Lip posture and its significance in treatment planning

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Since malocclusion, tooth stability, and facial esthetics are influenced in part by the total mass, position in space, and general activity of the soft-tissue structures, the orthodontist is vitally concerned with soft-tissue morphology and the posture of the lips. The present article will consider the role and significance of lip posture in orthodontics, particularly as applied to treatment planning.

Normally, two postural positions of the lips can be observed. In the relaxed-lip position, the lips are relaxed, apart, and hanging loosely with no effort made at lip contraction. In the closed-lip position, the lips are lightly touching in order to produce an anterior seal of the oral cavity. The closed-lip position is characterized by minimal contraction in the effort to effect this anterior closure. In the Class II, Division I case in which there is a significant overjet, the closed-lip position is interpreted as that position in which light contact exists between the lower lip and the maxillary incisor. As will be shown, a great deal of confusion can arise if one does not differentiate between the relaxed-lip and closed-lip positions in the evaluation of dental and facial abnormalities. For that reason, a detailed description of the relaxed-lip and closed-lip positions will be presented. Certainly, before an attempt is made to describe the more complicated types of lip activity seen in swallowing, mastication, or speech, it would seem advantageous to consider the role of lip posture in subjects with normal occlusion as well as those with malocclusion.

The research on lip posture has been remarkably sparse and, with few exceptions, has been ignored by American investigators, who have been primarily interested in dentoskeletal variation. To be sure, Brodie and others have alluded to the wrap-around muscle sheath as a restraint against forward migration of the dental arches. Furthermore, differences in lip posture in which the lower lip may lie either anterior or posterior to the maxillary incisors have been discussed as etiologic factors in the development of the Class II malocclusion. Schlossberg, employing an electromyographic technique, has gone one step further and has attempted to analyze the muscle areas and their sequence of contraction as the
lips move from the relaxed to the closed position. With this approach, the greater role of mentalis action in producing an anterior seal in Class II, Division 1 cases was noted.

The British school has intensively studied lip posture during both normal and abnormal swallowing. Tulley, for instance, has attempted to evaluate the relative amount of tongue and perioral muscle activity by means of an electromyographic technique. Collaborating previous observations, he found greater perioral concentration in abnormal swallowers. The term lip incompetence is widely discussed in the British literature, which shows an awareness of the importance of lip length in case analysis.

RELAXED-LIP POSITION

In theory, the relaxed-lip position represents a state in which there is no contraction of lip musculature. From a clinical standpoint it may appear that the problems encountered in trying to obtain a reliable record of this position are insurmountable unless an electromyographic technique is employed. This, however, should not discourage us from using such a position if it affords information that is helpful at the clinical level. It might be pointed out that determination of rest position of the mandible is likewise not highly reproducible or easily obtained. Yet this concept is quite helpful and useful in dental and orthodontic procedures.

The technique for obtaining the relaxed-lip position is standardized in the following way. The patient is placed with the Frankfort horizontal plane parallel to the floor. Although there may be certain advantages to positioning the head along a postural horizontal plane, head position in this study was determined by the cephalostat rather than the natural upright posture of the subject. Three methods have been successfully utilized for relaxing the upper and lower lips.

1. The mandible may be lightly jiggled in an opening and closing manner, as if one is attempting to establish centric occlusion. During this procedure the patient is encouraged to relax the mandible so that its movement is accomplished entirely by the operator. The amount of space between the upper and lower lips is carefully checked when the teeth lightly touch during successive elevations of the mandible. In attempting to relax the mandible, the patient usually simultaneously relaxes the lips. The opening and closing movement of the mandible serves a dual function, since it tends to block those reflexes which normally maintain an anterior lip seal under most circumstances.

2. The upper and lower lips, particularly the lower lip, may be lightly stroked with the fingers. In many instances, as the stroking continues, it will be seen that the lips relax and a space forms between the upper and lower lips.

3. Perhaps the least reliable method of producing a relaxed-lip posture is that of instructing the patient to relax his lips. Suggesting that the subject relax his lips will frequently produce an abnormal lip posture, for in attempting to achieve a relaxed-lip position the patient may curl the lips away from the teeth. Therefore, although verbal instruc-
tions may be helpful in establishing a relaxed-lip position, this should not be used as the only method in establishing lip posture.

How reproducible is the relaxed-lip position? To study the possibility of error in positioning the patient, as well as in tracing and measuring the head-plate, ten subjects with malocclusions were selected at random. Four different operators took four headplates of each subject with the lips relaxed and the mandible in centric occlusion. Tracings were made from the lateral headplate, and the shortest distance between the upper and lower lips was measured with a millimeter rule. Since this distance is fairly representative of the type of measurement that can be made in the relaxed-lip position it was considered typical in determining the amount of experimental error. The four readings for each subject were averaged, and the deviation was determined for each variable in the sample. The mean deviation was then calculated for the entire group of forty deviations. The mean deviation for the sample was 0.5 mm., which represents the total error on the average produced by tracing measurement and positioning of the patient. The greatest deviation was seen in one patient with a Class II, Division 1 malocclusion and a strong tendency toward mentalis contraction. In this subject, one deviation as high as 2.7 mm. was observed. At the other extreme, many of the subjects demonstrated no discernible difference in the linear distances measured from headplates taken by different operators. It might be anticipated that if the sample were made up of persons with fairly normal dental and lip relationships, the deviation would be considerably less. Likewise, a single operator or clinician would be expected to have less variation in his attempts to record a relaxed-lip position.

