Integumental Contour And Extension Patterns

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Superimposed upon a dentoskeletal framework lies a variable soft tissue mass comprising epithelium, connective tissue, and muscle. Variation in this soft tissue veneer can be an important factor in case analysis, as it influences: (1) facial form and esthetics, (2) muscle balance of the orbicularis oris complex and hence, the stability of the anterior dental segment.

In considering soft tissue, a number of approaches are possible. Methods of measuring superficial facial contour and the establishment of standards based on these methods can be presented.[1,2] Similarly dentoskeletal standards can be established from samples selected by esthetic criteria.[3] This investigation is concerned with two problems: (1) direct measurement of the soft tissue mass and, (2) differences in integumental contour and extension with respect to sex and maturation.

ACCEPTABLE FACE SAMPLES

Two samples, which possessed good or excellent facial profiles, were selected from a group of photographs by a panel of artists.* The only criteria for selection were age, race (Caucasian), and facial form. The younger age sample represented an adolescent group with a mean age of 14.7 years and a range from 13.4 to 15.6. This includes an age range at which orthodontic treatment is terminated in many instances. The second sample, a young adult group, possessed a mean age of 23.8 with a range from 16.5 to 36.3. In terms of orthodontic treatment, this sample reflects the post-retention period. The broad age range of the young adult sample might be criticized, but this criticism could be partly tempered by the knowledge that growth changes are not as marked in this group as they would be in a younger age.

The number in each sample and its distribution by sex is given in Table I.

TABLE I

Adolescent		*Young Adult*	
Male	11	Male	15
Female	26	Female	25
Total	37	Total	40

The reliability of artists choosing a sample of this type might be questioned. Perhaps, their esthetic criteria do not represent the criteria of the general population. With this in mind, the adolescent sample was rechosen by a group of housewives. There were no differences in opinion concerning faces that both housewives and artists had typed "excellent". The only difference occurred in the "good" face category. These substitutions were small in number and did not appreciably alter any of the mean values that were later determined. This tended to reaffirm the sampling procedure.

The faces of both samples are minimally interpreted and are referred to as "acceptable" rather than "good" or "excellent".

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Method of Integumental Extension Measurement

The basic record for the study was the lateral headplate, which was taken using the Broadbent technique.[4] The cassette was placed as close as possible to the subject. The lip posture was that of initial closure, with the mandible in centric position.

The development of a consistent, accurate, and meaningful method of measurement of the soft tissue mass presents inherent problems. These problems particularly arise in the dimension describing "thickness". The soft tissue of the face is quite irregular and variable and does not readily suggest planes of reference within the soft tissue itself and, therefore, if such planes are to be established, they must utilize dental or skeletal landmarks. There is a lack of uniform correspondence in a vertical plane between skeletal and soft tissue landmarks (standard deviations may be as large as 3 millimeters). Hence, simple lines connecting soft and hard tissue landmarks would cross the soft tissue at various angles and would not accurately reflect lip thickness.

A compromise method was adopted, which measures the amount of extension of integumental landmarks from adjacent skeletal points relative to one common plane. Since these measurements do not exactly reflect "thickness" and "length", they are best referred to as horizontal and vertical extensions. The common plane of reference for horizontal extension measurements is the nasal floor, and for vertical extension measurements, a perpendicular to the nasal floor is utilized.

Horizontal extension (Fig. 1A) represents the distance in millimeters between a dental or skeletal landmark and an integumental landmark as measured along the nasal floor (a line connecting anterior and posterior nasal spines). Seven horizontal extension readings are listed below and the dental or skeletal (S) and integumental (I) landmark for each is operationally defined.

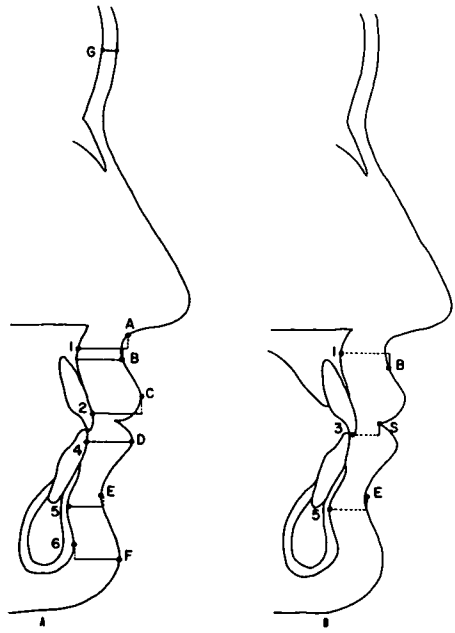

Fig. 1 Integumental and skeletal landmarks demonstrating extension measurements, A, horizontal extension, B, vertical extension. Skeletal landmarks: 1) subspinale, 2) incision superius, 3) incision superius, 4) incision inferius, 5) supramentale, 6) pogonion. Integumental landmarks: A) subnasale, B) superior labial sulcus, C) labrale superius, D) labrale inferius, E) inferior labial sulcus, F) menton, G) glabella, S) stomion.

