



RESEARCH ARTICLE

ULTRASONOGRAPHIC EVALUATION OF THE CIRCUMORAL MUSCULATURE IN SKELETAL CLASSES I AND SKELETAL CLASS II DIVISION 1 MALOCCLUSION SUBJECTS: A COMPARATIVE STUDY

*¹Dr. Shikha Rastogi, ¹Dr. Roopa Jatti and ²Dr. Santosh D. Patil

¹Department of Orthodontics & Dentofacial Orthopaedics, KLE Vishwanath Katti Institute of Dental Sciences, KLE University, Belgaum-590010

²Department of Radiodiagnosis, Dr. Prabhakar Kore Medical Hospital and Research Centre, Nehru Nagar

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ABSTRACT

Background and Objectives: There should a balance between the forces of the tongue from within the dental arches and compensating action of the lips and cheek musculature. Alterations in function of the facial muscle can establish changes in facial skeleton and in the development of malocclusion. The role of lips in determining the facial morphology and the tooth position has intrigued dental researchers for decades. Thus this prospective study was carried out to ultrasonographically measure the lip thickness in class II division 1 malocclusion cases and compare with class I subjects.

Methodology: Patients reporting to the Department of Orthodontics, for fixed orthodontic treatment between 18-25 years were screened for inclusion and exclusion criteria and 30 subjects (15 class 1 occlusion and 15 class 2 div I malocclusion) were included in the study. Ultrasonographic measurements were made for upper and lower lip in relaxed and contracted states; which were divided into three regions i.e. right, middle and left in both the groups and the resultant data was subjected to analysis.

Results: Thickness of oral musculature of different sites of the lower lip were increased in skeletal class II division 1 group as compared to skeletal class I group in the contracted state and in relaxed state. A more predisposition towards females was observed in skeletal class II division 1 group.

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INTRODUCTION

Facial attractiveness plays a key role in social interaction. A smile plays an important role in the facial expression and appearance. The lips are the controlling factor in which a portion of the teeth, gingiva, and oral cavity will be seen in an individual's smile. (Pieter Van der Geld *et al.*, 2007) In 1942, Breitner stated that there should be a balance between the forces of the tongue from within the dental arches and which is compensated by the musculature of the lips and cheek. He called this as functional equilibrium. (Surinder Singh, 2009) The theory advanced by Tomes almost a hundred years ago stated role of Circumoral musculature and the tongue; which principally determines the position of the teeth. Subjects with Class II division 1 malocclusion usually make an effort to touch their lips while swallowing, the exaggerated lip eversion on the maxillary incisor makes lip seal difficult.

(Bianchini, 1995; Cleal, 1965; HeliVinkka-Puhakka *et al.*, 1989) this causes the lower lip to touch the palatal surface of the maxillary incisors, which causes lower lip hyper function. Swallowing this way may maintain or increase the overjet, and even cause over contraction of the Mentalis muscle. Alfred Paul Rogers (Rogers, 1918) was among the first to recommend the use of muscles for correction of malocclusion. In order to describe facial morphology, many authors have studied the structure of the facial muscles to determine the pattern of interaction of facial skeleton and muscles. It was in 1984, Weijs and Hillen (Weijs and Hillen, 1984) studied masticatory muscle thickness of adults, by using computed tomography. The method was reliable, but was associated with high radiographic exposure. The development of Ultrasonographic techniques has found wide spread applications in the field of medicine in the recent years. It is an accurate, convenient, easy, safe and cost effective method. Hence, the present study was taken up to investigate Quantitative measurements of the Circumoral muscle thickness in skeletal class II division 1 cases and comparing it with the class 1 cases.

*Corresponding author: Dr. Shikha Rastogi,

Department of Orthodontics & Dentofacial Orthopaedics, KLE Vishwanath Katti Institute of Dental Sciences, KLE University, Belgaum-590010.

MATERIALS AND METHODS

Patients reporting to the Department of Orthodontics, for fixed orthodontic treatment between 18-25 years were screened for inclusion and exclusion criteria and 30 subjects were included in the study. The ethical approval was obtained for this study from the ethical committee. Sample consisted of 2 groups of 15 subjects each. GROUP I had Skeletal CLASS I subjects with balanced profile with 8 female and 7 male subjects.