Fig. 1. Normal interlabial gap. Relaxed-lip position showing small space or gap between upper and lower lips.
If lip posture is to be evaluated, it is well to standardize the vertical dimension of the jaws. The simplest procedure is to have the mandible elevated with the teeth together in occlusion. However, in certain conditions, such as marked overjet, it is possible that in centric or maximum occlusion the lower lip may be deflected by the maxillary incisors. In such cases it is desirable to open the mandible to rest position or beyond so that a truer picture of lower lip posture may be achieved.

Relaxed-lip posture, like body posture, is a muscle-determined position. Therefore, it cannot have the reproducibility that is associated with measurements on hard structures. The recording of lip posture is further complicated by the fact that we are dealing with muscles innervated by the seventh cranial nerve. The seventh nerve is closely associated with the autonomic nervous system and has connections at a higher level with the hypothalamus, which means that emotional states can strongly influence the contraction or lack of contraction of the muscle fibers of the lip. With care, however, the investigator or clinician can obtain records of the relaxed-lip position that are relatively reproducible.

**VERTICAL CHARACTERISTICS.** If the lips are relaxed there is normally a space between the upper and lower lips (Fig. 1). This space, known as the *interlabial gap*, represents the shortest linear dimensions between the inferior surface of the upper lip and the superior surface of the lower lip. In a sample composed of adolescents with acceptable faces,* the average gap is 1.8 mm. in centric occlusion and 3.7 mm. in rest position of the mandible. The standard deviations are, respectively, 1.2 and 1.6 mm. It can be seen that the interlabial gap is quite small in both centric occlusion and rest position of the mandible and that it does not increase proportionately with the opening of the mandible. Although normally variation is small, considerable variation can be seen in the interlabial gap in persons who have either malocclusions or facial disharmonies. Extreme conditions in which there is excessive space or lack of space between the upper and lower lips can commonly be observed.

Inadequacies of lip length relative to the vertical dimension of the lower face are characterized by large interlabial gaps; conversely, if there is a redundancy of lip tissue in relation to the existing vertical dimensions, no interlabial gap is present. Fig. 2 shows three patients with lip-length inadequacies and subsequent large interlabial gaps. In Fig. 2, A there is an interlabial gap of 7.0 mm., with the lips closely adapted to the upper and lower incisors. Fig. 2, B illustrates a similarly large interlabial gap, with the lips away from the labial surfaces of the teeth. The largest interlabial gap of the group (12.0 mm.) is shown in Fig. 2, C.

When the lips are long in relation to the vertical dimension of the lower part of the face (lip-length redundancy), the lips are in contact and tend to bulge forward away from the teeth (Fig. 3).

A number of factors can be responsible for variation in interlabial gap. In the first place, there may be differences in length of either or both lips. In the

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*Thirty-two boys and girls, 13 to 15 years of age, selected on the basis of facial appearance from a group of 3,000 Caucasian children by nonorthodontists (teachers, artists, and housewives). Throughout the remainder of the present article, these subjects will be referred to as the normal adolescent sample.
second place, there may be a variation in skeletal height in the anterior portion of the face. In view of the great amount of variation in interlabial gap, it is apparent that there must be a lack of correlation between vertical height of the skeleton and vertical length of the lips. In order to gain some insight into the last factor, a number of lip-length measurements were made. When one attempts to evaluate the relative length of the upper and lower lips, it is convenient to divide the lower face into two portions. The upper portion, representing the upper lip, is measured from subnasale to stomion (lowest point on the upper lip).
The lower portion, which encompasses the lower lip and the chin, is measured from stomion (highest point on the lower lip) to gnathion (Fig. 4). In order to establish soft-tissue gnathion, a line perpendicular to the palatal plane is dropped from the lowest point of the outline of the mandibular symphysis to the soft tissue of the chin. The linear measurement of upper lip length as well as the lower lip–chin dimension is measured perpendicular to the palatal plane.

Significant differences in length of the upper lip were noted between boys and girls in the normal adolescent sample; hence, the means and standard deviations are listed by sex (Table I). Approximate average lengths for the upper lip as measured from the lateral headplate are 24 mm. for boys and 20 mm. for girls. In a typical sample of malocclusions, considerably greater variation in lip length is usually to be expected. The type of variation that can be seen in adolescent girls with Class II, Division 1 malocclusions is shown in Fig. 5. The shortest lip is observed in Fig. 5, A where the vertical dimension from subnasale to the lower border of the upper lip is 16 mm. Fig. 5, B shows a more typical lip, which is 20 mm. in length. At the other extreme (Fig. 5, C) is an exceedingly long lip, with a dimension of 26 mm.

