Soft tissue analysis of chin, upper lip length and thickness in patients with different mandibular divergent patterns - A cephalometric study

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Abstract

Aim: To compare soft tissue chin, upper lip thickness and length in patients with different mandibular divergent patterns.

Materials and Methods: Pre-treatment lateral cephalograms of 180 patients was taken. Based on the mandibular plane angle (GoGn-SN), all the subjects were divided into three groups, Group 1 - hyper-divergent (30 males, 30 females), Group 2 - hypo-divergent (30 males, 30 females), Group 3- normo-divergent (30 males, 30 females). Soft tissue chin, upper lip thickness and length were measured on the cephalograms. The measurements were recorded by the same operator and analysed statistically.

Results: Soft tissue chin thickness (Pog-Pog'), (Gn-Gn') and (Me-Me') was found to be statistically significant only between hyperdivergent & hypodivergent groups ($p=0.008$), ($p<0.001$), ($p=0.001$) respectively. No statistical difference was seen in upper lip length among all the groups. Difference in upper lip thickness was statistically significant between hyperdivergent and hypodivergent groups only ($p<0.044$).

Conclusion: Soft tissue chin thickness was greatest in the hypodivergent group as compared to the other groups. Greater values for lip thickness were observed for hypodivergent patients. No difference in lip length was seen for all the groups.

Keywords: Soft tissue analysis, Cephalometrics, Mandibular divergence.

Introduction

Facial harmony in Orthodontics is determined by soft tissue profile of the patient, which is governed by the morphologic relationships, and proportions of the nose, lips and chin. The balance among these three anatomic structures can be altered in different types of malocclusion, thereby hampering the facial esthetics. Soft tissue changes because of growth, as well as mechanotherapy, further add to its importance in orthodontic evaluations.[1] Most of the patients approach for orthodontic services mainly due to the presence of facial disharmony including facial deformity and mal-alignment of the teeth, or both. Patients have least interest regarding changes occurring in bone or the angulations of the teeth as exhibited in a cephalometric radiograph, rather they have keen interest in visual changes which can be seen in form of improvement in the protrusion of the lips, curl of the lower lip and the apparent growth or the forward displacement of the chin.

Soft tissue profile is currently one of the most critical areas of interest in the selection of orthodontic treatment. Primarily through lateral cephalometric radiograph, soft tissue profile is studied extensively in orthodontics, under the belief that the soft tissue outline largely governs the aesthetics of the face. The facial soft tissues are considered a dynamic structure that can develop along with or independent of their skeletal substructure. Until the end of the 1950's, a common perception was that the integument profile followed passively the underlying hard tissue, although later studies demonstrated that the soft tissue have an independent growth potential.[2,3] Furthermore, the variations in thickness, length and tonicity of the soft tissues may have an effect on the position and relationship of the facial structures.[4]

Growth anomalies are often accompanied by different patterns of mandibular growth that are generally described as hyperdivergent, normodivergent, and hypodivergent.[5,6] The forward rotating patterns of growth allow pogonion to move in a relatively forward direction resulting in a prominent chin point while as backward rotating mandibles move pogonion backward and downward producing a less prominent chin.[7] The soft tissue chin thickness among different mandibular divergent patterns have an influence on diagnosis and treatment planning; and a disassociation between the underlying bony structures and soft tissue can affect the facial appearance in such a way that may shift the treatment into the range of orthognathic and cosmetic surgery. Very few studies have evaluated and compared the soft tissue chin thickness in different vertical growth patterns. The studies of Feres et al,[8] Macari et al,[9] Celikoglu et al,[10] Nanda et al[11] and Arnett et al[12] gave an insight of soft tissue chin thickness in various vertical and sagittal discrepancies. The mandibular divergent patterns not only have impact on the soft tissue chin, but it can entail changes in the length and thickness of the upper lip as well. Burstone[4] noted that not only can the absolute length of the upper lip be measured and compared to the position of the maxillary

incisor, but it can also be related to the length of the lower lip and chin.

To study the effects of different mandibular divergent patterns on soft tissues this study was done to compare soft tissue chin, upper lip thickness and length in patients with different mandibular divergent patterns.

Materials and Methods

This study was approved by the Institutional Research Development Committee (IRDC) and Institutional Human Ethical Committee (IHEC) of Saraswati Dental College, Lucknow. Pre-treatment lateral cephalograms of 180 patients who came to the Department of Orthodontics and Dentofacial Orthopaedics, Saraswati Dental College, Lucknow for treatment were chosen for the study.