Glabella (I) — det rmined by a tangent to the forehead from a line passing through subnasale.
Glabella (S) — the intersection of the outer plate of the frontal bone with a h rizontal line (parallcl to nasal floor) drawn from frontal point (1).
Subnasale (I) — the point where maxillary lip and nasal septum form a definite angle. If the depression is a gentle curve, subnasale is interpreted as the most concave point in this area as measured by a line angled 45 degrees from nasal floor.
Subspinale (S) — the deepest point between anterior nasal spine and prosthion relative to nasal floor.
Superior Labial Sulcus (I) — the deepest point on the upper lip as determined

by a line drawn from subnasale inclined so that it forms a tangent with labrale superius.
Subspinale (S) — the deepest point between anterior nasal spine and prosthion relative to nasal floor.
Labrale Superius (I) — the most prominent point on the upper lip as measured from a perpendicular to nasal floor.
Incision Superius (S) — the most prominent point on the maxillary incisor as determined by a tangent to the incisor passing through subspinale.
Labrale Inferius (I) — the most prominent point on the lower lip as determined by a perpendicular from nasal floor.
Incision Inferius (S) — the most anterior point on the lower incisor determined from a line tangent to the chin and mandibular incisor.
Inferior Labial Sulcus (I) the most concave point as measured by a line tangent to menton and labrale inferius.
Supramentale (S) — deepest point between pogonion and infradentale as determined from a line tangent to lower incisor and pogonion.
Menton (I) — most anterior point on chin determined by a line tangent to the lower lip and the chin.
Pogonion (S) — most anterior point on the chin as determined from a perpendicular to nasal floor.

Vertical extension (Fig. 1B) is the distance in millimeters between a dental or skeletal and integumental landmark measured along a perpendicular to nasal floor. If the integumental point is superior to the dental or skeletal one, the reading is given a plus sign; if inferior, a minus sign.

Superior Labial Sulcus —(I) — the deepest point on the upper lip as determined by a line drawn from subnasale inclined so that it forms a tangent with labrale superius.
Subspinale (S) — the deepest point between anterior nasal spine and prosthion relative to nasal floor.
Inferior Labial Sulcus (I) — the most concave point as measured by a line tangent to menton point and labrale inferius.
Stomion (I) — the juncture in the midline of the upper and lower lips.
Supramentale (S) — deepest point between pogonion and infradentale as determined from a line tangent to lower incisor and the chin.
Incision Superius (S) — the most inferior point on the maxillary incisor.

Integumental Extension Standards

The preceding method of integumental extension analysis was applied to the adolescent and young adult samples. Means, standard deviations, and standard errors of mean by sample and sex are given in Tables II and III.

The soft tissue mass of the face lying inferior to subnasale is quite thick in comparison to the mass of the glabellar

TABLE II

Integumental Extension Values of Acceptable Adolescent Profiles

	MALES			*FEMALES*			
Extension Measurements	*Mean*	*S.D.*	*S.E. of Mean*	*Mean*	*S.D.*	*S.E. of Mean*	*P**
Glabella	7.0	1.11	0.37	6.6	0.82	0.16	.20
Subnasale	18.7	2.33	0.78	16.9	1.45	0.29	.05
Superior Labial Sulcus	16.2	1.61	0.54	14.7	1.88	0.38	.05
Labrale Superius	15.5	1.88	0.63	12.1	1.83	0.37	.001
Labrale Inferius	16.1	1.54	0.51	13.4	1.29	0.26	.001
Inferior Labial Sulcus	12.9	2.20	0.73	11.6	1.31	0.26	.05
Menton	12.8	2.19	0.73	12.2	1.85	0.37	.20
Subspinale-Superior Sulcus	—4.4	1.90	0.63	—3.4	1.78	0.36	.20
Supramentale-Inferior Sulcus	1.3	1.69	0.56	1.6	1.94	0.39	.20
Incision-Stomion	3.1	2.21	0.74	3.5	1.64	0.33	.20

* t test

region. This difference, in part, reflects the high degree of development of the orbicularis oris complex. The upper lip gradually becomes thinner as one moves from subnasale to labrale superius. The horizontal extension at inferior labial sulcus and menton is less than any other region of the lower face.