It has been suggested that the length of the upper lip tends to be shorter in persons with Class II, Division 1 malocclusion than in those with normal faces or occlusions. For purposes of comparison with the normal sample, a group of Class II, Division 1 patients with full-cusp distoelusions were selected.* However, no significant differences in length of the upper lip between the two samples could be found with the use of the “t” test.

*The Class II, Division 1 sample was composed of a group of full-cusp distoelusions selected at random from the clinic at the Indiana University School of Dentistry. The sample is made up of twenty boys and girls in the age range of 12 to 14 years.
Table 1. Lip length in normal adolescent sample

<table>
<thead>
<tr>
<th></th>
<th>Mean (mm.)</th>
<th>S.D. (mm.)</th>
<th>Range (mm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper lip length</td>
<td>23.8</td>
<td>1.5</td>
<td>21.5 to 26.0</td>
</tr>
<tr>
<td>Lower lip length</td>
<td>49.9</td>
<td>4.5</td>
<td>42.0 to 58.0</td>
</tr>
<tr>
<td>Ratio Lower lip length/Upper lip length</td>
<td>2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper lip length</td>
<td>20.1</td>
<td>1.9</td>
<td>17.0 to 23.0</td>
</tr>
<tr>
<td>Lower lip length</td>
<td>46.4</td>
<td>3.4</td>
<td>38.0 to 52.0</td>
</tr>
<tr>
<td>Ratio Lower lip length/Upper lip length</td>
<td>2.3</td>
<td></td>
<td></td>
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</table>

Fig. 5. Variation in upper lip length. Length from subnasale to stomion: A, 16 mm.; B, 20 mm.; C, 26 mm. All three cases are Class II, Division 1 malocclusions.

Another method of evaluating the relative length of the lip is to measure the distance from the inferior border of the upper lip to the tip of the incisal edge. This vertical measurement between stomion and incision is made at a right angle to the palatal plane. In the normal face the maxillary incisor projects inferiorly 2.3 mm. to the lower border of the upper lip, with a standard deviation of 1.9 mm. A significant difference between the adolescents with normal faces and those with Class II, Division 1 malocclusions was noted in the stomion-incision measurement (0.1 per cent level of confidence). Since lip length, on the average, tends to be normal in the Class II, Division 1 case and yet the stomion-incision measurement is smaller than normal, it would appear that the maxillary incisor is supraerupted in the Class II malocclusion. This is not to imply that there is not considerable variation in the stomion-incision measurement in Class II malocclusions. The range of variation can be demonstrated by the two tracings shown in Fig. 6, in which both A and B show upper lips of patients with full-cusp distoelusions and marked overjet. The distance between the lower border of the lip and the incisal edge is 2 mm. in A and 8 mm. in B.

From an esthetic point of view, the relative length of the upper lip and the position of its lower border to the incisal edge of the maxillary incisor has considerable clinical significance. If only the appearance of the dentition is considered, the stomion-incision measurement may be somewhat useful in deter-
mining the anterior end of the occlusal plane. The position of the maxillary incisor may be quite precarious in a Class II, Division 1 case, since a high percentage of these patients have a greater than average stomion-incision measurement before treatment. Poor mechanics, such as indiscriminate use of Class II elastics, may cause added eruption of the maxillary incisors and thus further increase this dimension. A "treated look" is produced, with both tooth and gingiva showing.

Not only can the absolute length of the upper lip be measured and compared to the position of the maxillary incisor, but it can also be related to the length of the lower lip and chin. If a measurement is made between stomion and gnathion perpendicular to the palatal plane (Fig. 4), and if a ratio is made between this dimension and the length of the upper lip, it will be found that in the normal face there is a ratio of 2 to 1 in favor of the stomion-gnathion dimension. Some facial disharmonies are vertical in nature and are associated with a disproportion in the ratio between the upper lip and the area comprising the lower lip and chin.

It is thus that the interlabial gap is determined by a number of factors, including anterior skeletal height, dental protrusion, inherent lip length, and lip posture.

HORIZONTAL CHARACTERISTICS. In any discussion of lip posture, it is necessary to consider not only the vertical posture but also the horizontal or anteroposterior posture of the lip. A useful plane for evaluating the relative protrusion or retrusion of the lips is one connecting subnasale and soft-tissue pogonion. Practically, the plane is established by dropping a tangent to the chin area from subnasale (Fig. 7). Subnasale is that landmark where the upper lip meets the inferior border of the nose. In some lip contours, a definite point cannot be located at the juncture of the lip and nose and, for convenience of reproducibility, the deepest point relative to a 45 degree angle to the palatal plane is then used as subnasale. Lip protrusion or retrusion is measured as a perpendicular linear distance from the subnasale-pogonion plane to the most prominent point on the upper and lower lips.

