Soft tissue growth changes from 8 to 16 years of age: A cross-sectional study

ABSTRACT

Objective: The present cross-sectional study was conducted to evaluate and compare the soft tissue growth changes between males and females of two groups from 8 to 16 years.

Materials and Methods: One hundred sixty skeletal class I lateral head cephalograms were screened aged between 8 to 16 years-Subjects were divided into two groups. Group I (8 to 12 years) and Group II (12 to 16 years) and further these groups were subdivided into male and female subgroups. Total eight linear and four angular parameters were studied.

Results: All the parameters increased in their dimension while angle of total facial convexity including nose and Nasolabialangle decreases. Among the linear variables, Noseheight, Lip thickness at laberale inferious, Lip thickness at B point, Soft tissue chin thickness and Measurements of lips to E-plane were found significant for both subgroups. While rest of the linear variables like Upper lip height, Lower lip height, Nose depth and Sagittal depth also increased but this increase wasfound non-significant. Among the angular parameters angle of total facial convexity including nose and Nasolabialangle decreases and angle of facial convexity excluding nose, and Nose inclination increases with the age, and these changes were found non-significant.

Conclusion: In this study, we observed that males showed a greater value of all parameters in comparison to females, and with the advancement of age, all the parameters increased, except for angle of total facial convexity and nasolabial angle.

Keywords: 8–16 years age, cephalometric study, cross-sectional study, soft tissue growth changes

INTRODUCTION

An understanding of craniofacial growth and development is essential in orthodontics to attain treatment objectives. Craniofacial growth of the skeleton and soft tissue influences the final configuration of occlusion and overall facial esthetics. The interrelationship of soft tissue components of the face, such as nose, lip, and chin, changes during growth as well as with orthodontic treatment. Thus, it becomes imperative for orthodontists to understand normal growth trends of skeletal tissues as well as soft tissues such as the nose, lip, and chin.

The changes in the soft tissues resulting from growth have been examined by various types of studies such as cross-sectional, semi-longitudinal, and longitudinal studies.

There are so many studies reported in literature by authors such as Subtelny[1] and Posen[2] as they concluded the growth of various soft tissue parameters with age. In their study, they concluded that after the age of 14 years, the nose did not grow forward to the same extent as did the nasal bones and the nose tip became more prominent within the total

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facial profile after 2–3 years of age. The aims and objectives of our study were:
1. To evaluate the soft tissue parameters from 8 to 16 years of age
2. To compare the soft tissue changes from 8 to 16 years of age.

MATERIALS AND METHODS

The present cross-sectional study was conducted on 160 skeletal Class I lateral head cephalograms of growing subjects in the age ranging from 8 to 16 years with the following inclusion criteria:

- Skeletal Class I relationship on the basis of App-Bpp (5 ± 2 mm)
- Age range from 8 to 16 years
- No history of prior orthodontic treatment
- No history of bone deformities, or bone diseases, and major illness in the past
- No congenital abnormalities affecting growth and development.

Subjects were divided into two groups: Group I (8–12 years) and Group II (12–16 years) on the basis of chronological age, and further, these groups were subdivided into male and female subgroups [Table 1].

The lateral head cephalograms were traced on acetate tracing sheets. If the right and left structural outlines were lacking in superimposition on each other, then the average between the two was drawn by inspection and the cephalometric points were located in reference to the arbitrary line so obtained. The linear and angular measurements were made to the nearest 0.5 mm and 0.5°, respectively.