Each subject met the following inclusion criteria:

1. Age between 18-30 years
2. No history of previous orthodontic treatment or functional jaw orthopedic treatment
3. No history of orthognathic surgery
4. No history of craniofacial anomalies
5. No history of endocrine disorders affecting facial growth
6. No history of facial trauma
7. All the subjects were divided into three groups, based on the mandibular plane angle which is formed by the intersection of the lines made by joining SN Plane, (points Sella and nasion) and mandibular plane (gonion and gnathion)
8. 60 hyper-divergent individuals
9. 60 hypo-divergent individuals
10. 60 normo-divergent individuals

For recording the lateral cephalograms, patients were placed in the standing position with the Frankfort Horizontal plane parallel to the floor. The subjects were then asked to swallow and bite in centric occlusion. The head of the patient was erect, with seated condyles and passive lips. Relaxed lip position was established by opening and closing the mandible, since it tends to block those reflexes which normally maintain an anterior lip seal under most circumstances. Relaxed-lip posture, like body posture, is a muscle determined position. Therefore, it cannot have the reproducibility that is associated with measurements on hard structures. The recording of lip posture is further complicated by the fact that we are dealing with muscles innervated by the seventh cranial nerve. With care, however, the cephalograms were taken in a relaxed-lip position that was relatively reproducible.

All of the cephalograms were recorded with the same exposure parameters (KvP - 80, mA-10, exposure time 0.5 seconds) with the same magnification and the same machine (Kodak 8000C digital and panoramic system cephalometer Rochester, NY, USA). The x-rays were printed using standard Fujifilm Medical Dry Imaging film (8×10 inches in size) and the Fujifilm Dry pix plus printer. All cephalograms were traced manually on a cellulose acetate sheet of 36µm (0.003 inch) thickness and 4H tracing pencil by the same operator. Similar conditions of the light box and general illumination were maintained during viewing and tracing all the head films.

All reference landmarks were identified, located and marked. The reference planes were drawn and angular and linear measurements were recorded. Various reference planes, linear and angular parameters used for the evaluation of the soft tissue chin thickness and upper lip length and thickness in different mandibular divergent patterns were based on methods described by Arnett WG *et al*[12] and Macari et a;[9] (Fig. 1). The individuals were stratified into three groups hyperdivergent, hypodivergent and normodivergent based on the GoGn-SN angle. Two angular and five linear measurements were used to analyze soft tissue chin thickness and upper lip length and thickness (Table 1).

Statistics: A master file was created, and the data was statistically analyzed on a computer using Statistical Package for Social Sciences (SPSS) software (version 15). A data file was created under dBase and converted into a microstat file. The data was subjected to descriptive analysis for mean, standard deviation and chi square test. A probability (P value) of .05 was considered statistically significant. Group differences were analyzed with one-way analysis of variance (ANOVA). For multiple comparisons, a post- hoc Tukey Honestly significant difference (HSD) test was used. To identify errors associated with radiographic measurements, 15 radiographs were selected randomly. Their tracings and measurements were repeated 8 weeks after the first measurements were taken. A paired sample t-test was applied to the first and second measurements, and the differences between measurements were insignificant.

Results

Soft tissue chin thickness (Pog-Pog'), (Gn-Gn') and (Me-Me') was found to be statistically significant only between hyperdivergent & hypodivergent groups ($p=0.008$), ($p<0.001$), ($p=0.001$) respectively. No statistical difference was seen in upper lip length among all the groups. Difference in upper lip thickness was statistically significant between hyperdivergent and hypodivergent groups only ($p<0.044$).

Table 1: Cephalometric parameters used

S. No	Parameters
1	SN-GoGn
2	FH-N'Pog'
3	Sn-ULI
4	ULIn-ULA
5	Pog-Pog'
6	Gn-Gn'
7	Me-Me'

Table 2: Between group comparison for Pog-Pog' (Tukey HSD test)

S. No.	Comparison	Mean Diff.	Pooled SE of diff.	'p'
1	Hyperdivergent vs Hypodivergent	-1.52	0.49	0.008
2	Hyperdivergent vs Normodivergent	-1.04	0.49	0.096
3	Hypodivergent vs Normodivergent	0.48	0.49	0.597

Table 3: Between group comparison for Gn-Gn' (Tukey HSD test)

