Soft Tissue Changes Associated with Mandibular Subapical Osteotomy

T. Michael Speidel, D.D.S., M.S.D.
Konrad M. Marine, D.D.S., M.S.
Frank W. Worms, D.D.S., M.S.D.

Facial beauty is of importance in our society. Many patients consult the orthodontist because of concern for their esthetic shortcomings. The orthodontist may view the patient's problem as a variation from sophisticated concepts of normal facial proportions. Facial proportions are usually the result of variations in relationships of skeletal, dental and overlying soft tissue.

Treatment planning for individuals often involved orthodontically moving teeth to more acceptable positions to correct or compensate for the unacceptable variations. When a patient's problem involved a severe skeletal disproportion, treatment was limited by the orthodontic potential for influencing jaw growth or placing teeth in compensating positions within the jaws. When treatment objectives for facial esthetics, stability, and periodontal health could not be met by orthodontically influencing growth and dental relationships, surgery was introduced.

Developing treatment plans combining orthodontics and oral surgery to correct jaw imbalance requires careful pretreatment prediction. Accurate prediction of soft-tissue response to repositioning skeletal and dental structures is more difficult.

Prediction guidelines have been established for many surgical procedures.[1-5] However, the mandibular subapical osteotomy, where the dental alveolar portion of the mandible is surgically repositioned, has not been adequately quantified. The objective of this investigation was to evaluate soft-tissue profile changes in patients treated with combined orthodontic-surgical approaches involving mandibular subapical osteotomy.

Methods and Materials

Data were obtained from pretreatment and posttreatment cephalometric radiographs of twelve nongrowing patients treated with mandibular subapical osteotomies in conjunction with orthodontic treatment. Patients selected for this study were obtained from the files of the University of Minnesota, School of Dentistry, Division of Orthodontics. The sample included eight females and four males ranging in age from 14.0 years to 25.0 years at the start of treatment.

Pretreatment and posttreatment radiographs of the twelve patients met the following criteria:

1. Cephalometric radiographs had good hard and soft tissue definition.
2. All radiographs were exposed with the same cephalometric machine.
3. Radiographs were made with the patient's teeth in centric occlusion and the soft-tissue profile in a relaxed position with lips slightly touching.
4. Pretreatment and posttreatment tracings were completely superimposable with no evidence of growth.

The twelve patients in this study initially demonstrated *mild* mandibular prognathism with varying degrees of vertical problems.

Surgical procedures were either the mandibular subapical osteotomy for anteroposterior correction or the Kole

Given at the January 1978 meeting of the Midwestern Component of the Angle Society.

TABLE I
Surgical Procedure

	Male	*Female*	*Reduction Genioplasty*
Kole	4	3	7
Subapical	0	5	1

subapical osteotomy technique for a vertical correction. All surgical procedures were performed at the University of Minnesota Hospitals by the Division of Oral Surgery.

Surgical procedures are categorized in Table I according to type of surgery, sex, and genioplasty.

Radiographs were evaluated using conventional cephalometric techniques. Changes in the soft-tissue profile of each patient were evaluated from selected linear and angular measurements made according to the Minnesota Soft Tissue Analysis.[6] Means and standard deviation data were adapted from this analysis. Measurements are detailed in Table II and illustrated in Figure 1. In all cases, pretreatment measurements were made from the initial lateral head radiograph. All posttreatment measurements were made from cephalograms taken as far into the retention phase as possible. The average period of time between surgery and the final cephalogram was 25.5 months. This period of time allowed many postoperative changes to occur, i.e., swelling subsided, bone remodeling was completed, neuropathways were re-established, and soft-tissue adaptation to new bone positions was completed. Time periods for each phase of treatment are given in Table III.

Using the same pretreatment and posttreatment cephalograms, hard tissue measurements of overjet, overbite, ANB, mandibular plane angle and Wits analysis were made.