Vertical extension averages indicate that superior labial sulcus lies inferior to subspinale and inferior labial sulcus lies superior to supramentale. Stomion is positioned about three millimeters superior to the tip of the maxillary incisor.

Considerable variation in horizontal and vertical extension values is observed in the adolescent and young adult samples. However, the greatest variation is found in the lower face, particularly in the lips.

Correction of these linear values for enlargement has not been considered desirable. Most clinicians, who might find it useful to apply soft tissue standards would not consider it practical to use correction scales. The similarity in position of landmarks in respect to the central x-rays and the small linear dimensions tend to minimize error in the comparison of an individual to the standard.

To facilitate extension analysis, a grid based upon the adolescent acceptable profile sample is presented (Fig. 2). The grid is divided into two portions with male values at the top and female at the bottom. Mean values are listed above each measurement along the center line. Readings greater than the mean are plotted to the right and those less to the left. Standard errors of the mean and standard deviations are listed respectively at the right and left.

Integumental Extension Variation In Malocclusions

Malocclusions exhibit not only malrelations of teeth but also facial disharmony. In part, this disharmony may be produced by variation in the soft tissue mass. In many instances, the reverse will occur; soft tissue variation masks a dentoskeletal discrepancy.

If an individual is compared with an appropriate age and sex integumental extension standard, absolute values and

TABLE III

Integumental Extension Values of Acceptable Young Adult Profiles

	MALES			*FEMALES*			
Extension Measurements	*Mean*	*S.D.*	*S.E. of Mean*	*Mean*	*S.D.*	*S.E. of Mean*	*P**
Glabella	6.2	1.01	0.280	6.1	0.78	0.156	.20
Subnasale	19.3	1.74	0.482	15.5	1.64	0.328	.001
Superior Labial Sulcus	17.2	1.83	0.507	13.8	1.44	0.288	.001
Labrale Superius	15.1	1.92	0.532	11.8	1.54	0.308	.001
Labrale Inferius	16.3	1.45	0.402	13.4	1.68	0.336	.001
Inferior Labial Sulcus	11.9	1.24	0.344	10.9	1.10	0.220	.02
Menton	13.6	1.82	0.505	11.6	1.35	0.276	.001
Subspinale-Superior Sulcus	—6.2	2.08	0.576	—4.5	1.36	0.272	.01
Supramentale-Inferior Sulcus	1.1	3.21	0.890	2.5	1.52	0.304	.05
Incision-Stomion	2.3	2.56	0.709	3.7	1.68	0.336	.05

