Original Article

Comparative evaluation of perioral soft tissue of skeletal normal Class I and Class II Division 1 subjects: A lateral cephalometric study

ABSTRACT

Objective: This study aimed to evaluate and compare shape variability of soft-tissue outline of skeletal Class II Division 1 patients with various vertical patterns (low, moderate, and high SN-MP angles) and skeletal normal Class I occlusion patients and to evaluate correlative skeletal and dental variables affecting soft-tissue thickness using cephalometric analysis.

Materials and Methods: Sixty patients were selected with Class I normal occlusion and Class II Division 1 and divided into four groups based on horizontal and vertical skeletal pattern (SN-MP angles) on lateral cephalograms as Group I (normal occlusion), Group II-L (low angle <27), Group II-N (normal angle 27 –36), and Group II-H (high angle 37). The correlation and multiple linear regression analysis were used to determine skeletal and dental variables influencing soft tissue characteristics.

Results: The skeletal Class II patients with a high mandibular plane angle had significantly greater values than the skeletal Class II patients with a low mandibular plane angle for basic lower lip thickness and lower lip length. The measurements in perioral soft-tissue thickness were correlated with an inclination of the upper and lower incisors along with facial depth and facial length in skeletal Class II Division 1 patients.

Conclusion: Lip strain, lip thickness, and dental inclination must be evaluated based on various skeletal patterns for balanced perioral muscle activity.

Keywords: Perioral soft tissue, SN-MP angles, vertical pattern

INTRODUCTION

Balance and harmony of the soft-tissue facial profile in orthodontic treatment depends mainly on the characteristics of overlying soft tissues according to the horizontal and vertical skeletal patterns. For patient desire, in orthodontic treatment planning, it is necessary to consider facial appearance determined by the soft-tissue analysis as well as underlying skeletal pattern.[1] Facial balance depends on the form, proportion, and position of its various anatomical units. Chin plays a vital role in balancing facial profile in the lower third of the face.[2]

A lot of research showed that soft tissues have a significant factor in determining a patient's final facial profile. Due to the increasing acceptance of shift in paradigm, the diagnosis and orthodontic treatment planning are established predominantly by soft-tissue considerations than skeletal/dental relationships. Hence, the need for soft-tissue consideration is of significant use in orthodontics.[3]

According to studies, about 25% of patients exhibit skeletal Class II malocclusion and soft-tissue discrepancies. Not only skeletal patterns but also dental positions influence

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the soft-tissue profile, and hence, in this study, the focus is on Class II Division 1 patients with different skeletal patterns.[4]

Class II malocclusion may result from numerous combinations of skeletal and dental disorders. Class II Division 1 malocclusion can be developed due to three reasons such as, protrusive maxilla, retrusive mandible, or combination.[5]

Utsuno *et al*. stated that soft tissue was significantly thicker in Class II patients than Class I patients. Largest differences were observed in Class II with points subnasale, labrale superius, labiomentale, and pogonion. In Class II, soft tissue was thinner than in other skeletal classes in the upper lip region and thicker in the mental region.[6]

The vertical dimension influences orthodontic diagnosis and treatment planning in growing and adult patients. Variations in thickness, length, and tonicity of the soft tissues may affect the position of and the relationships among the facial structures, thereby affecting facial esthetics.[7] According to Kamak, significant differences in soft tissue thickness was greater in men than in women.[8]

The aim of this study was to evaluate and compare extraoral soft-tissue changes in skeletal Class II Division 1 patients with various vertical growth patterns and skeletal Class I patients. Along with the measurements of thickness and vertical length of the perioral soft tissues, a ratio of soft-tissue contour to hard-tissue contour was conceived to comprehend the interrelationship between soft tissues and underlying hard tissues. This study was carried out because no such studies were carried out or available in the past in the local population.

