

MUSCLE	SIDE	GENDER	N	Mean (μV)	Std. Deviation	Std. Error Mean
Mentalis	Right	Male	30	9.41	1.102	.201
		Female	30	9.60	1.221	.223
	Left	Male	30	9.15	1.042	.190
		Female	30	9.42	1.102	.201
Masseter	Right	Male	30	10.85	2.315	.423
		Female	30	10.67	2.123	.388
	Left	Male	30	10.88	1.584	.289
		Female	30	10.8	1.479	.270
Upper orbicularis oris	Right	Male	30	3.00	1.174	.214
		Female	30	3.15	1.042	.190
	Left	Male	30	3.27	1.015	.185
		Female	30	3.02	1.174	.214
Lower orbicularis oris	Right	Male	30	5.20	1.064	.194
		Female	30	5.34	1.093	.200
	Left	Male	30	4.87	1.167	.213
		Female	30	5.08	1.015	.185

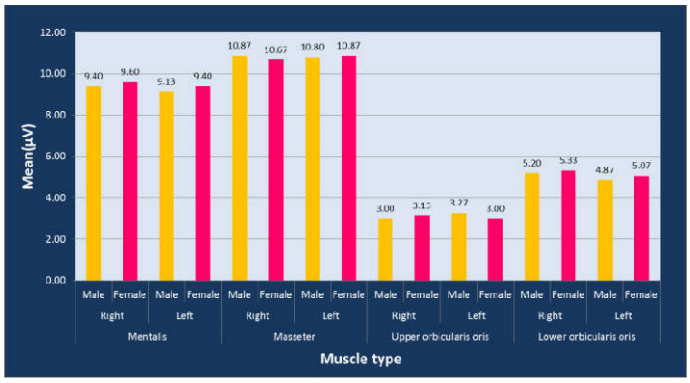


Table 2 Group statistics for male and female during isotonic contraction for Class I normal occlusion

MUSCLE	SIDE	GENDER	N	Mean (μV)	Std. Deviation	Std. Error Mean
Mentalis	Right	Male	30	230.49	15.030	2.744
		Female	30	230.07	15.414	2.814
	Left	Male	30	230.72	10.494	1.916
		Female	30	229.02	12.828	2.342
Masseter	Right	Male	30	1295.87	17.624	3.218
		Female	30	1294.14	18.322	3.345
	Left	Male	30	1294.53	17.244	3.148
		Female	30	1294.54	17.244	3.148
Upper orbicularis oris	Right	Male	30	165.40	11.708	2.138
		Female	30	166.03	9.720	1.775
	Left	Male	30	165.01	11.715	2.139
		Female	30	165.45	9.081	1.658
Lower orbicularis oris	Right	Male	30	208.62	17.745	3.240
		Female	30	207.95	21.330	3.894
	Left	Male	30	207.07	20.337	3.713
		Female	30	207.35	21.162	3.864

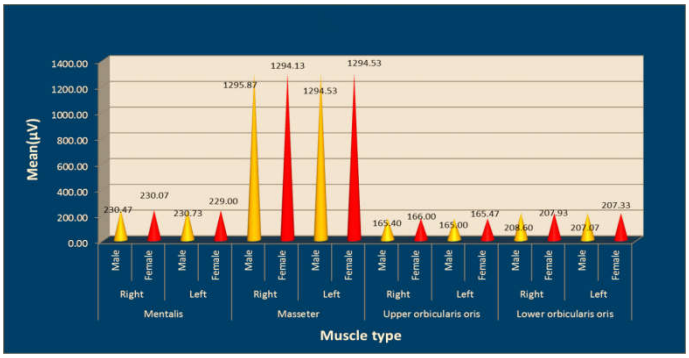


Table 3 Paired Sample Statistics – Paired "t" test**.**

Comparison of EMG activity of muscles between Left and Right side during rest position for Class I Normal Occlusion.

MUSCLE	SIDE	Mean (μV)	N	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Mentalis	Left	9.27	30	1.081	.197	.305
	Right	9.50	30	1.167	.213	
Masseter	Left	10.83	30	1.533	.280	.879
	Right	10.77	30	2.223	.406	
Upper orbicularis oris	Left	3.13	30	1.106	.202	.745
	Right	3.07	30	1.112	.203	
Lower orbicularis oris	Left	4.97	30	1.098	.200	.313
	Right	5.27	30	1.081	.197	

Table 4 Paired Sample Statistics – Paired "t" test

Comparison of EMG activity of muscles between Left and Right side during isotonic contraction for Class I normal occlusion

MUSCLE	SIDE	Mean (μV)	N	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Mentalis	Left	230.27	30	15.225	2.780	.794
	Right	229.87	30	11.752	2.146	
Masseter	Left	1295.00	30	17.998	3.286	.931
	Right	1294.53	30	17.244	3.148	
Upper orbicularis oris	Left	165.70	30	10.764	1.965	.199
	Right	165.23	30	10.484	1.914	
Lower orbicularis oris	Left	208.27	30	19.622	3.583	.834
	Right	207.20	30	20.754	3.789	

DISCUSSION

It has been widely accepted that function of the masticatory muscle has a considerable influence on craniofacial morphology. Also, craniofacial morphology is known to be related with biting force or with resting activity of the masticatory muscle From a functional point of view, the EMG activity of masticatory, neck and trunk muscles are strongly linked, due to a reciprocal innervation between the trigeminal and the cervical systems that produces mutual inhibition and activation; it seems to be present a dynamic relationship among dental occlusion, 'space condition' and head posture.[34]

Electromyography is an extremely useful tool in the study of neuromuscular aspect of the masticatory system. There are many reports in the literature about the importance of the perioral musculature as an etiologic factor of malocclusions. However, it was observed that there is great difficulty in evaluating the real participation of this in determining the positions of teeth.