Surgical repositioning of the anterior mandibular dental alveolus resulted in various changes in the soft-tissue profile. Changes in the profile were calcu-

TABLE II
Soft Tissue Measurements
Lengths and Angles

	Mean	*S.D.*
CF	22	1.8
C-K	67	3.6
F-K	45	2.8
BCE	119°	7.3
AC-CE	1°	4.5
EF	11	1.1
FG	9	1.2
FG/EF	.9	0.12
CJ-D	0	0.70
CJ-E	2.4	1.2
CJ-F	—2.6	1.4
CJ-G	2.3	1.5
CJ-H	—4.2	1.3
CDE	137°	10.0
GHJ	122°	11.7
Chin Radius	17	2.0
GJ-KL	109°	5.9
CJ	11°	4.3

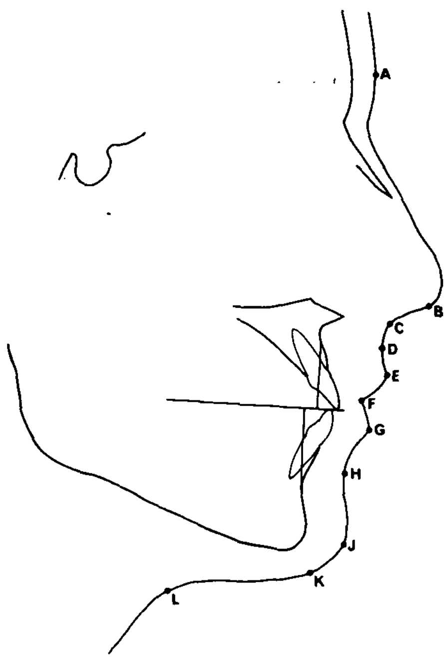

Fig. 1 A) glabella, B) junction of apex radius and columella, C) subnasale, D) superior labial sulcus, E) labrale superius, F) stomion, G) labrale inferius, H) inferior labial sulcus, J) pogonion, and K) menton.

TABLE III
Duration of Treatment

Phase	*Mean* (years)	*Range*
Age at surgery	20.4	15.0-25.0
Months of pre-surgery treatment	10.7	1.0-18.0
Months of post-surgery treatment	8.0	3.0-12.0
Months after surgery posttreatment cephalogram taken	25.5	8.0-89.0

lated as differences between pretreatment and posttreatment cephalograms. Means, ranges, and mean changes for the total sample were calculated for each soft-tissue measurement. The sample was also divided according to surgical technique used, either the Kole procedure or the standard subapical osteotomy. Mean changes of the two groups were calculated from measurements involving areas of important soft-tissue change. Correlation coefficients were calculated between soft-tissue changes and changes in overjet, overbite, and Wits analysis for all samples.

Results

Mean heights of subnasale-menton (C-K), subnasale-stomion (C-F), and stomion-menton (F-K) for the total sample are shown in Figure 2. On the average, treatment decreased lower facial height and increased upper lip length. Angular measurements of nasal lip contour and superior lip to facial plane increased as illustrated in Figure 3.

Figures 4 and 5 illustrate mean lengths of superior and inferior vermilion lips. Superior vermilion length increased, while inferior vermilion length decreased. The ratio between the superior and inferior vermilion lengths is illustrated in Figure 6. The presurgery ratio was greater than 1 while the postsurgery ratio was less than 1.

Superior labial sulcus and superior vermilion describe upper lip landmarks

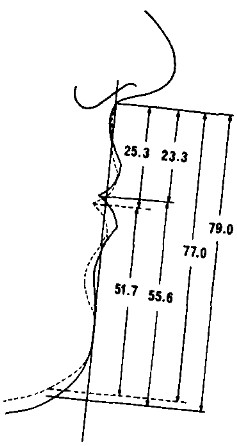

Fig. 2

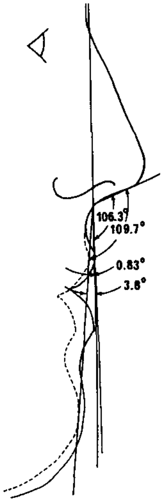

Fig. 3

and are related to the lower facial plane. Figure 7 illustrates mean decreased distances to lower facial plane of both superior labial sulcus and superior vermilion.