MATERIALS AND METHODS

This prospective study was carried out to compare and evaluate soft-tissue characteristics of skeletal Class II Division 1 patient s with various vertical patterns with normal skeletal Class I occlusion patients. From the outpatient department of the department of orthodontics and dentofacial orthopedics of the age group of 16–35 years, having Angle's Class I normal occlusion and Class II Division 1 malocclusion, 60 patients were selected. Lateral cephalograms of each patient were obtained.

Prior to commencement, patients were elucidated and their willingness to participate in this study was affirmed. Informed consent/parental permission was obtained from all patients who met inclusion criteria, and information regarding the purpose, procedure, and risks of the study was given to the patients/parents.

Inclusion and extrusion criteria for patient selection were selected as follows:

Inclusion criteria

Each group included patients with:

1. Patients with the age group of 16–35 years
2. Full set of permanent teeth excluding the third molars
3. Bilateral Class I molar relationship and Class I canine relationship with normal overjet (2 mm) and overbite (2 mm). Skeletal Class I, natural dentition, no alteration of facial morphology, no crowding, and no spacing of dental occlusion
4. Bilateral angle's Class II molar relationship with proclination of anteriors (Division 1), Class II canine relationship, and mild crowding
5. Healthy patients with no systemic diseases
6. Patients with healthy periodontal condition.

Exclusion criteria

1. Patients with facial asymmetry
2. History of previous orthodontic or orthognathic surgery
3. Craniofacial anomaly
4. Patients with large overjet exceeding 10 mm
5. Anterior open bite
6. patients with lips open on radiographs
7. Patients with cysts or tumors of either jaws or other pathology
8. Patients with unerupted, partially erupted, supernumerary, or over-retained deciduous teeth
9. Extensive caries with anterior and posterior teeth
10. Fractured anterior teeth.

The skeletal and dental measurements

These included SNA, SNB, ANB, Wits appraisal (AO-BO), SN-MP, FMA, facial length (S-Gn), Facial depth (N-Go), facial height ratio (S-Go/N-Me), U1 to SN, U1 to NA (in millimeters and degrees), L1 to NB (in millimeters and degrees), IMPA, interincisal angle, maxillary incisor exposure, overjet, and overbite [Figure 1].

The soft-tissue measurements

These included upper lip thickness, lower lip thickness, chin thickness, subnasale to H-line, lower lip to H-line, Ricketts' E-line to the upper lip and to lower lip, upper lip length, lower lip length, soft-tissue contour (subnasale-Me), hard-tissue contour (anterior nasal spine-Me), nasolabial angle, and H-angle.

As per inclusion and exclusion criteria, 15 patients were selected for each group which were grouped as follows:

