Soft tissue profile changes in late adolescent males

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Traditionally, it has been assumed that facial contours are primarily the result of underlying hard tissue positioning and the subsequent soft tissue drape.[1-4] Today, however, numerous studies are available that illustrate the fact that soft tissues vary considerably in thickness and undergo changes that are regionally independent of hard tissue growth.[5-16] Comprehensive evaluation of a patient's malocclusion and facial balance would be incomplete without inclusion of the soft tissue component and the subsequent changes imparted by growth or by orthodontic treatment. Since recent studies[17,18] have demonstrated significant skeletal facial growth in adolescent patients, changes to the soft tissues during the same period would seem to warrant further investigation.

Prior to the late 1950s, cephalometric studies of craniofacial growth emphasized hard tissue development.[19,20] Ricketts[21] and Burstone[5] suggested that treatment planning be based on hard and soft tissue development, but neither study took nasal changes or their effects on the overall soft tissue profile into account. Burstone recognized that "analysis of both dental and skeletal patterns alone may prove inadequate or misleading, for marked variation exists in the soft tissue covering the dentoskeletal framework."[5] Neger[22] noted that anthropologists had

Abstract

The purpose of this study was to document soft tissue profile changes in late adolescent skeletal Class I males from 14 to 20 years of age and to compare these changes with those of the underlying hard tissues. Using serial lateral cephalograms from a sample of 33 untreated Class I adolescent males, 26 soft and hard tissue parameters were assessed at ages 14 to16, 16 to 18, and 18 to 20 years. The concept that differential facial growth occurs from nasion to pogonion was substantiated by these data. The hard tissue chin moved forward more than A-point, which in turn moved forward more than nasion, resulting in the hard and soft tissue profile being flattened or reduced in convexity. Horizontal soft tissue thickening of 1.0 mm overlying the hard tissue surfaces from midface to chin was observed at 14-16 years. Continued change of the soft tissue profile from 16 to 20 was thus the result of underlying skeletal growth. Nasal tip increased significantly over all age periods, and underwent the largest growth change of all measurements assessed (approximately 8.0 mm). This growth increase declined by approximately one-half over each successive age period. Although variable, continued soft tissue movements throughout the 14- to 20-year age period affect treatment planning, maintenance of the posttreatment profile, and posttreatment occlusal retention requirements.

Key Words

Facial growth • Late adolescence • Class I • Males

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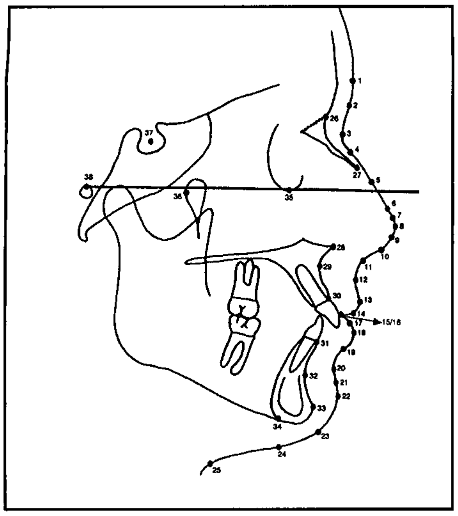

Figure 1

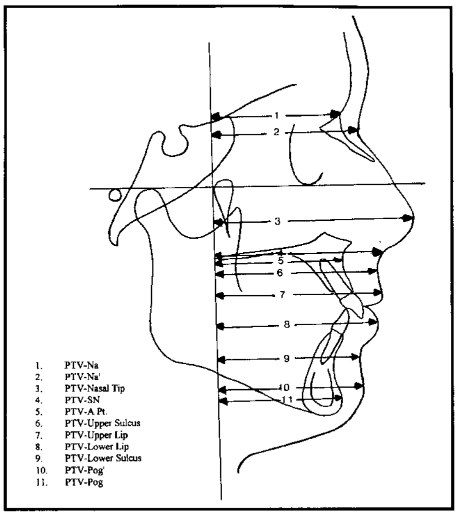

Figure 2

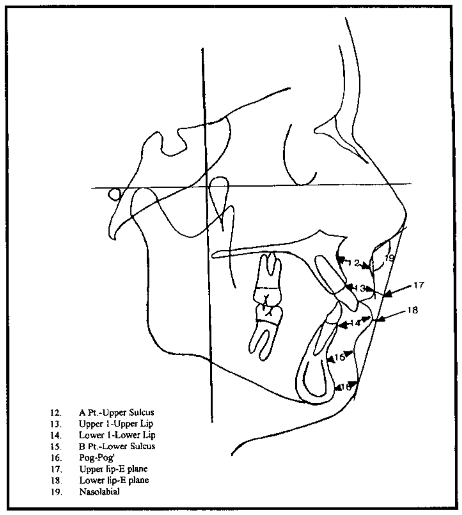

Figure 3

Figure 1
Cephalometric landmarks digitized.