Stomion, inferior vermilion, and inferior labial sulcus describe positions of lower lip relative to lower facial plane. Figure 8 shows a mean decreased distance to lower facial plane of inferior vermilion and mean increased distance to lower facial plane of both stomion and inferior labial sulcus following treatment.

Figure 9 shows a mean increase in the superior labial sulcus angle and a mean decrease in the inferior labial sulcus angle.

Chin radius and lip-chin-throat angle had mean decreases as illustrated in Figure 10.

The pretreatment facial contour angle was —8.42 with a range of —15.0° to —1.0°. Posttreatment, the mean was —8.50 with a range of —16.0° to —1.0°.

Pre- and postsurgery hard tissue measurements are illustrated in Figure 11. Mean measurements of overjet, overbite, and Wits analysis increased indicating a change away from the

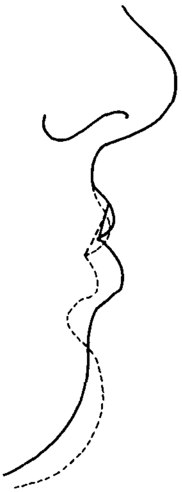

Fig. 4

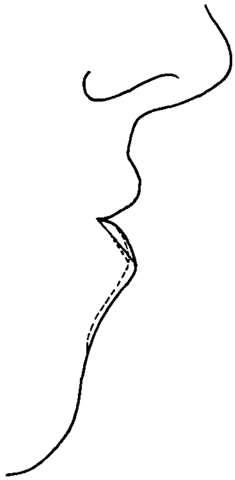

Fig. 5

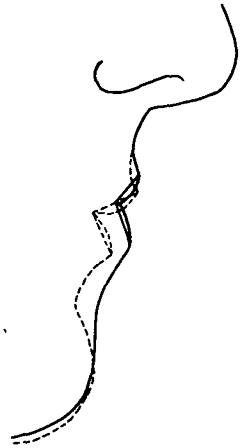

Fig. 6

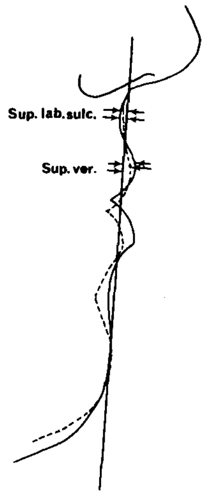

Fig. 7

Class III open-bite skeletal pattern.

When the total sample is divided into Kole and standard subapical procedures, some differences in mean measurements between the groups are noted and illustrated in Table IV. Mean subgroup changes are reported as trends designated as increases or decreases from the pretreatment state.

Significant correlation coefficients between soft-tissue changes and hard tissue changes for total sample are shown in Table V.

Significant correlation coefficients between soft tissue changes and hard tissue changes for the two subgroups are shown in Table VI.

Discussion

Mandibular subapical procedures provide many esthetic and functional advantages over orthodontic therapy. Conventional orthodontic correction of Class III malocclusion requires retraction of mandibular incisors, advancement of maxillary incisors, growth manipulation allowing a downward and backward rotation of the mandible, or a combination of the above.