1. Group I – Class I normal occlusion – 15 samples

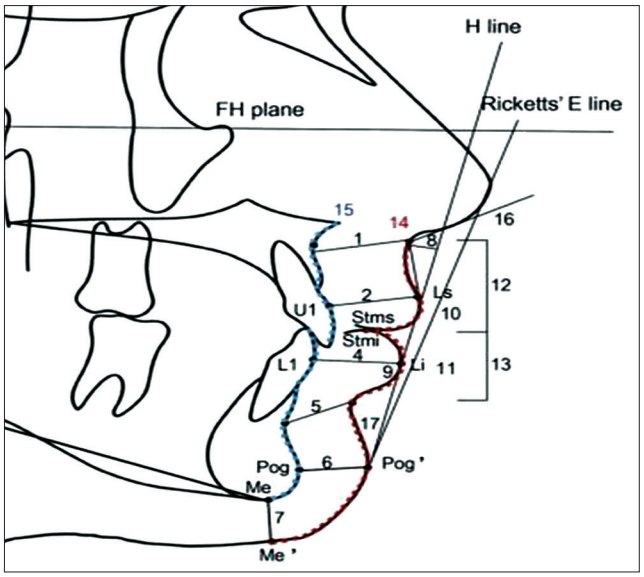

Figure 1: Soft-tissue landmarks and definitions of measurement for cephalometric analysis. Linear measurements: 1: Basic upper lip thickness, linear distance from 3 mm below A-point to subnasale, 2: Upper lip thickness, linear distance from the most prominent labial point of the maxillary incisor (U1) to labrale superius (Ls), 3: Upper lip strain, the difference between basic upper lip thickness and upper lip thickness, 4: Lower lip thickness, linear distance from the most prominent labial point of the mandibular incisor (L1) to labrale inferius (Li), 5: Basic lower lip thickness, linear distance from B-point to the deepest point of the labiomental fold, 6: Chin thickness-H, linear distance from pogonion to its sagittal projection on the soft tissue (Pog-Pog'), 7: Chin thickness-V, linear distance from menton to its vertical projection on the soft tissue (Me-Me'), 8: Subnasale to H-line, 9: Lower lip to H-line, 10: Ricketts' E line to the upper lip, 11: Ricketts' E-line to lower lip, 12: Upper lip length, vertical distance from subnasale to the lowest point of the upper lip (Stms) perpendicular to the Frankfort horizontal plane (FH plane), 13: Lower lip length, vertical distance from the highest point of the lower lip (Stmi) to the soft-tissue B-point perpendicular to the FH plane, 14: Soft-tissue contour (red dotted line), total length of lower facial profile (subnasale-Me'), 15: Hard tissue contour (blue dotted line), total length of hard tissue contour (anterior nasal spine-Me), and contour ratio was a percentage ratio of soft-tissue contour to hard-tissue contour, 16: Nasolabial angle, 17: H-angle, angle formed by H-line and soft-tissue nasion-Pog line

2. Group II – Angle's Class II Division 1 malocclusion.
   a. Group II – Low angle: Angle's Class II Division 1 with SN-MP <27° – 15 samples
   b. Group II – Normal angle: Angle's Class II Division 1 with SN-MP – 27°–36° – 15 samples
   c. Group III – High angle: Angle's Class II Division 1 with SN-MP >37° – 15 samples.

Statistical analysis

The data were collected, tabulated, and statistically analyzed using the SPSS 20 version software to get their interpretation. The mean, standard deviation, and *P* value were calculated for each parameter in each group. To find the significant differences between the groups, ANOVA test was used. *Post hoc* Scheff's test was used for the comparison between the groups. To determine dental and skeletal variables affecting soft-tissue characteristics, Pearson correlation analysis and multiple linear regression analysis were carried out. $P < 0.05$ was considered statistically significant.

RESULTS

The average intraclass correlation coefficient of the cephalometric analysis was 0.93 (range, 0.89–0.99) for the linear and angular measurements. The error of the method was measured according to Dahlberg's formula 26: 0.45 mm for linear measurements and 1.2 for angular measurements. Kolmogorov–Smirnov normality tests showed that the data had a normal distribution.

Upper lip thickness was less in Group II-N and II-H. Subnasale to H-line and H-angle was also increased in Group II-N and II-H. Chin thickness was less in II-N and II-H. Lower lip length was less in Group II [Table 1].

In our study, on comparison of soft-tissue measurements in Group I and Group II-L, II-N, and II-H, upper lip thickness was significantly less in Group II-N and II-H compared to Group I. Upper lip strain was significantly present in Group II compared with Group I. Group II-H had more upper lip strain values than Group II-L and II-N [Table 1].

Upper lip strain was significantly present in Group II-H with a significant value of 0.06 compared to Group II-N and II-L. Upper lip thickness was found to be less in Group II-H and II-N than II-L. Lower lip length was significantly short in Group II-H than Group II-L and II-N. Nasolabial angle was found to be more acute in high-angle cases [Table 1].

In our study, on comparison of dental and skeletal measurements in Group I and Group II-L, II-N, and II-H, significantly more values were found with U1-SN, U1-NA, L1-NB, IMPA, overjet, overbite, ANB, AO-BO, FMA, and facial height ratio in Group II-L, II-N, and II-H than Group I. Upper and lower incisors were more proclined in Group II compared to Group I. The mandible was more retruded in Class II cases than Class I. Facial height ratio was significantly more in Group II-L [Table 2].