The subnasale-pogonion plane has been selected as a plane of minimal variation in the area of the face. If tracings of nongrowing persons are superposed before and after treatment, subnasale and pogonion will not show a radical change, provided that the headplate is taken in the relaxed-lip position. Ricketts' has suggested the use of an esthetic plane joining points on the nose and the chin.
Fig. 7. Horizontal lip posture. Lip protrusion is measured perpendicular to subnasale-pogonion plane.

Table II. Lip line (incision-stomion) in normal adolescent sample

<table>
<thead>
<tr>
<th>Mean (mm.)</th>
<th>S.D. (mm.)</th>
<th>Range (mm.)</th>
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<tbody>
<tr>
<td>2.3</td>
<td>1.9</td>
<td>0.3 to 9.0</td>
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The question arises whether the selection of the point of the nose as a landmark brings into play an area that will vary more than the one we are interested in measuring, that is, the lips. To investigate the variation of nose length, two perpendicular lines were dropped to the palatal plane from subnasale and the tip of the nose (Fig. 8). The pertinent statistics from the normal adolescent sample are given in Table III. Of particular interest is the magnitude of the standard deviation, which is approximately twice as great as the standard deviations that are estimates of variation in lip protrusion (Table IV). For this reason, it was deemed desirable to avoid the area of the nose in any attempt to evaluate the protrusion or retrusion of the upper and lower lips. This is not to suggest, however, that the nose is not a factor to be considered in orthodontic case analysis.

In the normal adolescent sample, the upper and lower lips fall forward of the subnasale-pogonion plane. On the average, the upper lip is 3.5 mm. anterior to the line and the lower lip lies 2.2 mm. anteriorly. It can be seen that the upper lip projects slightly more than the lower lip relative to this line. The standard deviations and the range of variation are given in Table IV. No significant
Fig. 8. Measurement of nose length. Perpendicular lines are dropped from subnasale and tip of nose to palatal plane. Nose length is measured between these two intersections along palatal plane.

Table III. Nose length in normal adolescent sample

<table>
<thead>
<tr>
<th>Mean (mm.)</th>
<th>S.D. (mm.)</th>
<th>Range (mm.)</th>
</tr>
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<tbody>
<tr>
<td>15.5</td>
<td>2.8</td>
<td>12.0 to 20.0</td>
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</table>

Table IV. Lip protrusion in normal adolescent sample

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Mean</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper lip to Sn-Pg</td>
<td>3.5 mm.</td>
<td>1.4</td>
<td>1.0 to 6.0 mm.</td>
</tr>
<tr>
<td>Lower lip to Sn-Pg</td>
<td>2.2 mm.</td>
<td>1.6</td>
<td>-0.5 to 6.0 mm.</td>
</tr>
<tr>
<td>Upper lip inclination to palatal plane</td>
<td>97.5°</td>
<td>9.3</td>
<td>87.5° to 113.6°</td>
</tr>
<tr>
<td>Nasolabial angle</td>
<td>73.8°</td>
<td>8.0</td>
<td>60.0° to 90.0°</td>
</tr>
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</table>

differences in lip protrusion were found between male and female subjects in this sample. As might be expected in malocclusion groups, there may be considerable variation in the protrusion of the upper lip, the lower lip, or both lips. The variation that can be found in lip protrusion is demonstrated by four malocclusions in Fig. 9. A bimaxillary protrusion with an anterior cross-bite is seen in Fig. 9, A. Here, instead of minimal projection of lips beyond the subnasale-pogonion plane, the upper lip is 9 mm. forward and the lower lip 12 mm. forward of this plane. The lip posture in the Class II, Division 1 case shown in Fig. 9, B is different in that the lips do not hug the teeth and hence contribute more to
Fig. 9. Variation of horizontal lip posture (relaxed-lip position). A, bimaxillary protrusion; B, bimaxillary protrusion; C, upper lip protrusion and lower lip retrusion; D, retrusion of upper and lower lips. Plane of reference is subnasale-pogonion.

the measured protrusion in the relaxed-lip position. Both the upper and the lower lips lie 9 mm. in front of the subnasale-pogonion plane. The Class II, Division 1 case shown in Fig. 9, C demonstrates another type of variation that can be observed in the anteroposterior lip posture in cases of overjet. The upper lip lies 6 mm. anterior to the reference plane, while the lower lip lies on the plane. Finally, in the Class II, Division 2 case shown in Fig. 9, D both upper and lower lips are abnormally retrusive, particularly the lower lip. The upper lip lies 1.5 mm. forward of the subnasale-pogonion plane. The lower lip, however, is quite retrusive, lying 3 mm. behind the plane.