Orthodontic retraction of lower incisors risks mesial migration of posterior anchor teeth which reduces amount of incisor retraction. Space made available for retraction via extraction or pre-existing space is thus compromised and often

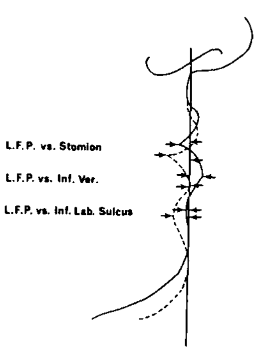

Fig. 8

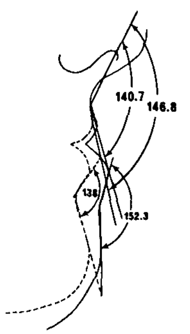

Fig. 9

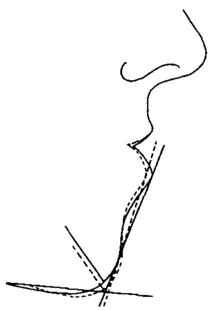

Fig. 10

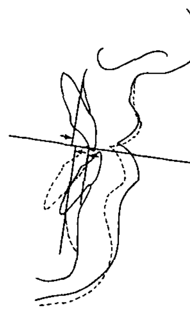

Fig. 11

TABLE IV

	Pretreatment Mean	Average Change	SSA Change	Kole Change
C-F	23.3	+ 2.0	++	+
C-K	79.0	− 2.00	0	—
F-K	55.6	− 3.9	−	—
BCE	106.3	+ 3.4	0	++
AC-CE	.83	+ 2.97	+	++
EF	10.75	+ 1.08	++	+
FG	12.5	− 1.2	−	−
FG/EF	1.17	− .23	−	−
CJ-D	−1.75	+ 0.13	+	0
CJ-E	2.3	− 0.7	+	—
CJ-F	−3	− 2.5	−	−
CJ-G	4.75	− 3.71	−	—
CJ-H	0.70	− 5.24	−	—
CDE	140.7	+ 6.1	+	++
GHJ	152.3	−14.3	−	—
chin radius	24.2	− 5.9	−	−
GJ-KL	102.6	− 3.0	—	−
AC-CJ	8.42	0.08	0	0
Ob	−1.45	+ 2.57	++	++
Oj	−0.41	+ 2.49	+	+
Wits	−5.41	+ 4.12	++	+

++ Relatively larger increase
\+ Small increase
0 No change
− Small decrease
— Relatively larger decrease

TABLE V

Significant Correlation Coefficients Between Soft Tissue Changes and Hard Tissue Changes for Total Sample

C-F distance vs. Wits	0.6803**
E-F length vs. overbite	−.5672*
F-G length vs. overbite	.5200*
FG/EF ratio vs. overjet	.5594*
CJ-G vs. overjet	−.5309*
CJ-G vs. Wits	−.5769*
G-H-J angle vs. Wits	−.5309

* Significant at 5 percent level
** Significant at 1 percent level

lost to anchorage requirements. Inadequate retraction of mandibular incisors may prevent complete correction of underjet and also compromise facial esthetics by leaving the lower lip in a prominent position.

Orthodontic advancement of maxillary incisors may create undesirable periodontal response and unstable axial inclinations. Tooth advancements may also create undesirable lip protrusions.

When severe skeletal malrelationships

TABLE VI

Significant Correlation Coefficients Between Soft Tissue Changes and Hard Tissue Changes by Surgical Subgroup

Kole Technique	
F-K distance vs. Wits	−.6938*
E-F length vs. ob	.7461*
E-F length vs. Wits	.7064*
F-G length vs. ob	.8712**
CDE-LFP vs. oj	.8667**
Standard Subapical	
C-F distance vs. Wits	.8429*
FG/EF ratio vs. oj	.8966*
F to LFP vs. oj	.9175*
F to LFP vs. ob	.8487*
FG to LFP vs. ob	.8259*
GHJ to LFP vs. oj	.9581*
GHJ to LFP vs. Wits	.8446*
Inf lab sulc angle vs. oj	.9148
Inf lab sulc angle vs. Wits	.9473*
Chin radius vs. oj	.7932*

* Significant at 5% level
** Significant at 1% level

exist, it may be impossible to fully compensate for this discrepancy by incisor movement, i.e., advancement of maxillary incisors and retraction of mandibular incisors. Severe axial inclinations may predispose periodontal deterioration. Vertical incisor relationships involving open bite are also extremely difficult to correct and maintain via orthodontic means.