On comparison of dental and skeletal measurements in Group II-L with Group II-N and II-H, significant values were found between the Groups II-L and II-H. High-angle cases showed more proclined upper incisors than low-angle and normal-angle cases [Table 2].

In our study, in multiple linear regression analysis, independent variables used in each regression group were selected according to the correlation test. Lower lip thickness was influenced by overbite, FMA, and facial depth. Subnasale

Table 1: Soft-tissue measurements (mean and standard deviation) for all patients

Soft-tissue measurements	Group I	Group II-L	Group II-N	Group II-H	Significance					
					I/II-L	I/II-N	I/II-H	II-L/II-N	II-L/II-H	II-N/II-H
Upper lip thickness	13.80±1.521	15.90±1.929	11.87±1.060	11.00±1.069	0.003	0.007	0.000	0.000	0.000	0.611
Upper lip strain	−0.067±0.594	1.6±1.84	0.66±1.49	2±1.06	0.013	0.525	0.001	0.311	0.879	0.069
Lower lip thickness	13.33±1.447	14.67±3.039	15.20±2.042	15.40±2.063	0.447	0.165	0.103	0.933	0.996	0.996
Chin thickness-horizontal	10.73±1.033	12.20±1.014	10.33±1.113	8.80±0.775	0.002	0.749	0.000	0.000	0.000	0.662
Chin thickness-vertical	8.60±1.882	7.53±1.407	7.73±1.831	7.07±1.981	0.453	0.626	0.151	0.992	0.791	0.791
Subnasale to H-line	6.70±2.016	10.00±3.873	10.33±3.155	10.27±2.404	0.033	0.015	0.018	0.992	1.000	1.000
Lower lip to H-line	0.57±0.704	0.63±2.768	1.97±1.778	2.10±1.514	1.000	0.241	0.172	0.281	0.281	0.998
Racket's E line to upper lip	−3.10±2.072	0.67±2.498	1.03±2.539	1.70±1.771	0.000	0.000	0.000	0.977	0.881	0.881
Rickett's E-line to lower lip	−1.27±1.624	1.27±3.634	2.33±1.799	3.40±2.131	0.053	0.002	0.000	0.696	0.696	0.696
Upper lip length	19.43±2.211	19.27±3.770	20.00±2.390	19.60±2.687	0.999	0.960	0.999	0.918	0.985	0.001
Lower lip length	14.23±1.972	11.80±1.521	11.43±1.657	9.70±1.099	0.002	0.000	0.000	0.940	0.008	0.960
Soft-tissue contour	65.93±4.096	65.47±10.743	66.60±6.695	68.13±7.558	0.999	0.996	0.891	0.983	0.983	0.959
Hard-tissue contour	58.47±3.226	57.87±10.703	60.47±5.643	62.40±8.218	0.997	0.911	0.562	0.824	0.918	0.918
Nasolabial angle	98.13±9.478	106.27±5.763	93.20±3.489	94.07±5.885	0.013	0.243	0.412	0.000	0.000	0.988
H-angle	16.00±3.891	24.87±3.847	23.73±4.118	22.63±5.428	0.000	0.000	0.000	0.883	0.486	0.486

$P \leq 0.05$ is significant, ≥ 0.05 is nonsignificant

Table 2: Skeletal and dental measurements (mean and standard deviation) for all patients