Reference plane

Pterygomaxillary vertical plane

It is drawn from the sphenoethmoid point (se) to the pterygomaxillary point (ptm) Nanda et al.[3] and Meng et al.[4]

Cephalometric landmarks

All the hard and soft tissue landmarks used in this investigation were determined according to the definitions of Nanda et al.,[3] Meng et al.,[4] Downs,[5] Broadbent,[6] Rakosi,[7] Bowker and Meredith,[8] Burstone,[9,10] and Steiner.[11]

Porion (Po), sella (S), sphenoethmoidal point (se), nasion (n), orbitale (Or), pterygomaxillary point (ptm), anterior nasal spine (ans), point A (A), projected labrale superius (Ls'), projected labrale inferius (Li'), point-B (B), projected soft tissue pogonion (Pgs'), projected pogonion (Pg'), soft tissue glabella (Gl'), projected point nasion (n'), pronasale (prn), anterior nasal spine projected to soft tissue (ans'), columella (cm), projected A-point (A'), subnasale (Sn), superior labial sulcus (SLs), labrale superius (Ls), stomion (St), labrale inferius (Li), projected supramentale point (B'), soft tissue pogonion (Pgs), chin tangent point (Ct), projected pronasale (prn'), projected anterior nasal spine (ans').

A total of 12 parameters were used in the study, of which eight were linear and four were angular, and these parameters are tabulated in Table 2 and shown in Figures 1 and 2.

Table 1: Distribution of skeletal Class I subjects into different groups and subgroups

| Total number of subjects (n) | Group I age 8-12 years (n=80) | Group II age 12-16 years (n=80) |
|-----------------------------|-------------------------------|-------------------------------|
|                             | Subgroup I (n) | Subgroup II (n) | Male | Female | Male | Female |
| 160                         | 40              | 40               | 40   | 40     | 40   | 40     |

Figure 1: Linear parameters used in the study
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Statistical analysis

The data obtained were summarized as mean ± standard deviation. The groups were compared by two-way ANOVA and the significance of mean difference within and between the groups was done by Tukey’s post hoc test after ascertaining normality by Shapiro–Wilk test and homogeneity of variances by Levene’s test. A two-tailed

RESULT

Linear measurements

The linear measurements of male and female children of two different age groups are summarized in Table 3.

Among the linear variables, a significant increase from Group I to Group II for male subgroup was observed for upper nose height, lip thickness at labrale inferior, lip thickness at B-point, soft tissue chin thickness, upper lip to E-plane, and lower lip to E-plane, whereas upper nose height, lip thickness at B-point, soft tissue chin thickness, upper lip to E-plane, and lower lip to E-plane for female subgroup were increased significantly. When we compared the values of Group I males to Group I females, the lower nose height, lower lip height, upper lip to E-plane, and lower lip to E-plane were differed significantly while rest of the values did not differ significantly.

PMV: Pterygomaxillary vertical
### Table 3: Linear measurements and angular measurements (mean ± standard deviation) of males and females of two groups