Long lower face heights preclude mandibular rotation as a viable orthodontic treatment plan. While a Class III malocclusion may be corrected by mandibular posterior rotation, it should be attempted in individuals with relatively normal or short lower face heights. Orthodontic solutions do not reduce lower face heights unless rigorous extraoral mechanics are instituted. While such procedures have shown temporary success, their long term stability has not been well-documented. Hence, orthodontic treatment tends to move teeth with little effect upon basal skeletal areas. Inability to reduce long lower face height is a distinct disadvantage in orthodontic correction of open bites and anteroposterior discrepancies.

Mature individuals have a reduced potential for successful orthodontic treatment because of a lack of growth. Growth assists treatment by increasing vertical dimension which affords room for dental adjustments. Lack of growth encourages unfavorable jaw rotation during orthodontic treatment and may be contraindicated in persons with long lower face height.

While heroic orthodontic corrections have successfully solved dental Class III malrelationships, all too often facial esthetics have been compromised. Surgical correction of lower incisor Class III and open bite relationships have been very successful in restoring proper dental function while at the same time improving facial esthetics. Differential diagnosis between orthodontic and surgical solutions depends upon a knowledge of each treatment's effect upon function and facial esthetics. To that end, this study describes specific areas of hard and soft tissue change.

Lower facial height (subnasale to menton) is affected by both subapical and Kole procedures. Upper lip lengths (subnasale to stomion) increase in both surgical types. It appears that, as the mandibular anterior alveolar segment is surgically repositioned to establish normal overjet, the subnasale-stomion distance increases. Increased upper lip length may be the result of the removal of the lower incisor influence on the upper lip, thus allowing the upper lip to assume its natural contour. The apparent increase in upper lip length is offset by the large decrease of the stomion-menton distance, which is largely responsible for the total reduction in lower facial height.

One may elect to have maximum lower facial height reduction by selecting the Kole procedure which involves the transfer of the inferior border of the mandible to fill the defect created by the vertical movement of the anterior alveolar segment. The standard subapical procedure, on the other hand, is usually directed toward a dentoalveolar prognathism in the nongrowing patient without open bite or vertical problems. The correction attained by this procedure is achieved mainly by movement of the mandibular anterior alveolar segment in a direction parallel to the occlusal plane. The decision concerning which mandibular alveolar technique to use may be dictated by the vertical soft tissue proportionality and dental functional requirements.

The form of the lips is also affected by surgical treatment. In Class III incisor relationships the upper lip appears short and the lower lip appears longer. Following surgery, the upper lip moves posteriorly decreasing its prominence. The superior vermilion length increases as normal overjet and overbite are established. In the surgical repositioning of the lower incisors behind the upper incisors, a positive overjet is established. The upper lip can now attain its normal contour and, as this occurs, the superior vermilion length increases. Establishing overjet or overbite results in a decreased inferior vermilion length. Normal overjet allows the lower lip to relax back under the influence of the upper incisor which in turn decreases inferior vermilion length. The decreased ratio of inferior/superior vermilion measurements shows the change from a prognathic profile to a straight profile. It may be that, as the Class III relationship is corrected to a normal overbite/overjet relationship, the lower lip no longer has to strain to achieve lip competence.

The distance of superior labial sulcus behind the lower facial plane increases as superior vermilion/lower facial plane decreases. This change follows the increase in superior vermilion length and the decrease in inferior vermilion length. However, in the Kole group, superior labial sulcus may actually move toward the lower facial plane. This difference is probably related to the greater lower facial height reduction in the Kole group.

Stomion, inferior vermilion, and inferior labial sulcus showed posterior movement as related to the lower facial plane. The posterior movement of stomion, inferior vermilion, and inferior labial sulcus reflects a close association with the mandibular alveolar segment as it is repositioned behind the upper incisors. The Kole group showed a larger posterior movement of these landmarks than did the standard subapical group. This may indicate that the hard tissue vertical disproportion was causing a large anteroposterior soft tissue discrepancy.