	Mean±SD				Significance					
	Group I	Group II-L	Group II-N	Group II-H	I/II-L	I/II-N	I/II-H	II-L/II-N	II-L/II-H	II-N/II-H
Dental measurements										
U1 to SN (°)	108.22±6.2	120.80±6.4	114.4±7.6	113.93±5.6	0.000	0.094	0.139	0.075	0.048	0.998
U1 to NA (°)	25.67±3.5	36.20±6.0	32.67±8.6	33.8±5.6	0.000	0.031	0.008	0.493	0.772	0.969
U1 to NA (mm)	4.07±1.4	9.0±1.5	7.4±2.4	8.67±1.9	0.000	0.000	0.000	0.159	0.972	0.347
U1 exposure (mm)	1.87±1.6	3.77±1.9	2.7±2.4	3.33±1.9	0.087	0.723	0.261	0.541	0.948	0.857
L1 - NB (°)	25.93±4.5	32.6±5.4	31.37±5.9	32.67±4.9	0.010	0.052	0.010	0.935	1.000	0.925
L1 - NB (mm)	3.53±0.74	7.20±2.2	7.07±1.8	8.20±1.9	0.000	0.000	0.000	0.998	0.500	0.389
IMPA (°)	96.73±3.5	110.53±4.8	105.73±5.6	101.47±5.4	0.000	0.000	0.086	0.079	0.000	0.143
U1 - L1 (°)	125.6±5.3	105.7±4.4	110.33±8.8	107.53±8.2	0.000	0.000	0.000	0.344	0.909	0.748
Overjet (mm)	1.97±0.61	13.27±1.7	7.9±1.3	8.27±2.3	0.009	0.330	0.278	0.420	0.483	1.000
Overbite (mm)	1.87±0.5	5.23±1.3	4.73±1.9	4.67±1.7	0.000	0.000	0.000	0.824	0.762	0.999
Skeletal measurements										
SNA (°)	81.13±3.3	84.07±3.3	82.07±3.1	80.27±2.8	0.103	0.883	0.904	0.399	0.018	0.493
SNB (°)	79.33±3.3	77.60±2.9	75.53±2.2	73.07±2.8	0.426	0.006	0.000	0.270	0.001	0.138
ANB (°)	1.80±0.8	6.47±1.9	6.53±1.8	7.20±1.9	0.000	0.000	0.000	1.000	0.700	0.612
AO - BO (mm)	1.80±0.8	7.67±2.7	7.67±2.4	8.87±3.2	0.000	0.000	0.000	1.000	0.612	0.612
SN - MP (°)	28.33±2.7	23.67±3.4	29.53±2.1	38.47±2.2	0.000	0.672	0.000	0.000	0.000	0.000
FMA (°)	59.8±2.9	53.47±5.7	54.17±5.1	52.2±5.6	0.011	0.029	0.001	0.985	0.921	0.758
Facial length (mm)	108.93±4.3	105.67±14.2	104.33±10.7	104.73±10.8	0.871	0.706	0.761	0.990	0.996	1.000
Facial depth (mm)	106.00±3.5	107.8±13.2	105.53±9.6	103.00±9.9	0.968	0.999	0.869	0.938	0.611	0.916
Facial height (mm)	64.73±2.3	72.99±3.1	68.99±1.6	62.09±2.8	0.000	0.001	0.051	0.001	0.000	0.000

$P \leq 0.05$ is significant, ≥ 0.05 is nonsignificant. SD: Standard deviation

to H-line was significantly affected by L1-NB, facial length, and facial depth. Lower lip to H-line was dependant on L1-NB, IMPA, overbite, facial length, facial depth, and facial height ratio. Upper and lower lip lengths were affected by U1-NA, upper incisor exposure, and facial depth. Soft-tissue contour was influenced by the facial depth and hard-tissue contour was affected by overbite and facial depth. Overbite and ANB angle influenced the nasolabial angle. H-angle was dependant on U1-NA and upper incisor exposure [Table 3]. Comparison of soft tissue measurements with dental measurements showed that lower lip thickness was correlated with overbite. Subnasale to H line was correlated with L1-NB. Lower lip to H line was correlated with L1-NB, IMPA and overbite. Rickett's E line to upper lip was correlated with U1-NA. Rickett's E line to lower lip was correlated with U1-NA, L1-NB, IMPA and overbite. Upper lip length was correlated with U1-NA and U1 exposure. Lower lip length was correlated with overbite. Hard tissue contour and nasolabial angle were also correlated with overbite. H angle was correlated with U1-NA and U1 exposure [Table 4].