* *t* test

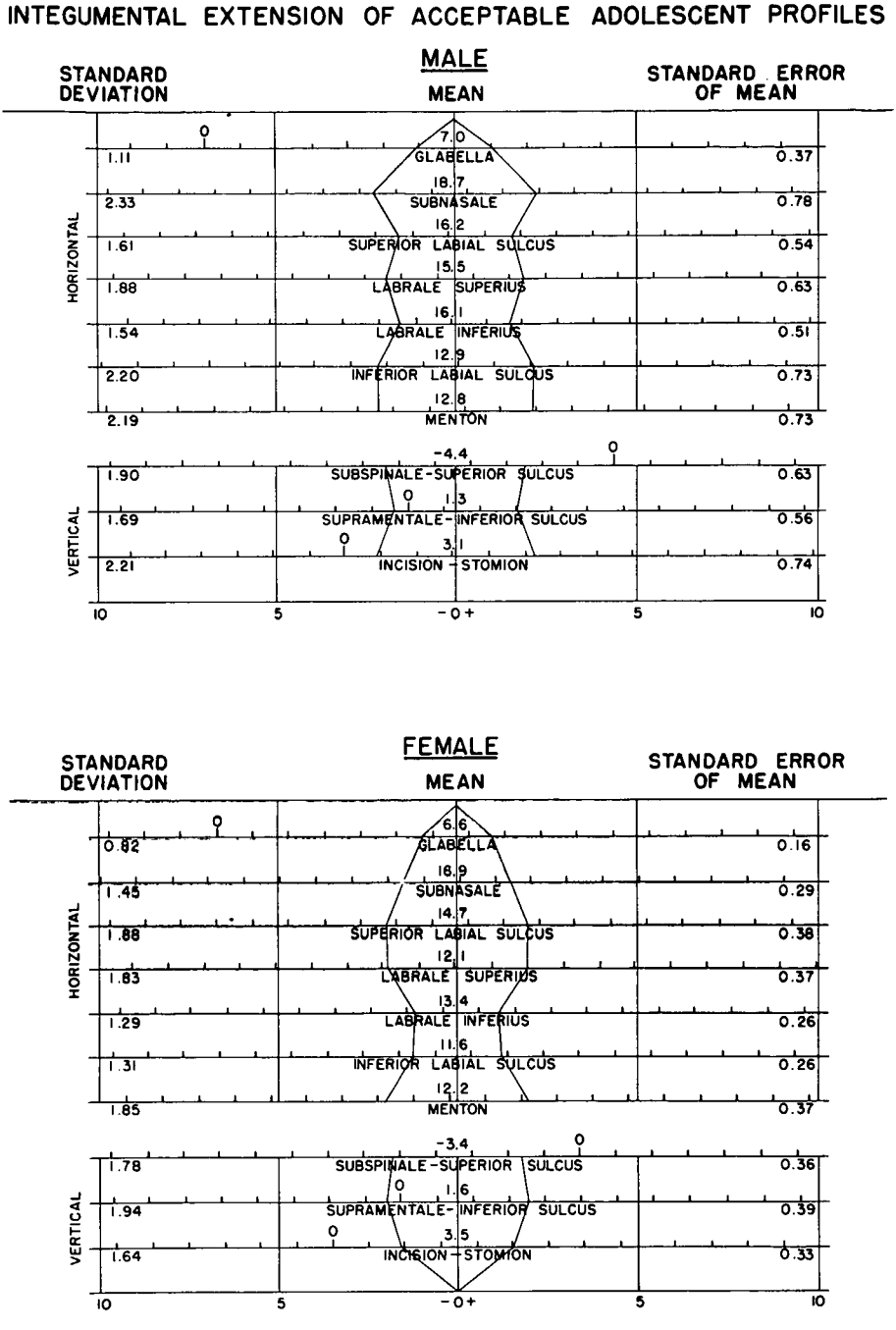

Fig. 2 The grid is divided into two portions by sex, male values at the top, female at the bottom. Mean values are listed above each measurement along the center line. Readings greater than the mean are plotted to the right and those less, to the left. Standard errors of the mean and standard deviations are listed respectively at the right and left.

their distance from the mean are not as important as the relationship of one value to another. Considering the relationship of one value to another, readings may deviate uniformly from the mean (cancellation of variation) or readings may deviate in opposite directions from the mean (accumulative variation).

Four cases are shown which present varying integumental extension patterns (Figs. 3, 4, 5 and 6). In case A, a large amount of maxillary horizontal extension is contrasted by a deficiency of mandibular extension. The accumulative variation between superior and inferior labial sulci should be noted (Figs. 3 and 4).

Case B demonstrates accumulative variation between horizontal extension values of subnasale and menton (8.7 millimeters). This soft tissue variation minimizes the total facial convexity that is inherent in the skeletal pattern. Superior labial sulcus lies considerably inferior to its normal position (Figs. 3 and 4).

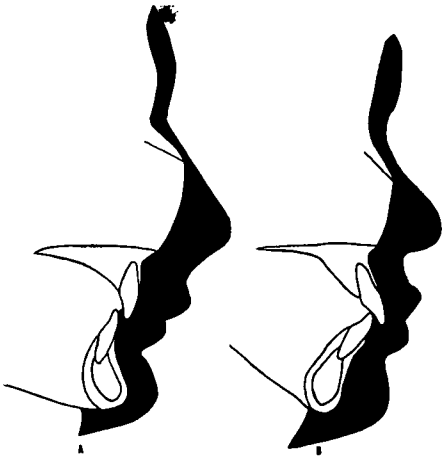

Fig. 3 Case A, a large amount of maxillary horizontal extension is contrasted by a deficiency of mandibular extension. Case B, demonstrates accumulative variation between horizontal extension values at subnasale and menton (8.7 mm.).