Figure 2
Horizontal cephalometric measurements from PTV.

Figure 3
Horizontal and angular cephalometric measurements.

previously documented a lack of uniformity of the soft tissue covering and concluded that one cannot depend on dentoskeletal analysis for accurate information on soft tissues.

One of the first longitudinal cephalometric studies to include the soft tissue was by Subtelny,[6] who found that despite the straightening of the skeletal profile with age, the soft tissue profile remained relatively convex. He observed that soft tissue contours diverge from those of the underlying skeletal framework in certain areas, and suggested that a disproportionate rate of growth of the nose aided in the increase of soft tissue convexity with age. The alteration of nose and chin position results in the apparent recession of the lips within the facial profile with time.[6]

Altemus,[23] using Burstone's methodology,[5] compared the soft tissue profiles of North American Caucasian and African American children. His data supported the conclusion, reached by others,[5,6,21] that the soft tissue profile does not depend wholly on the underlying skeletal foundation. Merrifield[7] analyzed a cross-sectional sample of 120 patients and concluded that the proportions of the lower face can be defined within a narrow range. Peck and Peck[24] also attempted to establish some population norms for a variety of soft tissue parameters. Establishing population mean values for soft tissue parameters may thus necessitate control of sample age, sex, racial background, and require a larger sample size.

Selected areas of the soft tissue profile have been analyzed independently. Posen[25] described a downward and anterior growth of the nose. There was no indication that nasal changes were complete in either sex by 18 years. Chaconas[26] also assessed nasal changes with growth and recorded linear and angular changes of hard and soft tissue parameters, finding similar directional growth to that described by Posen, but also noting a differentiation in nasal the profile between skeletal patterns. Genecov et al.[14] found sex differences both in the amount and the timing of facial growth. Blanchette et al.[13] suggested that the skeletal extremes of long and short vertical face height subjects are compensated by the soft tissue.

Vig and Cohen[27] and Mamandras[28] discuss an important problem associated with soft tissue studies: the ability of voluntary and involuntary muscle activity to affect the contours being studied. One must be cautious of comparisons between different soft tissue studies because some include nasal changes while others do not. As profile convexity is largely affected by nasal changes, those studies that exclude nasal changes[5,23,27,28] should be considered separately from those that include them.[6-9,12-16] Studies that include nasal changes seem to report increasing soft tissue convexity with age, while those that don't include nasal changes report a relative flattening.

Sample selection and reference planes have proven to be important in soft tissue studies. Chaconas[26] suggested that serial studies must take into account the facial pattern of the sample, for if all facial patterns do not behave equally, pooled growth assessment would mask potential underlying trends. In other studies, the use of semilongitudinal data, mixed sex of sample, racial composition, or different reference planes for serial comparisons has very likely influenced the conclusions drawn. Various opinions[12-16] exist as to which reference planes—soft or hard tissue, internal