Planes of reference other than subnasale-pogonion may be used to evaluate the protrusion or retrusion of the upper lip. For instance, an angular reading can be employed to measure upper lip protrusion (upper lip inclination). The upper lip inclination (Fig. 10) is measured by the intersection of the line subnasale-labrale superius with the palatal plane. Normally, the lip is slightly flared, forming an angle of 97.5 degrees with the palatal plane. It should not be particularly surprising that the upper lip was found to be significantly flared when the Class II, Division 1 sample was compared with the normal sample (0.1 per cent level of confidence). This is not to imply that in all Class II, Division 1 cases the upper lip is flared, for considerable variation in the inclination of the upper lip can be observed in these malocclusions. For instance, two upper lips from Class II, Division 1 cases are shown in Fig. 11. In Fig. 11, A an angle of 90 degrees is formed between the lip and the palatal plane, while in Fig. 11, B the upper lip is in protrusion, with an angle of 111 degrees. The protrusion of the upper lip in the Class II case is not only produced by the flared upper incisors but may also be influenced by how closely the upper lip is adapted to the incisor as well as by the thickness of soft tissue in the area of subnasale.

From an esthetic viewpoint, it may be somewhat useful to measure the
protrusion of the upper lip relative to the inferior border of the nose. This is done by the nasolabial angle (Fig. 10), which is formed by the intersection of a line, originating at subnasale, tangent to the mean of the lower border of the nose and a line from subnasale to labrale-superius. A typical nasolabial angle is approximately 74 degrees. Clinically, the nasolabial angle may be significant, since the layman is likely to evaluate upper lip protrusion in relation to the nose. Class II, Division 1 cases which, before treatment, have obtuse nasolabial angles are particularly difficult. Following retraction of the anterior teeth, the obtuseness may increase to the point of deformity. The patient may then have a typical "orthodontic look," with a sunken-in upper lip.

Observing the variation in the anteroposterior positioning of both upper and lower lips, one may ask what factors determine the relative position of these lips in a horizontal plane. Certainly, the variable of lip thickness must be considered one major factor which can influence the amount of protrusion or retraction of the lips. The question of the role of tooth position in lip protrusion has still to be answered. Do the teeth push the lips out into varying positions? Or do the lips have a posture of their own independent of tooth position? In an effort to answer this question, a sample of young adult edentulous patients was selected. Special bite rims were constructed to maintain the vertical dimension, which was previously established by a phonetic method. The anterior portions of the bite
rims were radically cut away to make certain that they afforded no lip support. It was thus possible to study the horizontal posture of the lips without any tooth or alveolar process support (in several subjects some alveolar process was present). The horizontal posture of the lips in a relaxed state, as observed in the edentulous sample, is reported below.

Subject 1 illustrates a fairly normal type of soft-tissue profile (Fig. 12, A). Both the interlabial gap and the lip protrusion are fairly typical. It can be seen that, even without the support of the teeth, the lips have remained in a fairly normal position and have not fallen back to the level of the bite blocks. The bite blocks have served a dual function. First, they have maintained the proper vertical dimension for the patient and, second, they have prevented the tongue from coming forward and adding to the lip support.

In Subject 2 (Fig. 12, B) the lips are slightly protrusive in relation to the
subnasale-pogonion plane; yet this protrusion occurs without the support of the upper and lower incisors. Subject 3 (Fig. 12, C) demonstrates even greater lip protrusion without dental support. In this case both upper and lower lips lie 5 mm. in front of the subnasale-pogonion plane. Once again, the lack of dental support should be noted.

In Subjects 4 and 5 (Fig. 12, D and E) the lips are found to be more retrusive than normal; however, they still have not fallen back to approximate the labial surfaces of the bite rims. The lower lip of Subject 5 lies 5 mm. behind the subnasale-pogonion plane. It is interesting to compare Subjects 3 and 5, since both patients exhibit retrognathic skeletal patterns, that is, the mandible lies posterior to the maxilla. In Subject 3, however, the lower lip is postured protrusively, and in Subject 5 it maintains a retrusive position.

The edentulous patients presented up to this point have been characterized by fairly typical interlabial gaps. In the next series, the patients are lacking an interlabial gap and demonstrate the effect of lip redundancy on the general posture of the lips. In the headplates shown from Fig. 12, F through 12, J, attention is called to the support that the upper and lower lips give to each other. In Subjects 9 and 10 the excess lip length has forced the upper and lower lips into a state of protrusion. The lower lip of Subject 10 is bulged forward of the subnasale-pogonion plane by 9 mm. (Fig. 12, J).

A careful study of the edentulous sample suggests that there is a relaxed-lip position that is independent of teeth and the supporting alveolar process. In this group with loss of dental-alveolar support, the lips did not fall back routinely into retrusive positions. It is interesting to note that this group of young adult edentulous patients did not exhibit the facial concavity which is usually associated with an older age group. Perhaps other changes, including age changes, in the soft-tissue mass of the lips may be responsible for this difference.

The point might be raised that, even though the teeth have been extracted, the upper lip may be supported by the apical base area of bone or by the remaining alveolar process. In most of the cases which have been studied, the remaining area of bone in the maxilla is apical to that bone which is most dramatically changed during routine orthodontic tooth movement. On the other hand, the lower lip appears relatively free and away from the bony support of the mandible in this group.