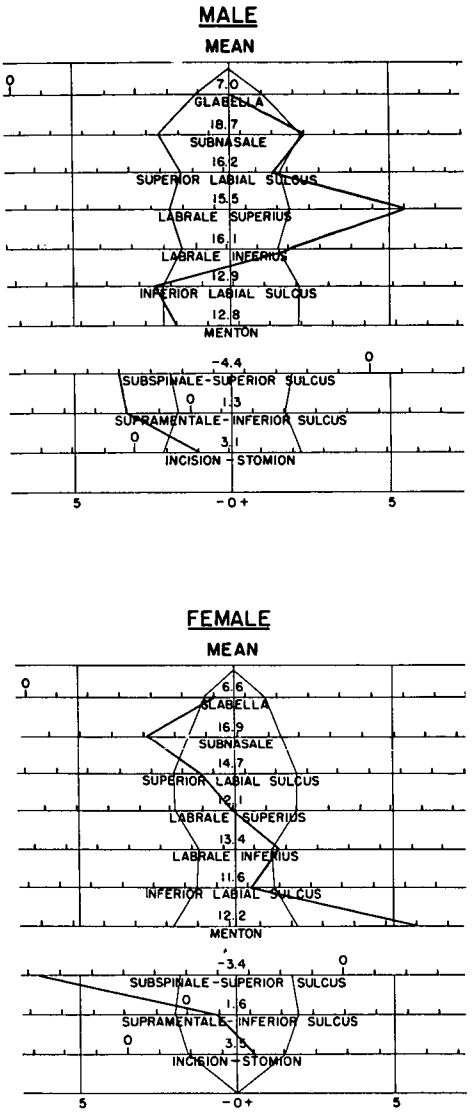

Fig. 4 Values from case A, above, and B, below, are plotted on grid.

A boy with a repaired unilateral cleft of the lip is seen in Case C. Lip mass has been noticeably reduced, especially in the region of labrale superius. Labiomandibular contour is benefited by decreased horizontal extension at labrale inferius and increased extension at menton. Superior and inferior sulci are atypically positioned in the vertical

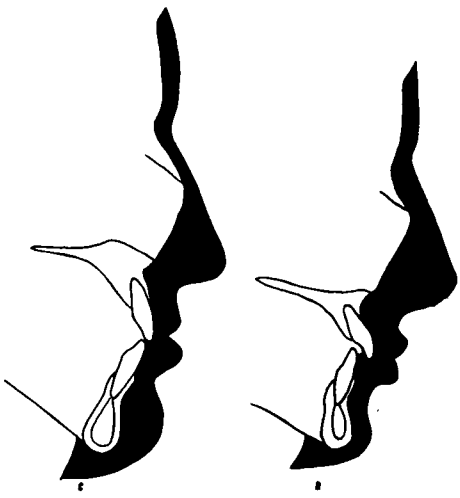

Fig. 5 Case C demonstrates a repaired unilateral cleft of the lip. Case D, the profile possesses slightly greater horizontal extension than the standard in the maxillary region. Extremely small amounts of soft tissue extension are seen around the inferior labial sulcus and menton.

plane (Figs. 5 and 6).

The profile in case D possesses slightly greater horizontal extension than the standard in the maxillary region. The increased value of labrale inferius can be partly attributed to deflection of the lower lip produced by the overjet. Extremely small amounts of soft tissue extension are seen around the inferior labial sulcus and menton (Figs. 5 and 6).

In evaluating extension variation, particularly in the horizontal plane, a number of factors have to be considered. Not all of the variation need be produced by inherent structural variation in the soft tissue mass. For example Fig. 7 demonstrates two individuals with the mandible in centric position. The dotted line indicates soft tissue form with the lips relaxed and the solid line represents a closed lip position. In case B, little space is present between the lips in their relaxed state (interlabial gap equals 1 millimeter). By contrast in case A, the patient exhibits a large interlabial gap (12 millimeters) associated with a vertical labial insufficiency. In an effort to produce lip closure a marked effort is required. The ensuing muscular imbalance alters the soft tissue extension pattern. Likewise, in excess lip length cases (vertical

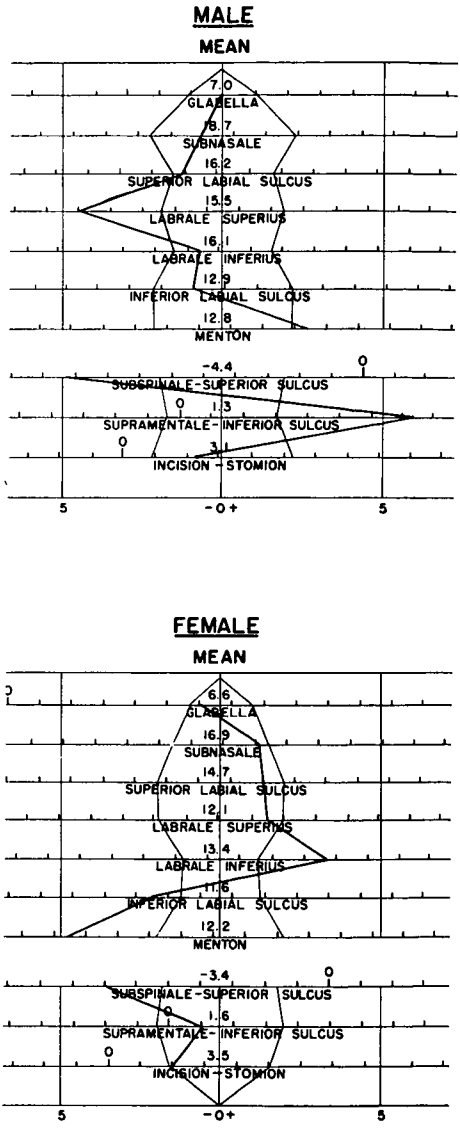

Fig. 6 Values from case C, above, and D, below, are plotted on the grid.