Table 3: Results of multiple linear regression

Dependent variable	Adjusted R^2	Independent variable	*B*	SE	β	*T*	Significance
Lower lip thickness	0.579	Constant	−11.595	34.836		−0.333	0.741
		Overbite	0.450	0.164	0.376	2.750	0.009
		FMA	−0.176	0.079	−0.431	−2.244	0.030
		Facial depth	0.247	0.088	1.030	2.804	0.008
Sub nasale to H-line	0.534	Constant	−54.827	51.595		−1.063	0.294
		L1-NB (°)	0.751	0.328	1.333	2.291	0.027
		Facial length	−0.496	0.136	−1.603	−3.640	0.001
		Facial depth	0.556	0.131	1.644	4.256	0.000
Lower lip to H-line	0.597	Constant	32.615	28.535		1.143	0.260
		L1-NB (mm) l	0.511	0.171	0.654	2.982	0.005
		IMPA	−0.263	0.113	−0.957	−2.321	0.025
		Overbite	0.545	0.134	0.544	4.065	0.000
		Facial length	−0.154	0.075	−0.834	−2.037	0.048
		Facial depth	0.215	0.072	1.070	2.979	0.005
		Facial height	−0.139	0.095	−0.349	−1.463	0.151
Rickett's E-line upper	0.609	Constant	−25.247	41.903		−0.603	0.550
		U1-NA (mm)	0.609	0.203	0.568	3.000	0.005
		Facial length	−0.309	0.111	−1.128	−2.794	0.008
		Facial depth	0.327	0.106	1.089	3.076	0.004
Rickett's E-line lower	0.748	Constant	14.030	34.308		0.409	0.685
		U1-NA (mm)	0.414	0.166	0.379	2.489	0.017
		L1-NB (mm) l	0.450	0.206	0.380	2.186	0.035
		IMPA	−0.312	0.136	−0.747	−2.290	0.027
		Overbite	0.506	0.161	0.332	3.139	0.003
		FMA	−0.176	0.077	−0.339	−2.276	0.028
		Facial length	−0.380	0.091	−1.359	−4.193	0.000
		Facial depth	0.434	0.087	1.421	4.996	0.000
Upper lip length	0.655	Constant	−29.064	37.795		−0.769	0.446
		U1-NA (mm)	0.578	0.183	0.562	3.155	0.003
		U1-exposue	−0.406	0.126	−0.302	−3.214	0.003
		Facial depth	0.237	0.096	0.823	2.475	0.018
Lower lip length	0.651	Constant	18.393	36.521		0.504	0.617
		Overbite	−0.428	0.171	−0.311	−2.499	0.017
		Facial depth	0.246	0.093	0.890	2.660	0.011
Soft tissue contour	0.869	Constant	−27.597	63.204		−0.437	0.665
		Facial depth	0.529	0.160	0.676	3.302	0.002
Hard tissue contour	0.92	Constant	33.697	49.354		0.683	0.499
		Overbite	−0.503	0.232	−0.129	−2.170	0.036
		Facial depth	0.495	0.125	0.634	3.957	0.000
Naso labial angle	0.078	Constant		235.167		1.595	0.118
		Overbite	−2.362	1.104	−0.433	−2.139	0.038
		ANB	7.734	3.100	1.995	2.495	0.017
H angle	0.65	Constant	−56.273	74.588		−0.754	0.455
		U1-NA (mm)	0.771	0.361	0.383	2.134	0.039
		U1-exposue	−0.669	0.249	−0.254	−2.684	0.010

SE: Standard error

DISCUSSION

It has been reported that soft tissue more closely determines therapeutic modifiability. Thus, soft-tissue analysis is a critical part of orthodontic decision-making, and this can be accomplished by recognizing the differences in soft-tissue thickness in each skeletal classification.[2]