| Linear measurements (mm) | Male (n=40) | Female (n=40) | P |
|--------------------------|-------------|---------------|---|
| 1a. Upper nose height    | Group I: 37.88±4.09 | Group I: 38.43±3.77 | 0.922 |
|                          | Group II: 42.15±4.22 | Group II: 40.68±3.45 | 0.327 |
|                          | P <0.001 | 0.048 | - |
| 1b. Lower nose height    | Group I: 15.08±1.83 | Group I: 13.55±2.89 | 0.014 |
|                          | Group II: 16.03±2.41 | Group II: 14.45±1.72 | 0.010 |
|                          | P 0.238 | 0.284 | - |
| 2. Nose depth            | Group I: 24.93±5.14 | Group I: 24.35±4.31 | 0.914 |
|                          | Group II: 25.93±3.71 | Group II: 25.23±1.89 | 0.855 |
|                          | P 0.685 | 0.751 | - |
| 3. Sagittal depth        | Group I: 45.83±3.55 | Group I: 44.85±3.03 | 0.691 |
|                          | Group II: 47.93±6.01 | Group II: 46.93±2.29 | 0.673 |
|                          | P 0.084 | 0.090 | - |
| 4. Upper lip height      | Group I: 12.38±1.55 | Group I: 11.58±1.55 | 0.128 |
|                          | Group II: 13.15±1.73 | Group II: 12.23±1.72 | 0.056 |
|                          | P 0.149 | 0.286 | - |
| 5. Lower lip height      | Group I: 15.05±1.69 | Group I: 13.55±2.72 | 0.005 |
|                          | Group II: 15.73±2.10 | Group II: 14.30±1.20 | 0.008 |
|                          | P 0.435 | 0.339 | - |
| 6a. Lip thickness at A point | Group I: 13.88±2.05 | Group I: 13.10±1.89 | 0.372 |
|                          | Group II: 15.08±2.27 | Group II: 14.15±2.36 | 0.218 |
|                          | P 0.061 | 0.128 | - |
| 6b. Lip thickness at labrale superius | Group I: 12.08±2.47 | Group I: 11.13±1.49 | 0.126 |
|                          | Group II: 12.70±2.14 | Group II: 11.35±1.46 | 0.010 |
|                          | P 0.473 | 0.955 | - |
| 6c. Lip thickness at labrale inferius | Group I: 13.33±1.93 | Group I: 12.78±1.80 | 0.473 |
|                          | Group II: 14.73±1.55 | Group II: 13.30±1.51 | 0.001 |
|                          | P 0.001 | 0.514 | - |
| 6d. Lip thickness at B point | Group I: 11.38±1.53 | Group I: 10.60±1.48 | 0.122 |
|                          | Group II: 12.53±1.71 | Group II: 11.88±1.56 | 0.250 |
|                          | P 0.006 | 0.002 | - |
| 7. Soft tissue chin thickness | Group I: 10.45±1.89 | Group I: 9.63±1.72 | 0.234 |
|                          | Group II: 11.73±2.16 | Group II: 11.60±2.02 | 0.992 |
|                          | P 0.019 | <0.001 | - |
| 8a. Upper lip to E-plane | Group I: 0.20±2.03 | Group I: −2.00±1.54 | <0.001 |
|                          | Group II: −1.60±2.02 | Group II: −3.10±1.55 | 0.001 |
|                          | P <0.001 | 0.032 | - |
| 8b. Lower lip to E-plane | Group I: 1.43±1.62 | Group I: −0.19±1.70 | 0.001 |
|                          | Group II: 0.23±2.22 | Group II: −1.85±1.92 | <0.001 |
|                          | P 0.022 | <0.001 | - |

### Angular measurements (°)

| Angular measurements (°) | Male (n=40) | Female (n=40) | P |
|--------------------------|-------------|---------------|---|
| 1. Angle of total facial convexity including nose | Group I: 142.23±3.89 | Group I: 141.98±4.31 | 0.991 |
|                          | Group II: 140.38±3.37 | Group II: 141.38±3.26 | 0.627 |
|                          | P 0.118 | 0.889 | - |
| 2. Angle of facial convexity excluding nose | Group I: 164.43±4.45 | Group I: 164.65±5.02 | 0.997 |
|                          | Group II: 165.98±3.81 | Group II: 166.13±5.84 | 0.999 |
|                          | P 0.479 | 0.523 | - |
| 3a. Upper nose inclination | Group I: 32.00±4.77 | Group I: 31.73±5.45 | 0.993 |
|                          | Group II: 31.90±4.87 | Group II: 32.98±2.96 | 0.724 |
|                          | P 1.000 | 0.618 | - |
| 3b. Lower nose inclination | Group I: 35.15±5.56 | Group I: 36.18±7.45 | 0.873 |
|                          | Group II: 35.98±4.98 | Group II: 37.28±5.88 | 0.771 |
|                          | P 0.929 | 0.848 | - |
| 4. Nasolabial angle | Group I: 104.25±6.02 | Group I: 103.93±6.78 | 0.992 |
|                          | Group II: 101.90±4.67 | Group II: 101.05±1.96 | 0.884 |
|                          | P 0.179 | 0.084 | - |
Angular measurements
The angular measurements of male and female children of two different age groups are summarized in Table 3.

Among all the angular variables, angle of total facial convexity including nose, angle of facial convexity excluding nose, upper nose inclination, lower nose inclination, and nasolabial angle change on transition from Group I to Group II, but these changes were nonsignificant.