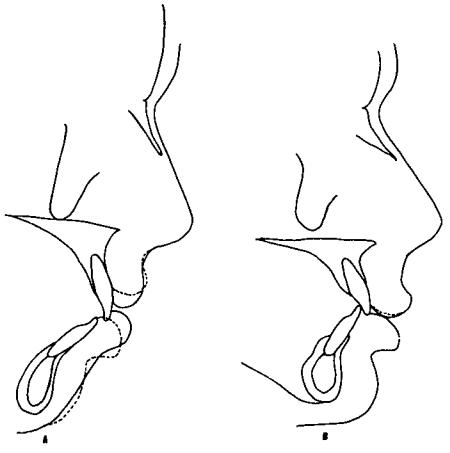

Fig. 7 Integumental extensions as influenced by postural variation: relaxed lip position — dotted line, initial lip closure — solid line, A) marked soft tissue change associated with vertical labial insufficiency, B) minimal change in soft tissue mass.

labial redundancy) the lips will protrude and thereby increase the extension pattern.

Some variation is associated with the method itself. Changing planes of reference (used for measurement and selection of landmarks) and variation in the relative position of landmarks should be considered as a possible source of variation.

Sex Differences In Extension

The soft tissue mass of the face demonstrates sex differences which are reflected in both adolescent and young adult samples, but are most marked in the latter. (Tables II and III)

In the young adult sample, there is no apparent difference between the sexes in the thickness of soft tissue covering the forehead. By contrast, in the lower face where the development of the orbicularis oris complex exerts its influence, significant differences are to be found. The soft tissue mass of all areas from subnasale to menton are thicker in the male. In particular, horizontal values in the upper lip average three to four millimeters greater in the male than in the female.

Vertical differences in the upper lip can be observed with respect to the skeletal points, subspinale and incision. In the male, superior labial sulcus and stomion are found to be in a more inferior position.

Maturation Changes in the Integumental Profile

The maturation of integumental extension and contour from the adolescent to the young adult has been studied on a cross-sectional basis utilizing two acceptable face samples. This type of procedure is useful in detecting unidirectional changes but tends to mask bidirectional variation. This, added to the danger of sampling error, suggests that these cross-sectional studies should be followed by longitudinal ones.

Considering horizontal extension (even though some significant differences can be demonstrated), the levels of confidence and the small magnitude of the mean differences suggest that longitudinal methods could best study the problem.

In the direction of vertical extension, it is seen that superior labial sulcus becomes more inferior in its relation to subnasale with age (Male: p .05, Female: p .02).

A method for measuring the integumental profile by angular means has been previously described. Readings are of two types: inclination angles, (profile components relative to nasal floor) and contour angles (profile components relative to each other).[2]

Table IV gives the means, standard deviations and probabilities for the two samples. For graphic purposes, the means of the *adult* sample are plotted on the *adolescent* grid (Fig. 8).

Lower facial inclination is significantly greater in the adolescent group. This is true for both anterior

and posterior measurements. Mandibular and interlabial inclinations are similarly greater in the younger age period. This difference could be partly explained by an increase in the mandibular prominence as part of the maturation process.

The protrusion of the upper lip from the sulcus (superior labial inclination) increases with age as contrasted with the curl of the lower lip (inferior labial inclination) which shows a significant decrease in the young adult sample. The prominence of the chin from the inferior sulcus shows an increase in the older group.

With reference to the contour angles of the face a significant difference is seen in only one, total facial contour. The total face becomes less convex with maturation.

Even though many inclination angles in the lower face demonstrate significant differences, contour angles formed in this area do not show significant differences. Labiomandibular contour remains fairly constant. Cross-sectional studies in younger age groups further suggest that the labiomandibular angle changes minimally with growth and maturation.[5] Maxillomandibular contour, a measurement of facial convexity below the nose, demonstrates no significant difference. It appears, therefore, that there is no evidence to suggest marked flattening of the lower face in the post adolescent period.