S. No	Comparison	Mean Diff.	Pooled SE of diff.	'p'
1	Hyperdivergent vs Hypodivergent	-2.52	0.57	<0.001
2	Hyperdivergent vs Normodivergent	-1.74	0.57	0.009
3	Hypodivergent vs Normodivergent	0.78	0.57	0.360

Table 4: Between Group Comparison for Me-Me' (Tukey HSD test)

S. No.	Comparison	Mean Diff.	Pooled SE of diff.	'p'
1	Hyperdivergent vs Hypodivergent	-2.06	0.55	0.001
2	Hyperdivergent vs Normodivergent	-0.95	0.55	0.205
3	Hypodivergent vs Normodivergent	1.11	0.55	0.119

Table 5: Between Group Comparison for ULT (ULIn-ULA) (Tukey HSD test)

S. No.	Comparison	Mean Diff.	Pooled SE of diff.	'p'
1	Hyperdivergent vs Hypodivergent	-1.48	0.61	0.044
2	Hyperdivergent vs Normodivergent	-0.30	0.61	0.874
3	Hypodivergent vs Normodivergent	1.18	0.61	0.132

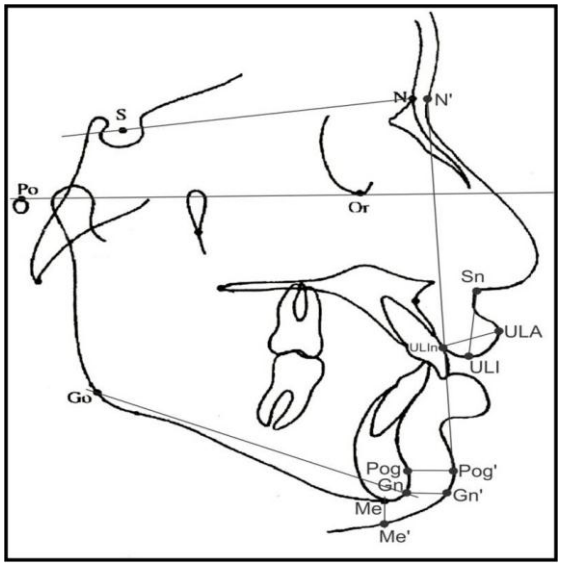

Fig. 1: Various cephalometric reference planes, angular and linear parameters used in the study

Discussion

Evaluation of the soft tissues plays an important role in diagnosis, treatment planning and obtaining facial harmony. Holdaway[13] found that treatment goals were much improved when soft tissue features were taken into consideration. The soft tissue profile has been studied extensively in orthodontics, primarily from lateral cephalometric radiographs, under the assumption that the form of soft tissue outline largely determines the aesthetics of the face. Burstone[3] in his study stated that not only can the absolute length of the upper lip be measured and compared to the position of maxillary incisor, but it can also be related to the length of lower lip and chin.

In the present study the age range of the subjects was 18–30 years to ensure that the upper lip length and thickness as well as the soft tissue chin thickness had reached adult size. Subtelny[2,14] found that after the eruption of the maxillary central incisors, the upper lip was found to maintain a fairly constant vertical relationship to prosthion and the incisal edge of the central incisor. He further mentioned that the lower and the upper lips gradually increase in length and this occurred till 15 years of age. Chaconas[15] also concluded in their study that the lips when measured linearly did not become retruded with age as is often asserted; rather there is slight decrease in angular or proportional convexity from age 10 to 16 years.

Mamandras AH[16] in his study found that in females vertical lip growth was complete by 14 yrs whereas in males at 18 yrs. He calculated the total lip area instead of relating lip growth to a single lip point, increase in the total lip area, in both numerical and proportional terms, was observed from age 8 to 18 years. The largest incremental growth increase for both lips took place between ages of 12 to 14 years, whereas no significant changes were observed after 16 years of age. Nanda et al[17] found that lip thickness increased uniformly from age 7 to 18yrs and females attained full lip thickness by age 13yrs with slight thinning starting then. In males, however, the thickness continued till the age of 18 yrs. Genecov[18] documented that soft tissue chin thickness in females from age 7 to 9 years was greater than males. Females only had a 1.6mm increase upto age 18 whereas the males had a 2.4mm increase in soft tissue

drape over the chin. As a result both sexes had a similar soft tissue thickness at age 17. Foley et al[19] observed no change in the soft tissue thickness over menton beyond age 16.