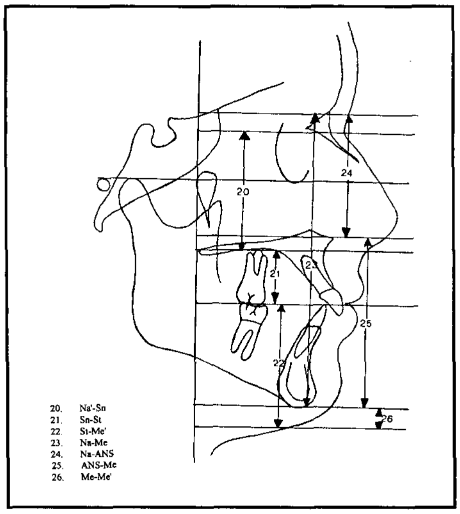

Figure 4

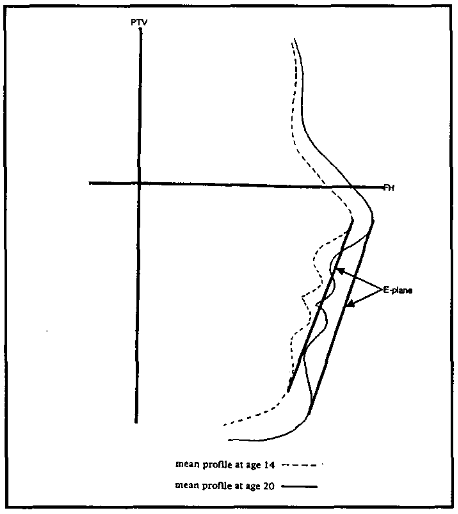

Figure 5

Figure 4
Vertical cephalometric measurements.

Figure 5
Soft tissue profile changes relative to E-line between ages 14 to 20 years.

or external—are more meaningful for serial cephalometric studies. Several researchers[15,29] have proposed the use of natural head position and extracranial reference planes, such as "true vertical" and "true horizontal." Riolo and TenHave,[30] Nanda et al.,[12] and Blanchette et al.[13] used the vertical reference plane from sphenoethmoidal point and pterygomaxillary point, which was derived from the work by Enlow, Kuroda, and Lewis.[31] Perhaps reference planes should thus be chosen on the basis of their reproducibility between serial cephalograms and their relevance for study of serial cephalometric changes of the soft tissue.

Because orthodontists may alter the lip position by dental movements during orthodontic treatment, it would be advantageous to have an idea of what potential soft tissue changes could occur to the nose and chin, both during and after treatment and when growth is complete. Soft tissue growth in young adults may negatively impact treatment. The purpose of this study was to document serial soft tissue growth changes of late adolescent skeletal Class I males from age 14 to 20 years. These changes were compared with underlying hard tissue changes.

Materials and methods

Sample

Longitudinal lateral cephalograms of 33 males were drawn from the Burlington Growth Centre sample. All subjects were Caucasian and met the following selection criteria: no prior orthodontic treatment; Class I or end-to-end molar dental relationship; Class I skeletal relationship, ANB $< 4.5°$; relaxed lip contact with teeth in occlusion.

The cephalometric data were obtained from lateral cephalograms of each subject taken 2 years apart at ages 14, 16, 18, and 20 years; however, only 19 cephalograms were available at age 18.

Method

Tracings of the lateral cephalograms were digitized using a software program[1] purported to be accurate to 0.1 mm and 0.1 degrees. Thirty-eight hard and soft tissue cephalometric landmarks (Figure 1) were used for the angular and linear measurements as described by Burstone;[5] Nanda et al.;[12] Genecov, Sinclair, and Dechow;[14] and Riolo et al.[32]

The reference planes used in this study were chosen on the basis of their reproducibility between serial cephalograms, their relevance for study of serial cephalometric changes of the soft tissue,[21,30] and for comparison with the recent literature.[12-14] Frankfort horizontal reference plane through the posterior border[21] of the pterygomaxillary fissure was used as the vertical reference plane. Successive serial tracings were superimposed on the preceding cranial landmarks to ensure consistency of the Frankfort reference landmarks.

The horizontal and vertical measurements depicted were calculated using linear distances either parallel or perpendicular to Frankfort horizontal (Figures 2 and 4). Measurements shown in Figure 3 were made using both linear and angular dimensions. The method for determining the differences in soft tissue profile as a result of growth involved comparison of the cephalometric measures during the four age periods: 14 to 16 years, 16 to 18, 18 to 20, and 14 to 20. Both quantitative and directional growth tendencies were studied.