Although common experience tells us that lip posture can be influenced by tooth movement, it can now be postulated that there is a relaxed postural position of the lips which is independent, or partially independent, of tooth position. As observed in the edentulous sample, there is considerable variation in an antero-posterior direction in the relaxed position of these lips. In some persons the lips are postured in a relatively protrusive manner, while in others they maintain a retrusive posture. In the same person there may be different degrees of protrusion and retraction between the upper and lower lips.

CLOSED-LIP POSITION

Even though an understanding of the relaxed-lip position is essential to an appreciation of lip function, the patient normally does not assume this pose in
his daily activity. Rather, he maintains an effective lip seal which facilitates swallowing, protects the teeth and the gingivae, and adds certain retaining forces to maintain the position of the anterior teeth.

In the normal person, minimal muscular contraction is required to move the lips from their relaxed position to one of light closure (Fig. 13). Since the interlabial gap is small, this is to be expected. During typical contraction the lower lip contributes more movement to the closure of the interlabial gap than does the upper lip. Simultaneously, both upper and lower lips flatten against the incisors. There may or may not be a small amount of flattening in the area of the chin which is associated with contraction of the mentalis muscle. Typically, this flattening is extremely small or nonexistent.

It is difficult not to be impressed by the great amount of variation in the manner of lip closure during the change from the relaxed to the closed-lip position in persons with dentofacial disharmonies.

Two cases are used to illustrate the variation that can be observed. Fig. 14, A shows a Class II, Division 1 malocclusion with an 11 mm. interlabial gap. In order to effect closure, the patient must elongate the upper lip, which increases in length during contraction by 6 mm., and at the same time he must project the lower lip upward and forward by contraction of the mentalis muscle. During this process the upper lip is flattened against the upper incisor, which eliminates the normal contour of the maxillary sulcus. The contraction of the mentalis muscle flattens the chin area and moves the inferior sulcus upward and forward. By this action, the lower lip appears to be reaching for the upper lip and, in a sense, is attempting to avoid the maxillary incisor.
Fig. 14. Abnormal path of closure from relaxed-lip position. A, Class II, Division 1 case. Upper lip flattens and elongates; lower lip moves upward and forward with flattening of chin area. B, Class III case. Normal upper lip response; lower lip moves upward and backward.

The typical manner of lip closure in the Class III case is somewhat different. For example, the Class III malocclusion patient shown in Fig. 14, B elevates the lower lip in an upward and backward manner. He must close an interlabial gap of 6 mm. in order to produce a lip seal. The lower lip contributes the most to this closure, as it rises 5 mm. The upper lip elongates 1 mm. as it retrudes and flattens against the upper incisor.

ANTEROPosterior POSITION OF THE DENTITION. One of the central problems in orthodontic treatment planning is the determination of the anteroposterior position of the incisors. Some orthodontists prefer to solve this problem by the arbitrary use of cephalometric standards based upon dentoskeletal landmarks. Perhaps an added dimension for establishing the position of the incisors is available if one considers soft-tissue morphology and lip posture. It is generally agreed that one of the objectives of orthodontic treatment is improvement of facial form. There are dangers, however, in using average profile readings of teeth, skeleton, or soft tissue as guides or objectives for a given patient.

Fig. 15 shows two dental bimaxillary protrusions. In the first (Fig. 15, A), the lips are relatively short in comparison with the vertical dimension, and hence the patient has a great deal of difficulty in effecting lip closure. In the other patient, on the other hand, lip length is quite adequate and the patient experiences no difficulty in maintaining contact of the upper and lower lips (Fig. 15, B). Should the orthodontic treatment objectives be the same for both cases? In the first instance a facial disharmony is produced for, when the patient attempts to close his lips, the upper lip is flattened, the mandibular sulcus is raised, and the chin area is flattened. For esthetic reasons alone, it would be desirable in this type of case to reduce the dental protrusion and, therefore, to make it easier for the patient to effect anterior lip seal. The second bimaxillary protrusion presents a slightly
Fig. 15. Two patients with bimaxillary protrusion. A, Lip-length inadequacy with large interlabial gap. B, Lip-length redundancy.

Fig. 16. Lip posture in two Class II, Division 1 cases. A, Lower lip tight and retruded against lower incisors. B, Lower lip flaccid and away from teeth.

different problem (Fig. 15, B). Here lip length is adequate and the protrusion of the anterior teeth does not affect the ease of lip closure. Even though, for esthetic reasons, it would be desirable to retract the upper and lower lips, it is questionable whether the lips would retract following retrusion of the anterior teeth since a redundancy of lip length does exist. From the standpoint of soft tissue, all bimaxillary protrusions do not present the same problems.
Not only might the degree of interlabial gap be helpful in determining the position of the anterior teeth, but the horizontal posture of the lips might be suggestive as well. As was seen in the edentulous sample, the relaxed-lip posture is retrusive in some patients while in others it may be protrusive. Although positive proof cannot be given at this time, it may be well to formulate the following working hypothesis, which needs further clinical testing, as a guide for planning the final anteroposterior positioning of the incisors.