Soft-tissue cephalometric values are as important as hard-tissue values when assessing the success of treatment. One of the predominant goals of orthodontic treatment is to improve facial esthetics.[9] Sometimes, the esthetic result is more important to the patient than the occlusal changes. Hence, good occlusion and improved facial appearance are distinct yet parallel objectives of orthodontic treatment.[4]

Table 4: Pearson correlation coefficients of Group II between soft-tissue thickness and skeletal and dental variable

Soft tissue parameters	Skeletal parameters	Correlation coefficient
Lower lip thickness	Facial depth	0.61
	FMA	−0.1
Subnasale to H-line	Facial length	0.16
	Facial depth	0.32
Lower lip to H-line	Facial length	0.19
	Facial depth	0.23
	Facial height	−0.23
Rickett's E-line upper	Facial length	−0.04
	Facial depth	0.11
Rickett's E-line lower	FMA	−0.58
	Facial length	0.08
	Facial depth	0.17
Upper lip length	Facial depth	0.67
Lower lip length	Facial depth	0.49
Soft-tissue contour	Facial depth	0.85
Hard-tissue contour	Facial depth	0.82
Nasolabial angle	ANB	0.13
Soft tissue parameters	**Dental parameters**	**Correlation coefficient**
Lower lip thickness	Overbite	0.45
Subnasale to H-line	L1-NB (°)	0.5
Lower lip to H-line	L1-NB (mm)	0.52
	IMPA	0.15
	Overbite	0.29
Rickett's E-line upper	U1-NA (mm)	0.58
Rickett's E-line lower	U1-NA (mm)	0.5
	L1-NB (mm) I	0.7
	IMPA	0.35
	Overbite	0.46
Upper lip length	U1-NA (mm)	0.15
	U1-exposure	−0.15
Lower lip length	Overbite	−0.54
Hard-tissue contour	Overbite	−0.01
Nasolabial angle	Overbite	−0.25
H-angle	U1-NA (mm)	0.57
	U1-exposure	0.09

In our study, when the assessment of soft-tissue measurements in Class I normal occlusion was carried out, and Class I normal occlusion patients showed normal mean values of upper lip thickness, lower lip thickness, upper lip strain, chin thickness, subnasale to H-line, lower lip to H-line, Rickett's E-line to upper lip, and Rickett's E-line to lower lip, and nasolabial angle and H-angle in accordance with normal values of 15, 15, 2, 10–12, 12, 0, −4, and − 2 mm, and 90°–110° and 7°–15°, respectively.

Studies reported that upper and lower lips were retruded according to Rickett's E-line to the upper lip and Rickett's E-line to the lower lip with mean values of −5.4 and −4.1 mm, respectively, in Class I normal occlusion patients.[10]

In our study, when the assessment of soft-tissue measurements in Group II-L, II-N, and II-H (Class II Division 1 low angle, normal angle and high angle) was carried out, it was observed that upper lip thickness was less in Group II-N and II-H. Subnasale to H-line and H-angle was also increased in Group II-N and II-H. Upper and lower lips were found to be protruded in Group II-L, II-N, and II-H in relation to Rickett's E-line. Chin thickness was less in II-N and II-H. Lower lip length was less in Group II.

In our study, on comparison of soft-tissue measurements in Group I and Group II-L, II-N, and II-H, upper lip thickness was significantly less in Group II-N and II-H compared to Group I. Upper lip strain was significantly present in Group II compared with Group I. Group II-H had more upper lip strain values than Group II-L and II-N. Upper and lower lips in relation to Rickett's E-line were significantly protruded in Group II-H, II-N, and II-L compared to Group I.

Upper and lower lips were observed more protruding in Class II Division 1 cases in Chinese and European population.[5,11] Upper and lower lips in relation to E-line were also found to be protruded in Class II Division 1 with low, medium, and high angle patients studied by Mobarak *et al.*,[12] with more value in Class II Division 1 low-angle (2.18 mm) patients than medium-angle (1.63 mm) and high-angle (1.74 mm) patients.