Means and standard deviations were determined for each horizontal, vertical and angu-

Table 1
Mean and standard deviations of horizontal (1-18), angular (19) and vertical (20-26) cephalometric measurements by age group

	Age 14 n=33		Age 16 n=33		Age 18 n=19		Age 20 n=33	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Horizontal measurement								
1 PTV–Na'	64.11	2.89	66.52	3.17	68.23	3.38	68.34	2.95
2 PTV–Na	56.01	2.55	58.08	3.10	59.73	2.95	59.54	3.05
3 PTV–nasal tip	88.02	3.31	92.53	3.28	95.22	3.60	95.98	3.54
4 PTV–Sn	74.50	3.71	77.98	3.79	79.99	3.75	80.38	3.95
5 PTV–A-pt	56.45	3.03	58.37	3.12	60.33	3.25	60.28	3.35
6 PTV–upper sulcus	72.87	3.55	75.96	3.84	77.89	3.85	77.81	4.09
7 PTV–upper lip	75.99	3.97	79.16	4.40	81.16	4.49	81.08	4.94
8 PTV–lower lip	72.51	4.25	75.69	4.43	77.48	4.91	78.13	5.49
9 PTV–lower sulcus	62.87	4.19	65.59	4.78	67.56	4.77	68.56	5.74
10 PTV–Pog'	64.05	4.73	67.69	5.38	69.58	5.34	71.02	6.09
11 PTV–Pog	51.45	4.45	54.08	5.17	55.98	5.38	57.51	5.95
12 A-pt–upper sulcus	17.16	2.26	18.48	1.89	18.50	1.95	18.38	2.02
13 Upper 1–upper lip	16.98	1.69	18.12	2.11	18.35	1.91	18.38	2.25
14 Lower 1–lower lip	18.14	2.07	18.93	1.67	18.31	1.94	18.87	1.62
15 B-point–lower sulcus	13.13	1.88	13.61	2.15	13.48	2.02	13.49	1.65
16 Pog–Pog'	13.56	2.22	14.41	2.88	14.21	2.32	14.21	2.19
17 Upper lip–E-line	-1.46	2.33	-2.19	2.36	-2.97	3.00	-3.75	2.59
18 Lower lip–E-line	0.56	2.88	-0.24	2.80	-0.84	3.00	-1.54	3.14
Angular measurement								
19 Nasolabial	113.97	9.16	113.92	10.16	112.83	8.85	112.82	10.11
Vertical measurement								
20 Na'-Sn	54.22	3.24	57.00	3.66	58.28	4.16	57.95	3.48
21 Sn-St	22.60	3.02	23.34	2.80	24.13	3.26	23.88	3.37
22 St-Me'	48.59	4.49	51.05	4.46	52.85	3.88	52.92	4.07
23 Na-Me	119.65	6.05	124.40	6.29	127.53	6.81	127.96	6.67
24 Na-ANS	54.67	2.69	56.49	2.78	57.40	3.61	57.90	3.24
25 ANS-Me	64.98	5.26	67.92	5.42	70.13	5.73	70.06	5.59
26 Me-Me'	9.05	2.16	9.53	2.46	10.22	1.98	9.84	1.88

(all values in mm or degrees)

lar measurement at each age. In addition, paired *t*-tests were performed for the differences in the means of the measurements for the age ranges: 14 to 16 years, 16 to 18, 18 to 20, and 14 to 20.

Measurement error

The standard error of measurement was determined for all 26 parameters by comparing 15 random duplicate tracings with the original tracings. Standard error was then derived according to the following formula:

$$S.E. = \sqrt{d^2/2n}$$

The standard error of all cephalometric measures was, as expected, larger for the soft tissues than the hard tissues. Hard tissue standard error averaged 0.5 mm or 0.5 degrees. Standard error did not, however, exceed 2.3 degrees or 1.5 mm for soft tissue parameters.

Results

Mean values and standard deviations for horizontal, vertical, and angular measures at each age are presented in Table 1. Differential increases of various hard and soft tissue parameters were observed. Over the age period 14 to 16, horizontal growth of pogonion, A-point, and nasion were similar, which contrasts with the same observation over the 18 to 20 year period. During the latter period, growth of pogonion was over twice that of A-point, which in turn was over twice that of nasion measures[1,2,5,6,10,11] (Table 2).

Table 2 shows that the horizontal soft tissue contour thickness in the lower face, horizontal nasal tip (measure 3) movement, was quantitatively the largest noted, with a mean increase between 14 and 20 years of about 8 mm. The largest increase of 4.5 mm was observed in the age period 14 to 16, which diminished by about 50% over each successive age period.