The range of the facial angle (FH-N'Pog') in hyperdivergent, hypodivergent and normodivergent subjects included in the study was 78-99^0. The facial angle of hypodivergent was found to be maximum (89.0^0±4.0^0), followed by normodivergent (88.7^0±4.7^0) and minimum in hyperdivergent (84.7^0±3.6^0). Stoner[20] in his study concluded that a retrusive face must be recorded in terms of small facial angle while as a protrusive face would be recorded as a larger facial angle. Our finding correlate with that of Stoner, smaller angle was seen in hyperdivergent group indicating a retrusive face, while as larger angle in hypodivergent group indicated a protrusive face.

Linear distance Pog – Pog' ranged from 6-16mm, mean distance among hyperdivergent group was found to be minimum (8.9±1.4 mm), followed by normodivergent group (10.0±1.7 mm), while as for hypodivergent group it was found to be maximum (10.4±2.1mm). Our study correlates with Celikoglu et al[10] in which they concluded that the soft tissue thickness values were the lowest in the high angle group for both women and men. Further for women, the thickness values at pogonion were found to be statistically significantly smaller in the high angle group. In addition, the low angle and normal angle groups showed similar thickness values.

Macari et al[9] in their study found that patients with greater MP/SN angle have thinner soft tissue chin thickness, excluding Pog. More specifically, the finding that soft tissue thickness was statistically significantly different at Gn and Me, but not at Pog suggests the presence of a differential extension between hard and soft tissues during growth. Our findings correlate with that of Macari et al[9] as far as soft tissue menton and gnathion are considered, but disagreement lies for the point pogonion. Nanda et al[11] in their study on white North European patients concluded that for all chin measurements including the thickness of tissue at point B and pogonion, significantly larger thickness was noted in the long vertical patterns. This may have been nature's way of compensating for the shorter mandibular corpus length in an effort to mask the condition and provide a more normal facial appearance. The converse was true for subjects with the short patterns who showed a thinner tissue drape. However these findings do not correlate with our study.

Linear distance Gn-Gn' among overall, hyperdivergent, hypodivergent and normodivergent group patients ranged from 4 -15mm, mean distance was minimum in hyperdivergent (7.6±1.6mm) followed by normodivergent (9.4±2.2mm) while maximum distance was found among hypodivergent (10.2±2.1). Our study correlate with other studies which found a statistically significant difference at the level of Gn-Gn'.[9,10] The patients having larger MP/SN angle had thinner soft tissue thickness as compared to patients with low angle. The need for orthognathic surgery in combination with orthodontic treatment in adult patients has bestowed important information regarding the relation between soft and hard tissues. Genioplasty, indicated to restore adequate shape and projection of the chin in the face, has been performed to enhance soft tissue contours related to disproportion between soft and hard tissue and has produced stable long-term postsurgical changes. High correspondence of soft tissue changes at the chin level has been reported after advancement genioplasty, resulting in a ratio of bony tissue to soft tissue ranging from 1:0.75 to 1:0.92.[21] The deficient chin appearance in patients with hyperdivergent mandibular pattern indicates the requirement for advancement genioplasty. In contrast, genioplasty was not needed in patients with hypodivergent mandibles. In our study we found that the soft tissue thickness between the hypodivergent and normodivergent was similar at points Pog and Gn, this could well be the reason that adjunctive surgeries to improve the soft tissue drape is not required in the hypodivergent patients.

Linear distance Me-Me' among the hyperdivergent, hypodivergent and normodivergent group patients ranged from 3-13mm. Mean distance Me-Me' among hyperdivergent group was found to be minimum (5.3±1.5mm), followed by normodivergent group (6.3±1.8mm) while as maximum distance was found in hypodivergent group (7.4±2.4mm). The reason that might account for the minimum difference at menton between the hyperdivergent and normodivergent could be that the soft tissue at menton apparently adapts to severe hyperdivergence, presumably through increased stretching of soft tissue with progressive increase in facial divergence. The finding that statistically significant difference occurred between the hyperdivergent and hypodivergent patients emphasizes the fact that soft tissue thickness at menton is actually the thinnest of all the distances in all the groups. Our finding that the soft tissue thickness at menton is minimum in hyperdivergent facial types correlates with the study of Macari et al.[9]

Linear distance ULL among overall, hyperdivergent, hypodivergent and normodivergent group patients ranged from 15-25mm. Mean distance ULL (Sn-ULI) among hypodivergent was minimum (18.4±2.4mm), followed by normodivergent (18.6±2.1mm) and hyperdivergent (18.6±2.0mm). Kalha et al[22] in their study of soft tissue in South Indian ethnic population found the mean upper lip length of female patients to be (19.62±3.77mm) which was at par with the mean length of upper lip in all the three facial types found in our study. Grewal et al[23] in their study on 30 Indian females found that there was not much difference in length of upper lip in Indo-Aryans (23.07mm) and Caucasians (24mm), the range was

(18.48-28.73) which correlated with the mean values for upper lip length obtained in our study.