In our study, H-angle was significantly increased in Group II compared to Group I, and lower lip length was significantly decreased in Group II-N and II-H compared to Group I with values of 11.43 mm in II-N, 11.27 mm in II-H, and 14.23 mm in Group I.

Upper lip strain, soft tissue subnasale to H-line, upper lip thickness and H-angle were found to be more among the Lucknow population.[13]

Other studies concluded that H-angle was significantly larger in Class II Division 1 patients than Class I patients, and the upper lip was more protrusive in Class II Division 1 patients.[11,14]

We found that the characteristics of soft-tissue measurements according to vertical patterns (SN-MP) were distinct, with statistical differences in upper lip strain and lower lip length. Upper lip strain was significantly present in Group II-H with a significant value of 0.06 compared to Group II-N and II-L. Upper lip thickness was found to be less in Group II-H and II-N than II-L. Lower lip length was significantly short in Group II-H than Group II-L and II-N. Nasolabial angle was found to be more acute in high-angle cases.

In our study, dental and skeletal measurements in Class I normal occlusion showed significantly normal values with slight proclination of lower incisor and decreased interincisal angle with normal overjet and overbite. Group II-L, II-N, and II-H cases showed proclined upper and lower incisors, increased overjet and overbite, prognathic maxilla, and retrognathic mandible.

In our study, on comparison of dental and skeletal measurements in Group I and Group II-L, II-N, and II-H, significantly more values were found with U1-SN, U1-NA, L1-NB, IMPA, overjet, overbite, ANB, AO-BO, FMA, and facial height ratio in Group II-L, II-N, and II-H than Group I. Upper and lower incisors were more proclined in Group II compared to Group I. Mandible was more retruded in Group II than Group I. Facial height ratio was significantly more in Group II-L. Young Joo Lee[1] found that L1-NB value was statistically lower in Group I than Group II-N and II-H.

On comparison of dental and skeletal measurements in Group II-L with Group II-N and II-H, significant values were found between the Groups II-L and II-H. Upper incisors were found to more proclined in high-angle cases than low-angle and normal-angle cases. Proclined lower incisors were found with II-L and II-H patients.

In our study, in multiple linear regression analysis, independent variables used in each regression group were selected according to the correlation test. Lower lip thickness was influenced by overbite, FMA, and facial depth. Subnasale to H-line was significantly affected by L1-NB, facial length, and facial depth. Lower lip to H-line was dependant on L1-NB, IMPA, overbite, facial length, facial depth, and facial height ratio. Upper and lower lip lengths were affected by U1-NA, upper incisor exposure, and facial depth. Soft-tissue contour was influenced by the facial depth and hard-tissue contour was affected by overbite and facial depth. Overbite and ANB angle influenced the nasolabial angle. H-angle was dependant on U1-NA and upper incisor exposure.

Upper and lower lip thickness was influenced by L1-NB and overjet, and upper lip strain was associated with U1-NA and overjet according to other studies.[1] The measurements of perioral soft tissue were correlated with inclination and anteroposterior position of incisors along with the facial length and facial depth.

In this study, the sample size was too small to achieve statistical power to test each male and female group separately. Further comparative studies with larger samples and more additional skeletal classification could be conducted to increase statistical power. Different racial comparisons can also be studied.

CONCLUSION

1. Class II Division 1 malocclusion patients with various vertical pattern were found to have more soft-tissue imbalance than normal Class I occlusion patients
2. Lower lip thickness and lower lip length were found to be significantly greater in skeletal Class II Division 1 patients with high mandibular plane angle compared to low mandibular plane angle
3. Class II Division 1 patients had significantly protruded upper and lower lips and H-angle was significantly greater
4. Upper lip strain was evident in all Class II Division 1 cases
5. The inclination of upper and lower incisors with facial depth and facial length significantly affected perioral soft-tissue measurements in skeletal Class II Division 1 patients.

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Conflicts of interest

There are no conflicts of interest.

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