DISCUSSION
In the present study, we used pterygomaxillary vertical (PMV) plane as the reference plane. Investigators such as Burstone, Subtelny, Sarnas, and Vig and Cohen had used palatal plane as a reference plane to orient vertical and sagittal measurements of the tissues while the authors such as Brodie, Ricketts, and Mamandras noted that although the palatal plane has been shown to be fairly stable, its angulation may vary and the position of the plane may be altered by orthodontic treatment.

To study the changes in soft tissue profile, we need a stable and reproducible plane and both the pterygomaxillary (ptm) and sphenoethmoidal (se) points were regarded to be relatively stable during growth. Enlow noted that PMV plane is approximately perpendicular to the line of vision and is consistent with anatomically neutral position of the head.

While large fluctuations in size of soft tissue measurements were to be anticipated and any change in posture and movement in the facial musculature, can affect the length and thickness of soft tissues particularly at the lips and chin. These findings, however provide consistency even with fairly large variance at each age and orientation of these measurements either with vertical plane parallel to PMV plane or along a plane perpendicular to PMV plane provide stability.

For these reasons, PMV plane was used in the present study because the use of this PMV plane also negates many of the adverse factors of stability and reproducibility associated with other skeletal and soft tissue planes.

Nose height
The nose height was mainly divided into upper and lower nose height. We found that the nose height increased with age and the increment of upper nose height was found to be greater in males in comparison to females, and as we compared these increments from Group I to Group II, it was found significant for both male and female subgroups.

Lower nose height also increased with age and this increase was found to be more for female subgroup. This would be due to growth of the nasal bone as well as the overlying soft tissue, and as the age advances, the nasal growth changes in both size and form after the age of 13 years and the boys showed larger nasal bone component than females.

These findings were supported by Subtelny, Posen, Bishara et al., and Genecov et al.

Nose depth
Mean value of nose depth was nearly similar in males and females of Group I, and with age, it increases in both subgroups of Group II, while this increment was found nonsignificant.

Sagittal depth
Sagittal depth was found greater in males when compared to females of Group I. With the advancement of age, increase in sagittal depth was noted. This is due to growth of the nasal bone as well as the overlying soft tissue in the vertical as well as in the anteroposterior direction; there was no sexual dimorphism observed for sagittal depth and nose depth. The study was supported by Meng et al., Nanda et al., and Genecov et al.

Lip height
Our study revealed that the upper lip height as well as lower lip height was found to be greater in Group I males, and with the transition from Group I to Group II, both upper and lower lip height increases in both the sexes.

According to Nanda et al., lip length and thickness were important elements of facial profile. Lip position is affected by the placement and inclination of the maxillary and mandibular incisors and hence is responsive to orthodontic treatment.

Thickness of lip
Along with the lip length, the thickness of the lips adds another dimension to study the lip growth. In this study, we measured the upper and lower lip thickness at four different locations because variability in thickness of upper and lower lips can affect degree of facial convexity, and due to this variability of lip thickness at various points along the facial profiles, the upper and lower lip thickness were derived at four different locations. Hence, in the present study, lip thickness is measured at four different positions:

a. Upper lip thickness at A-point
b. Upper lip thickness at labrale superius
c. Lower lip thickness at labrale inferius
d. Lower lip thickness at B-point.
On evaluation, mean value for these parameters was higher in males as compared to females and lip thickness increased in both subgroups with age. We also found that this increase was greater at point A and point B than vermilion borders.

These changes can lead to thicker and longer lips for males. These findings were supported by Nanda et al.\(^\text{[3]}\).

**Soft tissue chin thickness**
The soft tissue chin thickness increased from Group I to Group II, soft tissue chin thickness was higher in male as compared to female. This growth increment was found to be significant in both the males and females subgroups. The possible reason for this finding would be the growth changes that occur in hard tissue chin as well as the increase in the thickness soft tissue covering. This finding was supported by Subtelny\(^\text{[1]}\), Nanda et al.\(^\text{[3]}\) and Genecov et al.\(^\text{[19]}\).