Knowing the nature of muscles is important for orthodontic field because diagnosis and treatment planning of most of the malocclusion and aberrant muscle activity is influenced by it. If role of muscles can be elucidated, interceptive measures can be instituted at an early age to direct facial morphology towards esthetic harmony. Apart from this, muscle behavior plays crucial role in treatment planning as strength of muscles and bite forces greatly influence anchorage planning.

The present study is carried out to investigate muscle activity of Mentalis, Masseter (superficial fibers), Upper orbicularis oris, Lower orbicularis oris in Class I normal occlusion with average growth pattern during rest position and isotonic contraction.

Table 1 shows on comparing right and left sided muscle activity between male and female, non-significant difference was found for Class I normal occlusion which was in accordance with the findings of BengtIngervall *et al*. (1974)[3], Hiroshi *et al*. (1998)[4]

BengtIngervall *et al*. (1974)[3]found no difference in muscle activity with side which agreed with the results reported by Findlay and Kilpatrik (1960)[5], Ahlgren (1966)[6] and Moller (1966)[7].

Hiroshi *et al*. (1998)[4]revealed Non significant difference in muscle activity between male and female.

Investigators like Gerstner and Parekh. (2005)[8] and Shiau *et al*. (1993)[9]reported sex differences in muscle activity which is contradictory to our findings. They proposed that increased muscle mass and cross section and large volume of craniofacial skeleton in men is responsible for this variation between genders.

Table 2 shows non-significant difference was found for right and left sided muscle activity between male and female during isotonic contraction for Class I normal occlusion which was in accordance with the findings of BengtIngervall *et al*. (1974)[3], Keisuke Miyamoto *et al*. (1996)[10], Hiroshi *et al*. (1998)[4].

BengtIngervall *et al*. (1974)[3]found no statistically significantly difference in EMG activity with gender.

Keisuke Miyamoto *et al*. (1996)[10] found no significant difference between gender in 24 hours masseter muscle activity.

Our results were in contradiction to Marcelo Palinkas *et al*. (2010)[11]who studied muscle activity at various ages and reported that all ages gender was found to be significant factor associated with maximum bite force and proposed that gender is associated with structural and functional alterations in the muscles of the stomatognathic system owing to the increased muscle thickness in males.

Our study shows that gender is not found to be a significant factor for muscle activity during rest position and isotonic contraction with average growth pattern.

Table 3 shows there was non - significant difference found on comparing the right sided muscle activity with left sided muscle activity during rest position for each muscle which was in accordance with the findings of SrikanthGunturu (2013)[23]. SrikanthGunturu (2013)[23]concluded that activity of the right and left muscles have not differed much.

The reason for non - significant difference could be an absence of gross facial asymmetry and any transverse discrepancy.

Table 4 shows on comparing the right sided muscle activity with left sided muscle activity during isotonic contraction for each muscle non - significant difference was found which was in accordance with the findings of M.C. Raadsheer *et. al*. (1996)[12], Hiroshi *et. al*. (1998)[4].

M.C. Raadsheer (1996)[12] found no significant differences between right and left sided muscle activity.

Hiroshi *et al*. (1998)[4]also found non - significant difference in study of bite force measurement in combined sample of children and adults.

In the present study bilateral chewing may be contributing factor for non significant difference. We have choosen non habitual masticatory activity on both the sides simultaneously for all the subjects but there may be all the possibilities in the differences of right and left sided muscle activity during isotonic contraction if we advise to chew unilaterally while EMG recording simultaneously on both the sides.

The study with aim of determining potential interaction between craniofacial morphology and muscle activity can further be substantiated by considering other parameters which influence development of facial morphology in some or other way. These factors include vertical relationship, malocclusion, muscle thickness and volume, body weight and stature, facial dimensions and muscle activity. In addition to this study other study can also be advocated along with other muscles simultaneously like digastric, neck and trunk muscle and number of occlusal contacts.

Hence further studies can be executed to resolve the controversies about correlation between the muscle activity and with different saggital and vertical skeletal facial type in form of multicenter studies with enough sample size and accurate measurement of muscle activity at rest and during function.

SUMMARY AND CONCLUSION

All of 60 subjects with skeletal Class I normal occlusion and average growth pattern were free of any TMJ disorder, facial asymmetry and had no previous history of orthodontic treatment. Following concluding findings drawn from present study:

- Males and females do not significantly differ in Mentalis, Masseter(superficial fiber), Upper orbicularis oris, Lower orbicularis oris muscle activity during rest position and also during isotonic contraction.
- Right and left sided muscles reveal comparable muscle activity during rest position and also during isotonic contraction

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