Myometric studies by Winders and others have shown that stable normal occlusions and malocclusions have minimal lingually directed pressures against the incisors. It is also known that relatively small forces can produce lingual tipping of the incisors. Stability of the incisors is dependent on an equilibrium of forces on the crowns of the teeth, since thresholds for bony resistance in simple tipping movements are very low. This equilibrium is time-linked and perhaps is best described as an "energy" equilibrium.

An anterior component of forces on the incisors can be produced by the tongue, the occlusion (normally the upper incisors have an anterior component and the lower incisors a posterior component), and the total resistance of the dental arch. The lips and occlusion supply the posterior component of force. Lip posture should be considered an important element, if not the most important element, in determining a stable position for the incisors.

The starting place for evaluating lip posture is the relaxed-lip position. A retruded lip pressed against a lower incisor is less suggestive of the desirability of protruding the lower incisor during treatment than a lip that is protruded and lying away from the incisor. Normally, a relaxed lower lip will contact the lower incisor at the junction of its incisal and middle thirds. This can be used as a rough guide in evaluating the relative inherent protrusiveness of the lip in its relaxed state.

The closed-lip position for the patient should next be evaluated. If the interlabial gap is small and the position of the teeth typical, lingually directed forces (the posterior component of force) will increase only slightly as the lower lip moves posteriorly from the relaxed to the closed-lip position. If the interlabial gap is large, the patient will markedly increase the posterior component of force as he attempts to close the lips. This implies that even if the lips are posturally protrusive, protrusion of the teeth may not be stable if the interlabial gap is large. In this type of situation, an overly protruded dentition may be stable if the patient adapts by using the relaxed-lip position as his habitual lip posture. If closure by the mentalis muscle is used to seal the lips, the lower lip is brought forward, which minimizes pressures on the incisors. Esthetically and functionally, the use of the mentalis muscle in this way is not desirable, even though the reduced posterior component of force may aid stability.

Thus, the desirability of maintaining the lower incisor in its original position or retruding or protruding it may be influenced by the postural position of the lower lip. For example, both of the Class II, Division 1 cases shown in Fig. 16 are characterized by an overjet, but there is a striking difference in the lower lip postures. In Fig. 16, A the lower lip is in close apposition to the lower incisor (retruded posture), whereas in Fig. 16, B the lower lip is protruded from the incisor (protruded posture). It should be remembered that the foregoing
statements which imply that the lower lip may be used as a guide for positioning the incisors should be tempered by the fact that other variables besides the posture of the lower lip can influence the position of the maxillary incisor.

It should also be pointed out that the lips have a striking ability to adapt to the teeth, whether they be protrusively or retrusively placed. In certain bimaxillary protrusions, the lips appear actually to reach to a more forward position to cover the teeth with minimal lingual pressures on the incisors. This adaptability of the lips to different tooth positions in the same person suggests that there may be multiple positions of stability for a given patient. It should be remembered that the starting position for the lips as they begin to effect an anterior oral seal is a relaxed position and that this position is fundamental to an understanding of the posture of the lips when they are closed.

PREDICTION OF FACIAL CHANGES

If we are interested in answering the question of how far forward or backward the lips will move following orthodontic treatment, the relaxed-lip-position headplate is the most useful. Attempts to predict soft-tissue changes on the basis of the closed-lip position are complicated by the fact that the lips may be overly stretched and flattened in their effort to effect lip closure.

Forgetting about the influence of growth, the most dramatic facial changes following the retrusion of teeth are seen in those cases in which there is a large or normal interlabial gap. If a redundancy or a potential redundancy of lip tissue exists, most likely the lips will not fall back following retraction of the teeth (Fig. 17). The treated case pictured in Fig. 18 shows the effect of lip-length redundancy on the fall-back of the lip following retraction of the maxillary incisors. The maxillary incisor has been retracted a considerable distance, and yet the posture of the upper and lower lips in the closed position is approximately the same. Lip contact because of the redundancy tissue has maintained the lips in a more protrusive position than normal. It can also be noted that there is an area of space between the upper and lower lips and the labial surfaces of the incisors. If one considers malocclusions, with and without interlabial gap, it appears that no simple formula can be given for predicting the amount of lip displacement following retraction of the incisors.

LIP POSTURE AS AN ETIOLOGIC FACTOR

One could theorize about the relationship between lip posture and the position of the teeth as well as the development of different types of malocclusion. The possibility exists that in persons of certain types who have large interlabial gaps, strong lingual forces are directed against the incisors in an effort to effect lip closure, producing a dental retrusion. In other persons who also have large interlabial gaps, there may be no attempt to produce lip closure, with the result that the teeth may move into a position of bimaxillary protrusion. Although these possibilities may reasonably explain certain bimaxillary retrusion and protrusion malocclusions, little documentation is available as yet.