Since the significant differences (or their lack) between the two samples represent average maturation changes, individual variation is not taken into consideration. Hence, attempts to estimate individual integumental changes on the basis of these generalizations

TABLE IV

INTEGUMENTAL PROFILE MEANS AND STANDARD DEVIATIONS FROM ADOLESCENT AND ADULT SAMPLES, AND PROBABILITIES

	Adolescent		*Adult*		
Angle	*Mean*	*S.D.*	*Mean*	*S.D.*	*p**
(XAG) Upper Facial Inc.	—5.7	3.5	—6.5	3.2	above 0.05
(XAF) Lower Facial Inc.	8.2	4.0	4.8	4.0	0.01
(XBE) Lower Facial Inc.	15.3	4.8	11.7	4.2	0.01
(XAC) Maxillary Inc.	—2.2	7.6	—4.0	6.7	above 0.05
(XDF) Mandibular Inc.	11.5	5.5	7.5	5.5	0.01
(XCD) Interlabial Inc.	11.7	5.0	8.0	5.0	0.01
(XAB) Subnasal Inc.	17.1	7.0	16.0	7.4	above 0.05
(XBC) Superior Labial Inc.	—22.6	8.7	—27.0	9.5	0.05
(XDE) Inferior Labial Inc.	47.5	9.6	41.9	9.2	0.02
(XEF) Supramental Inc.	—12.9	6.5	—16.1	3.7	0.01
(GAF) Total Facial Con.	13.9	3.8	11.3	4.1	0.01
(ACDF) Maxillo-Mandibular Con.	13.5	8.9	11.5	6.5	above 0.05
(CDF) Labio-Mandibular Con.	0.2	7.0	—0.5	6.0	above 0.05
(ABC) Maxillary Sulcus Con.	39.7	9.8	43.1	10.0	above 0.05
(DEF) Mandibular Sulcus Con.	59.7	11.4	58.0	11.7	above 0.05

*p — .05 or less denotes significant differences between adolescent and adult integumental angles.