**Measurements of lips to esthetic plane**
The upper and lower lips were posterior to esthetic plane, the distances were expressed with a negative sign and when in an anterior position with a positive sign. In our study, we had measured the distance for both the upper and lower lip to the E-plane. On observing these values, we saw that both the upper and lower lips were placed forward to the esthetic plane, except for Group II male for upper lip, while in females, these were placed behind the esthetic plane in all the groups. When we compared the values between males and females of Group I and Group II, we found that both the upper and lower lip distances for Group II were found to be significant.

However, when we observed males and females of both groups, it was found that in both groups, the position of lips become more retruded with the advancement of age. While on comparison, we found that backward positioning of upper and lower lip was seemed significant for both the subgroups. Our findings were also supported by Nanda et al.\(^\text{[3]}\) who stated that the means for upper and lower lips relative to esthetic plane show an increased retraction of lip and these changes can be accounted by increase in nasal depth and height accompanied by anteroposterior growth of the chin.

**Angular parameters**

**Angle of total facial convexity including the nose**
The mean value was higher in males related to females in Group I, and as the age advances, there is decrease in angle of total facial convexity including nose was observed for both male and female subgroups. This decrease was higher in males with age.

The angle of total facial convexity including the nose decreases with age because the tip of nose grows downward and forward with age and the growth at chin was not much when compared to growth at chin.

**Angle of facial convexity excluding the nose**
The mean values were nearly similar in both the males and females of Group I and Group II, and as the age progresses, value of angle of facial convexity excluding the nose increases, but this increment was found nonsignificant.

**Nose inclination**
The inclination of nose is divided into upper and lower nose inclination. The upper nose inclination was found nearly similar when comparison was made between male and female of Group I and Group II, and when compared between Group I and Group II, the upper nose inclination does not change in male group, but in female group, the increase in this value was noted. While lower nose inclination increased with age, this increase did not seem significant.

The angle of the dorsum of the nose to PMV plane depends on the sagittal growth of nose. These findings were supported by Meng et al.\(^\text{[4]}\) who noted that the increments in nose inclination are essentially complete in girls by 16 years of age while continuing to increase in males up to and beyond 18 years.

**Nasolabial angle**
In nasolabial angle, no significant difference was found on comparing the males and females of Group I and Group II, and as the age advances, the decrease in the nasolabial angle is observed when comparing male and female of Group I and Group II. These findings were also supported by Meng et al.\(^\text{[4]}\) and Nanda et al.\(^\text{[3]}\) who in their study found that the females have greater value of nasolabial angle at 7 years of age and there is decrease in the nasolabial angle was observed.

We evaluated and compared soft tissue growth changes at different age groups in males and females, most of the soft tissue growth changes at the nose, lips, and chin suggest sexual dimorphism. Most of the measurements in terms of growth percentage had attained their adult size by the age of 15 years, while boys continue to grow beyond 15 years, the period of study covered only 8–16 years, so most of the soft tissue measurements in males could not be predicted. In addition, data included only subjects with Class I skeletal relationship on the basis of App-Bpp for homogenous subjects; therefore, further research can be done to determine growth changes in soft tissue in different skeletal pattern.
CONCLUSION

1. Males showed a larger value of all the parameters in relation to females and all the parameters increased in their dimension with growth, except for angle of total facial convexity including the nose and nasolabial angle which decreased in their measurement.

2. We also observed that the growth changes from Group I to Group II for both subgroups were found to be greater for males than for females in respect to all parameters.

3. The upper and lower lips became significantly more retruded in relation to Ricketts esthetic plane with age.

4. It is important for clinicians to be aware of these changes when planning the orthodontic treatment of still-growing adolescent patients because the changes might influence the extraction/nonextraction decision.

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Conflicts of interest
There are no conflicts of interest.

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