The superior and inferior labial sulci are angular measurements that showed change following surgery. The increase in the angle for superior labial sulcus is probably associated with removing the influence of the lower incisor on the upper lip as a normal incisor relationship was established. The increased vertical dimension found between subnasale-stomion distance may also influence the reduction of the superior labial sulcus concavity. The decrease in the inferior labial sulcus angle indicates an increased concavity. The reduced vertical dimension from stomion to menton and posterior positioning of underlying hard tissue contributed to the increased concavity of the inferior labial sulcus.

The decrease in chin radius is an expected finding considering the increased concavity of the inferior labial sulcus and a reduction in the vertical height from stomion to menton. As these changes occur, the chin contributes more contour to the soft tissue profile. The lip-chin-throat angle decreased, an anticipated change due to the posterior movement of the lower lip vermilion border. The Kole subgroup reflected a smaller change in the lip-chin-throat angle than the total sample. This was probably caused by the transfer of the inferior border of the mandible which changed the position of soft tissue menton. Conversely, the larger change of the lip-chin-throat angle for the subapical group may be accounted for by the surgical movement of only the anterior dental alveolus.

As could be expected, there was essentially no change in the facial contour angle as a result of surgery. The pre- and posttreatment means of 8.42 and 8.50 are close to the mean of 11° for the over-all population.

Prediction of soft tissue changes as a result of hard tissue changes can be made with reasonable accuracy as indi-

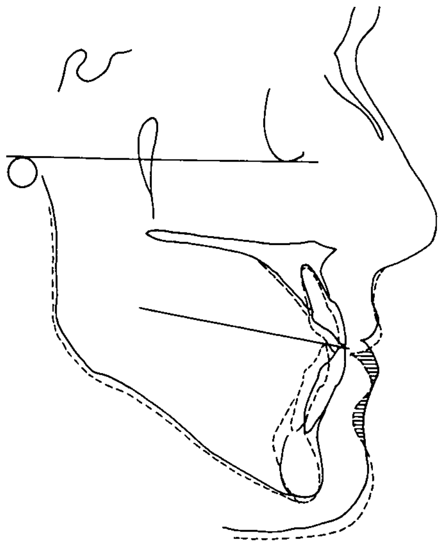

Fig. 12

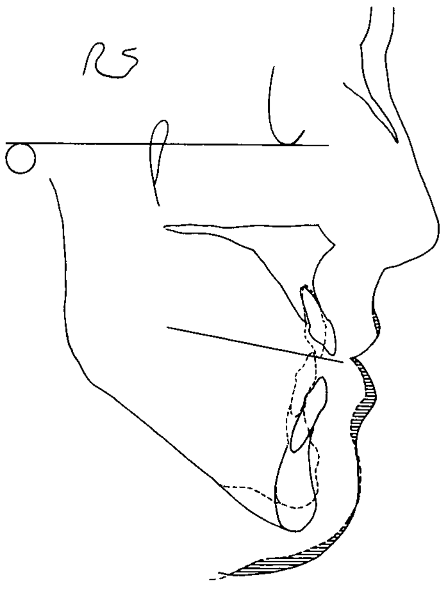

Fig. 13

cated in the table of correlation coefficients between soft and hard tissue landmarks (Table V). While the coefficient of predictability is only 25-35%, examination of the actual patient's cephalometric tracings will enhance one's ability to apply the predictions to a specific individual.

Pre- and posttreatment tracings of two representative cases are shown in Figures 12 and 13. These cases illustrate the trends in measurement changes listed in Table IV for the two surgical procedures used. Figure 12 illustrates a fairly typical result obtained with the standard subapical procedure in a non-growing patient. Note the increase in upper lip length (subnasale-stomion) and corresponding decrease in the stomion-menton distance as normal overjet is established.