Upper lip position increased in the horizontal direction over the age period 14 to 16 year and 16 to 18, but not over the 18-to-20-year pe-

Table 2
Mean changes (mm), standard deviations (SD), and p-values of horizontal (1-18), angular (19), and vertical (20-26) cephalometric changes by age period

	14 to 16 years n=33			16 to 18 years n=19			18 to 20 years n=19			14 to 20 years n=33		
	mn	SD	p	mn	SD	p	mn	SD	p	mn	SD	p
Horizontal measurement												
1 PTV–Na'	2.41	1.80	*	0.92	1.29	†	0.37	1.15	NS	4.23	2.42	*
2 PTV–Na	2.07	1.84	*	0.85	1.85	§	0.26	1.13	NS	3.53	2.01	*
3 PTV–nasal tip	4.51	2.47	*	2.22	1.84	*	1.11	1.40	†	7.96	3.78	*
4 PTV–Sn	3.48	2.59	*	1.26	2.46	§	1.22	1.18	‡	5.88	3.42	*
5 PTV–A-point	1.92	1.66	*	0.90	1.56	§	0.89	1.06	‡	3.82	1.90	*
6 PTV–upper sulcus	3.09	2.45	*	1.05	2.43	§	0.66	1.70	NS	4.94	3.28	*
7 PTV–upper lip	3.17	2.78	*	1.34	2.75	§	0.49	1.97	NS	5.08	3.67	*
8 PTV–lower lip	3.18	3.03	*	1.12	2.64	§	1.44	2.37	†	5.62	3.80	*
9 PTV–lower sulcus	2.72	3.08	*	1.30	2.75	§	1.97	2.64	†	5.69	3.86	*
10 PTV–Pog'	3.65	4.22	*	1.54	3.46	§	2.06	3.00	†	6.98	4.97	
11 PTV–Pog	2.63	3.40	*	1.73	3.12	§	2.04	2.95	†	6.06	3.95	*
12 A-point–upper sulcus	1.32	2.34	†	0.10	2.02	NS	-0.33	1.81	NS	1.22	2.63	†
13 Upper 1–upper lip	1.14	1.56	‡	0.63	1.84	NS	-0.36	1.79	NS	1.39	2.26	‡
14 Lower 1–lower lip	0.78	1.72	†	-0.12	1.99	NS	0.17	2.04	NS	0.73	1.95	§
15 B-point–lower sulcus	0.48	1.60	§	-0.41	1.06	NS	0.21	1.20	NS	0.37	1.57	NS
16 Pog–Pog'	0.85	2.14	§	-0.39	1.22	NS	0.24	1.37	NS	0.65	1.65	§
17 Upper lip–E-line	-0.73	1.31	†	-0.74	2.23	NS	-0.79	2.22	NS	-2.29	1.86	*
18 Lower lip–E-line	-0.80	1.59	†	-0.81	1.68	§	-0.45	1.90	NS	-2.11	2.08	*
Angular measurement												
19 Nasolabial	-0.39	1.05	§	-0.31	1.04	NS	-0.32	0.91	NS	-0.86	1.56	†
Vertical measurement												
20 Na'–Sn	2.78	2.61	*	1.28	2.79	§	-0.41	2.07	NS	3.73	3.21	*
21 Sn–St	0.74	1.58	†	0.51	1.57	NS	0.27	1.35	NS	1.28	2.03	‡
22 St–Me'	2.45	2.52	*	0.78	3.01	NS	1.04	2.41	§	4.32	2.57	*
23 Na–Me	4.75	3.36	*	2.80	3.81	†	1.36	1.38	‡	8.31	3.75	*
24 Na–ANS	1.82	1.77	*	1.09	2.11	§	0.66	1.71	NS	3.23	1.89	*
25 ANS–Me	2.93	2.27	*	1.71	2.70	†	0.71	1.41	§	5.08	2.61	*
26 Me–Me'	0.48	1.39	§	-0.18	2.00	NS	0.22	2.25	NS	0.79	2.39	§

(mean values in mm & degrees) * $p < 0.0001$ ‡ $p < 0.001$ † $p < 0.01$ § $p < 0.05$ NS nonsignificant

riod (measure 7, Table 2). Lower lip position increased throughout all age periods by a significant amount horizontally (measure 8, Table 2). Horizontal soft tissue chin change or movement (measure 10, Table 2) was second in amount only to nasal tip movement. Significant increases in the soft tissue chin position were observed over all age periods and amounted to about 7 mm over the 14-to-20-year period.