The British investigators have attempted to associate lip incompetence or large interlabial gaps with abnormal swallowing patterns. They believe that in
order to produce an anterior oral seal, the patient may project the tongue between the upper and lower lips and thereby initiate a more infantile type of swallowing response.

One can also theorize about the horizontal relaxed-lip posture and its relationship to retrusive and protrusive dentitions. If the interlabial gap is small, are dentitions more protrusive in those persons who have a protrusive relaxed-
lip posture? Conversely, do retrusively relaxed lips produce retrusive dentitions? Superficially, this is what has been observed. More study of this problem is needed, with pressure measurements of the lips in their various postural states.

The role of the lips in the formation of the Class II malocclusion has been discussed previously by Brodie and others. In the Class II, Division 1 case, the lower lip lies lingual to the maxillary incisor and exerts a labial pressure on it. Conversely, in the Class II, Division 2 case, the lower lip lies labial to the incisor and is in a position to exert lingual pressures. It is interesting to note that in most of the Class II, Division 2 cases that I have observed, there is an adequacy or redundancy of lip length. This may imply that, even in the face of a skeletal discrepancy, the lower lip is sufficiently long to position itself on top of the upper central incisor.

If one accepts the concept that tooth position is determined by the muscular environment of the dentition, lip posture and lip function assume an important role. This is not to preclude the importance of the tongue, the muscles of mastication, or other habitual activities in the development of a malocclusion.

Finally, the relationship between lip posture and the width of the dental arches needs to be explored. Since the orbicularis- oris complex is continuous with the buccinator muscle, forming part of the so-called “wrap-around” muscle sheath, it is logical to expect that changes in the postural position of the lips during treatment and development may alter the form of the dental arches.

**TREATMENT OBJECTIVES**

In planning treatment for a given malocclusion, it is well to keep in mind what the real objectives might be. It is easy to fall into the trap of believing that certain arbitrary standards, if adhered to, will automatically produce a desirable orthodontic result. A better approach is to treat to the real objectives of esthetics, stability, and function. It is not surprising that lip posture is intimately associated with all three of these objectives.

First, let us consider the objective of facial esthetics. In our present society, where conformity is appreciated and sometimes demanded, it may appear desirable to the orthodontist to attempt to make all faces alike. For this purpose, dentoskeletal and soft-tissue standards of normal or desirable faces can serve as guides in stereotyping the facial appearance of treated orthodontic patients. However, in the light of the postural variation of the lips, not to mention variation in the dentoskeletal patterns, the validity of this approach should be severely questioned. Consideration of postural variation necessarily leads to the acceptance of differences in facial form among individuals.

The objective of stability is relatively complicated and involves a great deal more than consideration of lip posture. It has been suggested, though not proved, that teeth cannot be placed forward of a relaxed postural position for the lips unless other forces are at work to maintain the teeth in a seemingly unstable position. The preceding statements are given only as a working hypothesis until more information about the role of lip posture and stability of the dentition is available.
In terms of a functional objective, it seems reasonable to position the teeth so that minimal muscular contraction is required to move the lips from the relaxed to a closed position. The ability to produce an adequate oral seal then becomes one of our functional objectives in orthodontic therapy.

**SUMMARY AND CONCLUSIONS**

Lip posture and its role in orthodontic case analysis has been considered. The posture of the lips in two fundamental positions (a relaxed and a closed position) are described for both normal and malocclusion groups.

1. The technique of obtaining a relaxed-lip position is reasonably reproducible, but, like all muscular positions, somewhat variable.

2. Normally, a small vertical space or interlabial gap is found between the upper and lower lips in the relaxed position. In malocclusions and facial disharmonies, the interlabial gap may be large or completely lacking.

3. Samples of dentulous and edentulous persons suggest that there is an anteroposterior posture of the lips which is independent of the teeth and the alveolar process.

4. Minimal lip contraction is required to seal the anterior portion of the oral cavity in the normal person. The lower lip normally contributes more movement to effect closure than the upper lip, as both lips simultaneously retrace and flatten against the incisors.

5. The path of closure may vary considerably in cases of malocclusion, depending upon the amount of overjet, underjet, protrusion, and retrusion of the incisors as well as the amount of interlabial gap.

6. Facial disharmonies may be observed in the absence of dentoskeletal discrepancies. These facial disharmonies may be associated with either inadequacies or redundancies of lip length.

7. The relaxed-lip posture of the lower lip has been discussed as a possible guide for the positioning of the upper incisors. It has been suggested that the incisor cannot be placed forward of the relaxed position of the lower lip, provided the overjet is normal and the patient maintains a habitual lip seal.

8. Soft-tissue changes following retraction of the incisors can more easily be predicted if the relaxed-lip position is used as a basis for such a prediction.

9. The role of lip posture as an etiologic factor in the formation of a malocclusion has been discussed.

10. It has been suggested that one of the objectives of orthodontic treatment should be to minimize the amount of lip contraction from the relaxed to the closed position.

**REFERENCES**