Figure 13 illustrates results achieved with the Kole procedure in a patient with anterior open bite. The increase in upper lip length is small with most of the over-all decrease in lower facial height accounted for by the large decrease in the stomion-menton distance.

Hard-tissue measurements for overjet and overbite increased while Wits analysis decreased in the total sample. Similar expected changes were found for the subgroups as normal overbite-overjet relationships were established by the surgical repositioning of the anterior mandibular alveolus. The shift of hard-tissue B point with the mandibular alveolar segment probably accounts for the change away from the Class III relationship as reflected in the improved Wits analysis.

For each individual, selection of the most appropriate combined surgical and orthodontic treatment plan requires knowledge of soft-tissue response for the indicated surgical procedure. Surgery must be planned to have a favorable alteration of the deviate facial soft-tissue contours. Accurate quantitative and qualitative predictions of the changes in an individual patient are difficult due to the variation in individual soft-tissue thickness.

By delineating specific soft-tissue landmark changes, results of this study will help in differential diagnosis regarding treatment planning for Class

III malocclusions. Subapical procedures preserve facial contour angles and throat lengths, thus they are most indicated in patients with short throats and acceptable facial contours. All too often surgical correction of Class III malocclusions by mandibular setback procedures result in compromised facial esthetics.[7] Differential diagnosis requires application of subapical procedures when facial contour angles are normal, lip-chin-throat angles are obtuse, throat lengths are short, and inferior labial sulci are obtuse.

This study provides prediction guidelines that can be applied to pretreatment planning for patients requiring mandibular subapical osteotomy in conjunction with orthodontic treatment.

Summary

Sophisticated treatment planning for those individuals with severe dental and facial disproportions requires accurate prediction of posttreatment results. Pre- and posttreatment cephalometric X-rays for a group of twelve patients treated by a combined orthodontic-oral surgical approach were evaluated. The surgery was of either the standard mandibular subapical osteotomy or Kole type of procedure.

Surgical repositioning of the anterior mandibular alveolus resulted in various changes in hard tissue and soft tissue profile.

In summary, these changes were:

1. Decreased lower facial height.

2. More relaxed lip posture as revealed by an increased superior vermilion lip length and decreased inferior vermilion lip length.

3. Stomion moved inferior and posterior relative to the lower facial plane.

4. Superior labial sulcus became less concave.

5. Inferior labial sulcus became more concave.

6. Superior vermilion and inferior vermilion moved posterior relative to the lower facial plane.

7. Chin radius and lip-chin-throat angle decreased.

8. Overbite and overjet increased while Wits analysis decreased.

9. Facial contour angle was unchanged.

Changes were similar for both standard subapical and Kole groups with the main difference being a greater reduction in facial height with the Kole group.

School of Dentistry
University of Minnesota
Minneapolis, Minn. 55455

References

1. Hershey, H. G., and Smith, L. H.: Soft tissue profile change associated with surgical correction of the prognathic mandible. *Am. J. Orthodont.* 65:483-502, 1974.
2. Kent, J. N., and Hinds, E. C.: Management of dental facial deformities by anterior alveolar surgery. *J. of Oral Surgery.* 29:13-26, 1971.
3. Lines, P. A. and Steinhauser, E. W.: Diagnosis and treatment planning in surgical orthodontic therapy. *Am. J. Orthodont.* 66:378-397, 1974.
4. Proffit, W. R. and White, R. P.: Treatment of severe malocclusions by correlated orthodontic-surgical procedures. *Angle Orthodont.* 40:1-10, 1970.
5. Robinson, S. W., Speidel, T. M., Isaacson, R. J., and Worms, F. W.: Soft tissue profile change produced by reduction of mandibular prognathism. *Angle Orthodont.* 42:227-235, 1972.
6. Worms, F. W.: Minnesota soft tissue analysis (in press).
7. Worms, F. W., Isaacson, R. J. and Speidel, T. M.: Surgical orthodontic treatment planning: profile analysis and mandibular surgery. *Angle Orthodont.* 46:1-25, 1976.