A-point to pogonion (measures 12 to 16) thickened significantly (by about 1 mm) over the age period 14 to 16. No further significant soft tissue thickening was observed over the age ranges 16 to 18 or 18 to 20. There was little difference in the magnitude of the increase regionally over the area between A-point and pogonion. The only exception was the horizontal parameter from B-point to lower sulcus, which did not increase from age 14 to 20. Variability of the mean changes (SD) was observed for all horizontal measures (Table 2), which often met or exceeded the mean differences observed.

Lip movements relative to the E-line indicate significant movement of the upper and lower lips away from E-line over the entire age period of 14 to 20 years. The movement took place primarily in the age period 14 to 16 years. The soft tissue angular measure, nasolabial angle, had large errors of measurement and yielded nonsignificant findings.

The data on vertical soft tissue measures found in Table 2 (measures 20-26) indicate that significant skeletal growth in a vertical direction occurred in both upper and lower facial height up to age 18 years. From age 18 to 20, however, upper vertical facial height did not change, and the continued increase in total face height was a function of continued lower facial height increases only. No change was observed in soft tissue thickness over menton beyond age 16. As with the horizontal measure-

Table 3
Number of subjects outside the mean change ± 1 standard deviation per age period

Measure	14 to 16 years n = 33 >1 SD	14 to 16 years n = 33 <1 SD	16 to 18 years n = 19 >1 SD	16 to 18 years n = 19 <1 SD	18 to 20 years n = 19 >1 SD	18 to 20 years n = 19 <1 SD	14 to 20 years n = 33 >1 SD	14 to 20 years n = 33 <1 SD
Nasal tip	5	6	2	2	3	3	5	5
A-point	5	4	3	3	5	4	4	5
Pogonion	7	4	4	3	4	3	5	5

ments, the variability of the changes often met or exceeded the actual mean change observed.

As evident in Table 2, the variability of the mean increases in standard deviation approached or exceeded the actual mean change over all age periods. Although the mean changes over the age period within the sample may have been significant, the variability of the change between the individuals was relatively large. Table 3 displays the extent of variability noted for selected horizontal measurements and shows the number from each age period who were either one standard deviation above or below the mean change.

Discussion

The interrelationship of soft tissue components, such as nose, lips, and chin, will be influenced by both growth and orthodontic treatment. Therefore, it is important that the orthodontist be conscious not only of changes imparted by treatment, but also those changes brought about by late adolescent and postpubertal growth. The complex interplay between hard and soft tissue structures of the face continues past the termination of pubertal growth, and although varying in magnitude, the changes brought about during this period are of clinical importance. Recognition and possible prediction of these typical changes may aid our handling of the posttreatment alterations that typically occur over the 14-to-20-year age period.

Soft tissue profile change is a result of both underlying skeletal growth and overlying soft tissue thickening. The data of Table 2 show that the underlying hard tissue of the chin advances more than the hard tissue maxilla, which in turn advances farther than hard tissue nasion. This differential growth pattern of hard tissue progression from nasion to pogonion results in a relative flattening or reduction in convexity of the facial profile with time, as shown by Lande[33] and Coben.[34] During the 16-to-18-year period, and especially during the 18-to-20-year period, a distinct pattern is seen whereby growth at pogonion is over twice that seen at A-point, which in turn is over twice that seen at nasion. These data support the concept of a differential growth pattern of the hard tissue, and would seem to indicate that the pattern is more striking with increasing age, as the differences are more notable between 18 and 20 years than between 14 and 16 years. Figure 5 is a representation of the average soft tissue profile changes between age 14 and 20, relative to a constructed E-line. This illustrates the flattening of the facial profile with age, exclusive of nasal tip growth, and the overall recession of the lip position relative to E-line (Table 2). Nasal tip growth itself may be quite striking during the 14-to-20-year period and results in a differential change in the soft tissue profile.

The overlying soft tissue appears to follow a somewhat different pattern. The soft tissue lips and chin overlying the hard tissue surfaces from ANS to pogonion were observed to thicken significantly from 14 to 16 years (Table 2, measures 12 to 16). Further thickening of the soft tissues over age periods 16 to 18 years and 18 to 20 was not observed for the sample of males studied. Other soft tissue studies[12-14] have shown increasing soft tissue contour thicknesses during age periods that include 10 to 16 years of age. A lack of significant increase over the entire age period for B-point to lower sulcus is not characteristic of the remaining data, and the lack of significant movement may be peculiar to this sample.