GROUP II had Skeletal CLASS II DIVISION 1 MALOCCLUSION (ANB angle more than 5) with 8 female and 7 male subjects. Informed consent was obtained from each subject. The study was conducted in the Department Of Radiodiagnosis. The phillips ultrasound system with b mode was used here which is equipped with high resolution probe with frequency ranging from 5MHz to 14MHz. The Upper Lip and Lower Lip region of the subjects was divided into three parts each, (Right, Middle and Left). (Figure 1) Air tight inert gel was applied on the recording site; the transducer was

Table 1. Comparison of thickness of oral musculature of different sites between experimental (skeletal class ii division 1) and control group (skeletal class i) in contracted state using students't-test

	Group	N	Mean	Std. Deviation	Mean difference	t-value	P-value
Contracted lower right	Control	15	2.53	0.19	-1.02	-7.805	<0.001**
	Experimental	15	3.55	0.47			
Contracted lower middle	Control	15	2.27	0.26	-1.35	-8.201	<0.001**
	Experimental	15	3.63	0.58			
Contracted lower left	Control	15	2.53	0.18	-0.99	-8.478	<0.001**
	Experimental	15	3.53	0.41			
Contracted upper right	Experimental	15	2.43	0.19	-0.95	-9.995	<0.001**
	Control	15	3.39	0.32			
Contracted upper middle	Experimental	15	2.17	0.23	-1.13	-6.459	<0.001**
	Control	15	3.30	0.64			
Contracted upper left	Experimental	15	2.43	0.20	-1.32	-7.163	<0.001**
	Control	15	3.75	0.68			

** denotes statistically significant.

Table 2. Comparison of thickness of oral musculature of different sites between experimental (skeletal class ii division 1) and control group (skeletal class i) in relaxed state using students't-test

	Group	N	Mean	Std. Deviation	Mean difference	t-value	P-value
Relaxed lower right	Control	15	2.19	0.12	-1.11	-11.14	<0.001**
	Experimental	15	3.30	0.37			
Relaxed lower middle	Control	15	2.00	0.24	-2.09	-15.88	<0.001**
	Experimental	15	4.09	0.45			
Relaxed lower left	Control	15	2.23	0.08	-1.44	-7.09	<0.001**
	Experimental	15	3.67	0.78			
Relaxed upper right	Experimental	15	2.13	0.16	-1.17	-7.77	<0.001**
	Control	15	3.30	0.56			
Relaxed upper middle	Experimental	15	1.99	0.27	-1.21	-7.22	<0.001**
	Control	15	3.21	0.59			
Relaxed upper left	Experimental	15	2.16	0.15	-0.87	-5.240	<0.001**
	Control	15	3.03	0.62			

** denotes statistically significant.

Table 3. Comparison of thickness of oral musculature of different sites between male and females in contracted state in control group (skeletal class i) using students't-test

	Gender	N	Mean	Std. Deviation	Mean difference	t-value	P-value
Contracted upper right	Female	8	2.450	0.207	-0.164	-1.791	0.097
	Male	7	2.614	0.135			
Contracted upper middle	Female	8	2.325	0.333	0.111	0.811	0.432
	Male	7	2.214	0.146			
Contracted upper left	Female	8	2.463	0.226	-0.152	-1.699	0.113
	Male	7	2.614	0.069			
Contracted lower right	Female	8	2.313	0.181	-0.259	-3.517	0.004*
	Male	7	2.571	0.076			
Contracted lower middle	Female	8	2.150	0.307	-0.050	-0.416	0.684
	Male	7	2.200	0.082			
Contracted lower left	Female	8	2.313	0.181	-0.259	-3.174	0.007*
	Male	7	2.571	0.125			

* denotes statistically significant.

Table 4. Comparison of thickness of oral musculature of different sites between male and females in relaxed state in control group (skeletal class i) using students't-test

	Gender	N	Mean	Std. Deviation	Mean difference	t-value	P-value
Relaxed upper right	Female	8	2.150	0.107	-0.079	-1.311	0.212
	Male	7	2.229	0.125			
Relaxed upper middle	Female	8	2.050	0.316	0.107	0.847	0.412
	Male	7	1.943	0.113			
Relaxed upper left	Female	8	2.213	0.099	-0.030	-0.722	0.483
	Male	7	2.243	0.053			
Relaxed lower right	Female	8	2.175	0.198	0.089	1.093	0.294
	Male	7	2.086	0.090			
Relaxed lower middle	Female	8	2.075	0.354	0.175	1.275	0.225
	Male	7	1.900	0.082			
Relaxed lower left	Female	8	2.200	0.177	0.086	1.112	0.286
	Male	7	2.114	0.107			

* denotes statistically significant.

Table 5. Comparison of thickness of oral musculature of different sites between male and females in contracted state in experimental (skeletal class ii division 1) group using students't-test

	Gender	N	Mean	Std. Deviation	Mean difference	t-value	P-value
Contracted upper right	Female	8	3.650	0.550	0.221	0.907	0.381
	Male	7	3.429	0.359			
Contracted upper middle	Female	8	3.913	0.681	0.613	2.325	0.037*
	Male	7	3.300	0.141			
Contracted upper left	Female	8	3.525	0.573	-0.004	-0.016	0.987
	Male	7	3.529	0.138			
Contracted lower right	Female	8	3.550	0.312	0.350	2.515	0.026*
	Male	7	3.200	0.208			
Contracted lower middle	Female	8	3.613	0.692	0.670	2.331	0.037*
	Male	7	2.943	0.331			
Contracted lower left	Female	8	4.088	0.755	0.716	2.315	0.038*
	Male	7	3.371	0.330			

* denotes statistically significant.