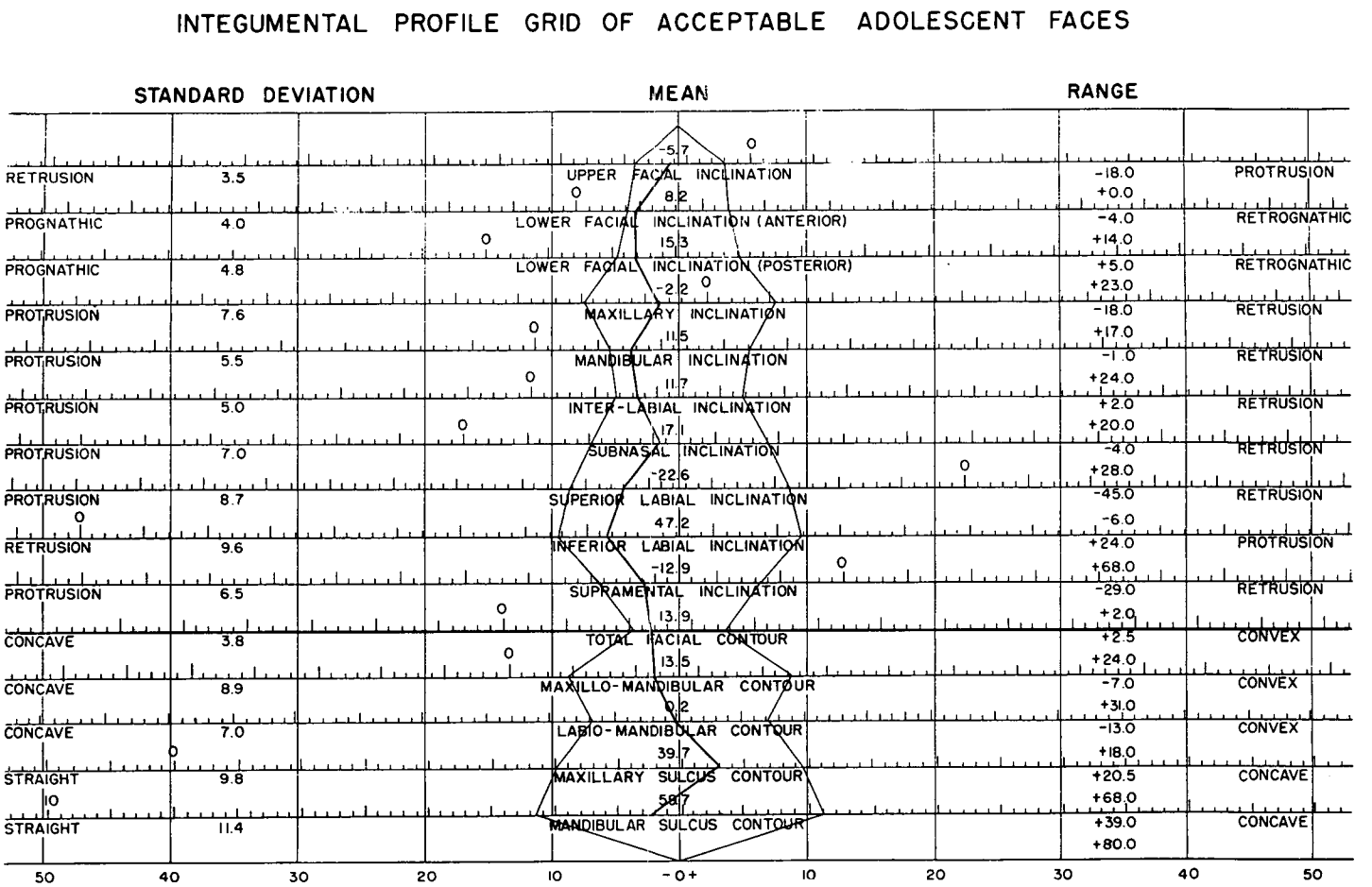

Fig. 8 Young adult profile mean values plotted on grid of acceptable adolescent faces.

should be made with considerable reservation.

Discussion

An awareness of integumental extension and contour is an essential element of case analysis. Since considerable variation may occur in the soft tissue mass of the face, treatment based on arbitrary dentoskeletal standards cannot be expected to consistently produce desirable facial form. In many individuals application of an absolute standard will lead to increased facial disharmony or the substitution of one type of disharmony for another. Since the soft tissues as well as dentoskeletal structures demonstrate variation, both should be considered in establishing the anteropostero-positioning of the denture and the axial inclinations of the anterior teeth.

Concomitant with hard tissue changes during treatment, a redistribution of soft tissue may occur. Soft tissue changes become evident if horizontal and vertical extension values are compared before and after treatment (Fig. 9 and 10). The alteration of the soft tissue mass is in part postural, reflecting a change in the manner of lip closure and in part, the result of growth. Further investigations are needed to determine if altering dentoskeletal structures or myofunctional therapy can inherently change the soft tissue mass of the face (non-postural alteration).

In an orthodontic case, esthetics is closely related to stability. Rarely should facial esthetics be achieved at the expense of denture stability. Stability and esthetics need not be separate objectives, for those same muscular imbalances that may operate to produce denture instability may also be responsible for disharmony in facial contour.

The present study is basically static in nature. Future functional investigations are needed to relate variation in soft tissue mass with the muscle activity of the orbicularis oris complex.

Fig. 9 Integumental extension changes incident to orthodontic treatment, A) pretreatment, B) posttreatment.

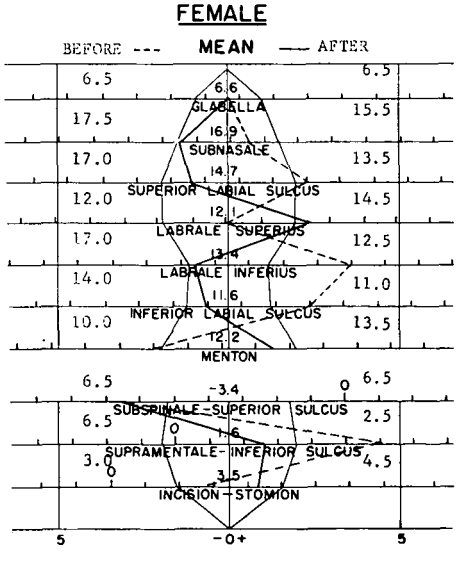

Fig. 10 Integumental extension changes of patient shown in Fig. 9. Dotted line — pretreatment, solid line — posttreatment.

Summary

1. Utilizing the oriented lateral headplate, a method of measuring integumental (vertical and horizontal) extension was presented.

2. Integumental extension standards based on artist-chosen samples were established for adolescent and young adult groups.

3. Malocclusions exhibited considerable variation in integumental extension from the means of the standards. If accumulative variation were measured, deviations from the average increased in value.

4. Sex differences were noted in integumental extension. Areas inferior to the nose in the male, generally, had greater horizontal extension of soft tissue.

5. Maturational changes in the integumental profile from adolescence to the young adult were considered. Significant differences were demonstrated in: lower facial, mandibular, interlabial, superior labial, inferior labial, and supramental inclinations. The only contour angle to show a significant difference was total facial contour which tended to flatten with age.

6. Increasing evidence suggests that an awareness of variation in the soft tissue mass should become an integral part of orthodontic case analysis.

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