In males from 14 to 20 years, nasal tip may, on average, be expected to display 8 mm of forward growth, although quantitatively the increase decreases with age by about 50% over each period. However, the quantitative drop with age of nasal tip growth does not negate the importance of this change. In the current study, continued nasal tip growth may be seen to age 20, and may surpass 1 mm over the 18-to-20-year period, which is important for treatment planning and management of any potential soft tissue alterations secondary to orthodontic treatment. Thus, cases exhibiting nose and chin prominence at the treatment planning stage may warrant different consideration. By leaving the lip profile intentionally full, one may be able to minimize growth changes that might alter the profile with age. Excessive nasal projection may give the impression of retraction in the midfacial contour, due to the differential growth of these soft tissue components, as found by Posen[25] and Chaconas.[26] Blanchette et al.[12] showed that the lower lip as measured to E-line became more retrusive from 7 to 17 years, which is in agreement with the findings of this study.

Vertical soft tissue changes (Table 2) were less accurate than hard tissue and horizontal measures. Skeletal upper, lower, and total facial height values did show significant changes up to age 18. During the 18-to-20-year period, upper face height remained the same and total changes were a result of increases only in lower face height.

When noting the variability in the mean increase between patient samples (Tables 2 and 3, SD), the use of mean values for individual clinical comparisons will not always be accurate. For example, during the 14-to-16-year period, nasal tip moved forward less than 2.0 mm in six subjects and more than 7.0 mm in five subjects. The clinical problem is not that 33% of the sample has less than 2.0 mm or more than 7.0 mm nasal growth, but rather that one has no idea in advance which patients will fall into these "exceptional" categories. Similar comparisons may be made for the other measures at various age periods, which is one of the few disadvantages of using longitudinal data, and is referred to by Moyers as an "averaging" problem: "The changes in average size of a group of individuals do not adequately indicate the sequence of events that is followed by any single individual."[35] From a clinical perspective, these data indicate new findings relative to serial soft tissue changes and validate existing concepts of craniofacial growth and development. They cannot, however, be used as a clinical yardstick by which to judge individuals.

Several significant trends were observed from analysis of these serial data. Overall, skeletal changes were significant throughout all age periods, especially in the horizontal and vertical planes, which concurs with several studies done on postpubertal hard tissue growth.[17,18] Any latent skeletal growth is of concern clinically, as most orthodontically treated cases are either finishing active treatment, in retention, or in postretention by the end of the 14-to-20-year period. Significant skeletal growth following treatment and its effects on soft tissue profile changes that are the visual result seen by the patient and others are of critical importance from an esthetic point of view.

Treatment planning decisions may be influenced by the knowledge that soft tissue contour thicknesses will be established by about age 16, but significant soft tissue projection may still be expected on the basis of continued skeletal growth. Treatment modalities involving extraction and/or surgery should be influenced by the fact that there will be a differential change in the soft tissue topography, with the nose and chin areas exhibiting more growth relative to the midface and nasal regions. The net perceptual effect of the midface flattening or receding within the facial complex is created by the differential soft tissue movements rather than the perceived result of orthodontic manipulations. It would appear that soft tissue profile changes are caused by both skeletal movement and soft tissue thickening. As nose and chin growth are expected to exceed lip growth, allowances at the treatment planning stage for this differential tendency may minimize any untoward growth effects on the soft tissue profile.

Conclusions

1. Soft tissue profile change is a result of varying degrees of skeletal growth and soft tissue thickening.
2. As soft tissue contours between ANS and pogonion are established by age 16, continued projection of the soft tissue profile in a horizontal and vertical direction from age 16 to 20 is a result of underlying skeletal growth, not increased soft tissue thickness.
3. Nasal tip soft tissue growth is quantitatively the largest parameter noted over the entire age period.
4. Variability of the mean increases may approach or exceed the actual mean change over all age periods, making clinical comparisons on an individual basis difficult.
5. Continued skeletal and soft tissue movements throughout the 14-to-20-year age period may have significant clinical impact on maintenance of the posttreatment profile and posttreatment occlusal retention requirements.

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