Table 6. Comparison of thickness of oral musculature of different sites between male and females in relaxed state in experimental (skeletal class ii division 1) group using students't-test

	Gender	N	Mean	Std. Deviation	Mean difference	t-value	P-value
Relaxed upper right	Female	8	3.400	0.478	0.214	1.135	0.277
	Male	7	3.186	0.146			
Relaxed upper middle	Female	8	4.113	0.610	0.041	0.170	0.867
	Male	7	4.071	0.189			
Relaxed upper left	Female	8	3.988	0.876	0.688	1.836	0.089
	Male	7	3.300	0.490			
Relaxed lower right	Female	8	3.513	0.712	0.455	1.671	0.119
	Male	7	3.057	0.098			
Relaxed lower middle	Female	8	3.088	0.567	-0.255	-0.825	0.424
	Male	7	3.343	0.632			
Relaxed lower left	Female	8	3.125	0.778	0.211	0.640	0.533
	Male	7	2.914	0.414			

*denotes statistically significant.

placed and the upper and lower lips were imaged at the vermilion border in the midline, and then midway between the midline and the angle of the mouth on each side. The lower lip was imaged 0.5 cm down from the vermilion border in the midline in order to record the Mentalis muscle. All the scans were made by the single operator. The measurements were recorded immediately, both in the relaxed and contracted states of the upper and lower lips in both the groups. Muscle thickness was recorded in centimeters (cm) and converted to millimetre scale (mm). The data gathered was stored and analyzed using the SPSS V. 15 statistical analysis program.

DISCUSSION

The role of the lips in determining tooth position is complex and not well understood.

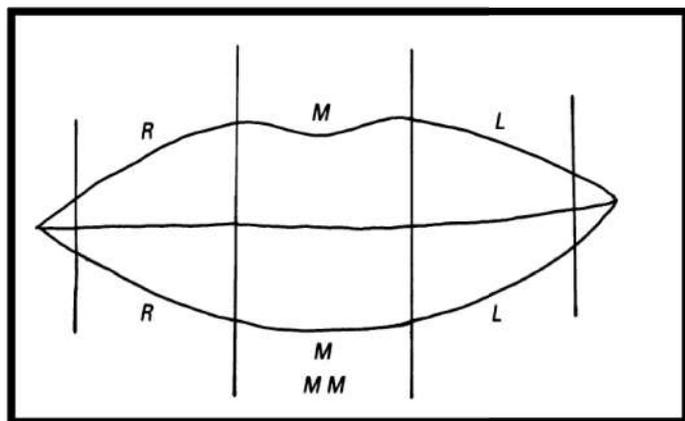


Figure 1. Division of upper and lower lip into right(r);middle (m); and left (l) region

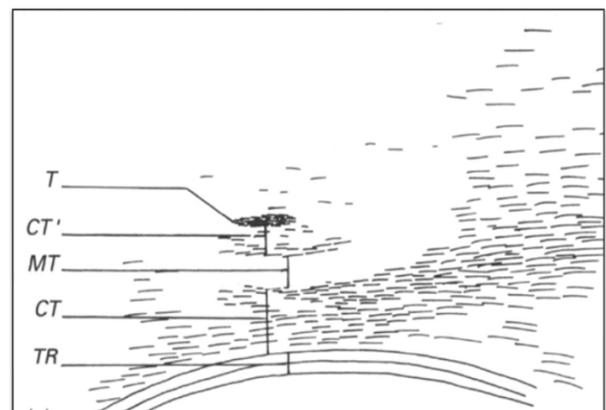


Figure 2. Schematic representation of layers of upper lip as seen in ultrasound image; from buccal to lingual are thickness of transducer probe (tr), connective tissue (ct), muscle tissue layer (mt), connective tissue layer (ct) and teeth (t)

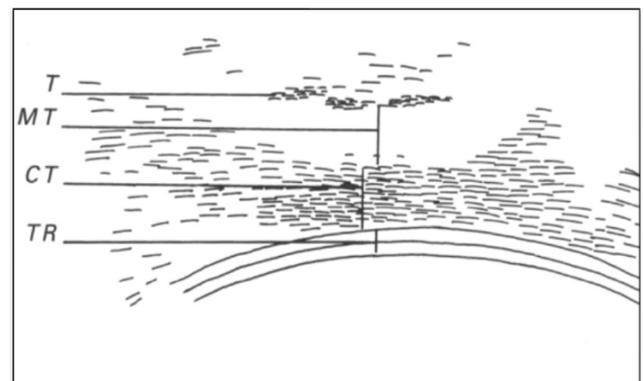


Figure 3. Schematic representation of layers of lower lip as seen in ultrasound image; from buccal to lingual are thickness of transducer probe (tr), connective tissue (ct), muscle tissue layer (mt), and teeth (t)