Arnett GW and Bergman RT[24] mentioned that an anatomically short upper lip should be recognized as a soft tissue problem and should not be treated by excessively shortening the maxilla; this can lead to a short, round facial outline. In our study the mean distance in the ULL was minimum in the hypodivergent group patients (18.4mm) (Table 8), one can argue that smaller lip length in short face subjects was due to lip closure, which would lead to greater gathering of lip tissue and enhanced thickness. The upper lip thickness was found to be maximum in the hypodivergent group in our study. This correlates with the findings of Blanchette et al,[25] however in their study the lip thickness was less in short face subjects.

Burstone[4] in his study concluded that the approximate average lengths for the upper lip as measured from the lateral headplate are 24 mm for boys and 20 mm for girls (range being 17.0-23.0 mm for girls). It has been suggested that the length of the upper lip tends to be shorter in persons with Class II, Division 1 malocclusion than in those with normal faces or occlusions. For purposes of comparison with the normal sample, a group of Class II, Division 1 patients with full-cusp distocclusions was selected. However, no significant differences in length of the upper lip between the two samples could be found with the use of the "t" test. In his study however, lip length in sagittal malocclusions was considered, but it correlates with our study in which no significant differences were found in the upper lip length between the three facial types in vertical dimension, indicating that lip length does not show a significant difference in various sagittal or vertical malocclusions.

Blanchette et al[25] and Nanda et al[11] in their study found that dolichofacials have longer lips, whereas brachyfacial lips are shorter. The size of dolichofacials lips is greater in the vertical direction in order to compensate for lip seal difficulties, as these individuals are more prone than others to develop lip incompetence. Feres et al[8] also agree with the finding of Blanchette and Nanda. However in our study there was no significant difference in the upper lip length among the three facial types. The mean values for hyperdivergent group was slightly more than that for the hypodivergent group, however the difference was not statistically significant.

Linear distance ULT (ULIn-ULA) among overall, hyperdivergent, hypodivergent and normodivergent patients ranged from 6-18mm. Mean distance ULT among hyperdivergent patients was found to be minimum (8.7±1.5mm), followed by normodivergent patients (9.0±2.1mm) and maximum in hypodivergent patients (10.1±2.7mm). The mean distance of ULT was maximum in the hypodivergent patients was (10.1±2.7mm), this could be due to lip closure in short face individuals, which would lead to greater gathering of lip tissue and enhanced thickness as proposed by Blanchette et al.[25]

Kamak et al[26] in their study found that the thickness at the labrale superius point was significantly increased in Class III compared to Class I and Class II for both males and females ($p < 0.01$). They also found in their study that the thickness at labrale superius among each skeletal type was greatest in Class III for both males and females. In this study sagittal malocclusions were considered, however, in our study the upper lip thickness was found to be maximum in hypodivergent and minimum in hyperdivergent group patients. It is difficult to make a valuable comparison between our findings and those of other authors since a limited number of studies have been published on this subject. The disagreement between our findings and those of others might be due to the racial differences, the age group taken for the study and the sample size. Very few studies have analyzed and compared the soft tissue chin thickness and upper lip length and thickness in various vertical discrepancies, further research in this section can provide insight and lead us to provide a better diagnosis and treatment plans for the orthodontic patients.

Conclusion

In our study, it was concluded that the soft tissue chin thickness is less in hyperdivergent group as compared to the hypodivergent group. This is true for point's pogonion, gnathion and menton. The thickness was least at menton in hyperdivergent group because it apparently adapts to severe hyper divergence, presumably through increased stretching of soft tissue. There was no statistically significant difference in the upper lip length in the hyperdivergent, normodivergent and hypodivergent groups, even though the mean value for lip length was less for hypodivergent groups, one can argue that smaller lip length in short face subjects was due to lip closure, which would lead to greater gathering of lip tissue and enhanced thickness. Greater values for lip thickness were observed for hypodivergent group. The difference in the upper lip thickness was found to be statistically significant among the three facial types.

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