The main function of the lips, i.e., oral competence, is controlled by the Orbicularis Oris muscle, which is a concentric, sphincter-like muscle around the mouth that closes, withdraws, and protrudes the lips and Mentalis muscle which plays a key role in maintaining anterior oral seal.⁸ According to equilibrium theory it is the muscle tissue layer both in terms of thickness and activity which is responsible for influencing the form and position of dental arches. (Surinder Singh, 2009; Tais de Souza Barbosa *et al.*, 2012) So, only the muscle tissue layer (MT) thickness (Figure 2 and 3) is measured in both upper lip and lower lip in relaxed and contracted states in both the groups prior to the orthodontic treatment.

In contraction state; thickness of upper lip muscle tissue increases evenly from left region to right region and the thickness of lower lip muscle tissue is found to be more thick at right region and left region in lower fascicle of Orbicularis Oris muscle and less in middle portion as compared to lateral sites and is even more for Mentalis muscle. These findings are in accordance with the results obtained by Vinkka and Puhakka⁵ who have clearly stated the reasons that uniform contraction of Orbicularis Oris muscle in upper lip and contraction of only lateral parts of Orbicularis Oris muscle in lower lip along with active contraction of Mentalis muscle in lower lip. In experimental group, increase in lower lip muscle tissue thickness in all three regions was observed in contracted state and in relaxed state (Table 1) which is in contradiction to the study done by Prabhu and Munshi (1995) wherein a statistical insignificant results were observed. In control group, increase in muscle thickness was observed in upper lip in all three regions. (Table 2) Whereas in the study done by Prabhu and Munshi¹⁰ a statistical significant difference in muscle thickness was found only in left region of upper lip. Class II division I malocclusion subjects generally present with lesser electromyographic activity of the upper portion of the Orbicularis Oris muscle during mastication and swallowing due to reduction in adequate dental contacts in the anterior region causing hypotonicity of the upper lip and hyperactivity of the lower portion of the Orbicularis Oris muscle even at rest (Ahlgren *et al.*, 1973; Vania Celia Vieira de Siqueira *et al.*, 2011) Simpson (1976) recorded increased EMG activity in both muscle groups, It was concluded that the upper lip played a passive role in these patients, and maintenance of anterior oral seal was dependent on the Mentalis muscle pushing the lower lip up and forward, while the tongue was brought forward by the suprahyoid group of muscles. This agrees with the findings of Marx (1965) who found greater Mentalis muscle activity in class 2 division I subjects. Oliver (1982) found that patients with thin lips or a high lip strain displayed a significant correlation between incisor and lip retraction, which was not observed in patients with thick lips or low lip strain. Due to technical constraint, Emg activity was not recorded in the present study and correlation was done with previous available data.

Few literatures have observed gender dimorphism of Circumoral muscle thickness. Therefore an attempt was made in the present study to observe such changes. In control group, in the contracted state an Increase in Circumoral muscle thickness was noted in lower lip right and left region in males (Table 3). In experimental group, in the contracted state, increase in thickness was seen in upper lip middle region in females. Increase in lower lip muscle tissue thickness was seen in all the three regions in females in class 2 division I malocclusion group (Table 5). Thus in present study a

predisposition toward females subjects is seen in class II division I malocclusion group in contracted state. These findings can be clinically correlated with observations made by Simpson and Marx which states increased lower lip activity in class II division I malocclusion. However, in the present study lip muscle tissue thickness was observed and could not be correlated with tissue activity which influences the incisor position and angulation. The effects of lip strength, lip tonicity were not taken into consideration as these parameters can influence the lip morphology. Further comparative studies with larger samples and additional skeletal classifications (Class II Division 2 or Class III) should be conducted and analysis on the changes of perioral soft tissue measurements after orthodontic treatment should be considered as well.

Conclusion

Increase in lip thickness could possibly cause greater muscular activity, but not necessarily influencing the position of teeth or inclination of incisors. Persistence of the pattern of Circumoral muscle dysfunction after orthodontic treatment may cause relapse. Removal of the etiological factor and treating the underlying cause of malocclusion is more important rather than just treating the dentoalveolar component. It will account for long term retention and stability and prevent relapse. Clinician can start the lip seal therapy and oral screen exercises as early as possible to restore the normal function and aid in the normal dentofacial development.

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