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# *Skeletal morphologic features of anterior open bite*

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Lateral cephalograms of sixty patients with open bite and sixty untreated subjects who were determined clinically to have Class I normal occlusions were studied. The following six values were recorded: (1) ratio of posterior to anterior face height, (2) ratio of upper to lower face height, (3) Sn GoGn angle, (4) gonial angle, (5) SN-PP angle, and (6) PP-GoGn angle. Results were compared with previous studies. The constancy of the ratios and angles with age was tested and an attempt was made to separate the open-bite sample into skeletal and dentoalveolar groups. Results were generally consistent with those reported previously, except for the Sn PP angle, which was not significantly different from the normal group. In the open-bite sample the study showed a decrease in the ratio of PFH/AFH, a decrease in the ratio of UFH/LFH, and an increase in the other angles measured. Upon further division of the sample into mixed- and permanent-dentition groups, it was found that the angles and ratios remained relatively constant with age. An attempt to divide the open-bite sample into skeletal and dentoalveolar groups resulted in more extreme values for all the measurements made. The difficulty in differentiating between the two groups and the variability of dentoskeletal patterns in open bite is discussed.

**Key words:** Open bite, skeletal, face height, ratio, angle

In the past, much attention has been given to the diagnosis and treatment of anteroposterior malrelationships of the dental arches. Most of the literature and the mechanotherapy which accompanied it were directed primarily at the solution of this problem, as is evidenced by the Angle classification of malocclusion which is directed only to the horizontal discrepancies of the maxilla and the mandible. However, the cases which have proved most difficult to treat and which have the least favorable prognosis are frequently those in which there is a vertical discrepancy that is manifested anteriorly either as a deep overbite or as an open bite. This study will be limited to the discussion of anterior open bite.

In order to determine the prognosis for a case involving anterior open bite, it must be decided whether the open bite is a true skeletal dysplasia or a habitual problem involving only the dentoalveolar structures. In addition, any means of identifying the skeletal pattern of an open bite may be helpful in the possible prevention or early treatment of this condition and also be a guide in assuring that the mechanics employed will not aggravate the condition. Many studies have been done and much information has been obtained regarding the morphologic characteristics and specific areas of this dysplasia.

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## REVIEW OF THE LITERATURE

In 1931 Hellman[1] conducted a study on 43 patients, both treated and untreated, who exhibited anterior open bite. Of those cases which were treated, he found that the percentage of successful treatments was equal to the number of spontaneous self-corrections in the untreated group. On the basis of these observations, he suggested that open bite is primarily due to skeletal growth deficiencies. However, Swinehart[2] and Straub[3] concluded that tongue thrust is the primary cause of open bite and that retraining the tongue and eliminating muscle dysfunction will correct the condition. On the other hand, Subtelny and Subtelny[4] have indicated, after reviewing the literature, that muscular activity during deglutition is principally dictated by form. That is, the tongue is thrust forward in order to effect the oral seal necessary for this act. Therefore, it becomes questionable as to whether tongue thrust causes open bite or whether the reverse is true.

Age and growth factors also play an important role in anterior open bite. In a study of 1,408 Navajo children, Worms[5] found that there was a spontaneous correction of 80% of the anterior open bites as one proceeds from a 7- to 9-year age group to a 10- to 12-year age group. Other studies[6, 7] have shown that tongue thrust is the main mode of swallowing up to the age of 10 years. After that age, there is a marked decrease in this form of swallowing, which may account for the spontaneous correction in the study previously referred to.

In a review of the literature, it has become obvious that most investigators believe that tongue thrust cannot be considered the primary etiologic factor in the majority of open-bite cases. Cephalometric appraisal of open-bite and normal patients has proved to be a useful tool in pointing out the morphologic differences in both and indicating the specific areas responsible for this condition.

In 1964 Schudy[8] stated that vertical dimension is the most important dimension to the clinical orthodontist and that vertical dysplasias are inseparably related to both open and closed bites. He also stated that retrognathic persons are likely to exhibit greater lower face height, whereas prognathic persons are more likely to exhibit a shorter lower face height. In computing the ratio of posterior to anterior face height, he measured posterior face height from articulare to the mandibular plane, tangent to the posterior border of the ramus at the gonial angle. Anterior face height was measured from nasion to menton. He found that the ratio was 62.91% in an average group, 57.23% in a retrognathic group, and 69.28% for a prognathic group.

Hapak,[9] in a cephalometric appraisal of open bite, concluded that it occurs with a variety of skeletal patterns. The sample that he studied showed a Class II tendency and proved to be retrognathic on the Downs facial diagram. It also showed an average Frankfort-mandibular plane angle of 33.4° and a sella-nasion to GoGn angle that was 6.3° greater than normal.

Richardson[10, 11] found that there was a significantly greater lower face height and greater jaw and joint angles in open-bite cases. He concluded that the cause of open bite from 7 to 10 years of age is delayed vertical growth of the upper face and increased lower face height, combined with a lack of vertical growth of the dentoalveolar structures. He believes that, with time, the growth of the upper face will correct itself but that vertical development of the dentoalveolar structures will never catch up. Therefore, it seems that anterior open bite may be attributed to both skeletal and dentoalveolar discrepancies.

Moss and Salentyn[12] studied the position of the inferior alveolar nerve. They took a large series of skulls at various dental ages and placed metallic implants in the three foramina (foramen ovale, mandibular foramen, and mental foramen). They then took cephalometric radiographs and, using norma lateralis, described the following. They showed that the three foramina of the inferior alveolar nerve fall on a logarithmic curve and that in open-bite cases the foramen ovale is placed further down on the logarithmic spiral than for any other group studied. This is as a result of developmental abnormalities in the oral functioning space acting as a capsular matrix. They stated that this information might be significant and diagnostic of an impending open bite at an early age before it is manifested clinically.

Nahoum[13] found that the ratio of upper face height to lower face height was smaller for open-bite subjects and that this ratio was constant at all ages. These measurements were made for both male and female patients and, although there was a 10% increase in total face height in males, the ratios of upper to lower face height for the control group were not significantly different. In the open-bite group, this ratio was extremely similar for both males and females; therefore, the data were pooled. Nahoum also found that the SN-to-palatal-plane (SN-PP) angle was smaller and the PP-GoGn angle was greater for open-bite subjects, which may suggest a tipping upward of the palatal plane anteriorly. The Sn GoGn angle was greater in the open-bite subjects, suggesting a greater overall anterior face height.

In a second study[14] it was concluded that persons with open bite have a greater lower anterior face height and generally a shorter posterior face height. They were also found to have a larger gonial angle. In this study, posterior face height was measured from sella to gonion.

## OBJECTIVES OF THIS STUDY

The purpose of this study was to determine whether results obtained in previous studies may be duplicated in the sample being used. The constancy with age of the ratios and angles measured was also tested. An attempt was also made to separate skeletal from dentoalveolar open bites in compiling statistics in order to give a more accurate picture of skeletal open-bite morphology.

## METHODS AND MATERIALS

The material consisted of lateral cephalometric radiographs of 60 open-bite patients from the files of the Columbia University Orthodontic Department. The criterion for determining open bite was at least a 1 mm opening when the incisal edges of the maxillary and mandibular incisors were projected perpendicularly onto the facial plane (N-Me). Of these patients, 30 were in various stages of mixed dentition and 30 were in the fully developed permanent dentition. There were 33 female and 27 male patients. The entire group was further broken down according to the Angle classification of malocclusion; 31 were Class I, 24 were Class II, and 5 were Class III.

The control group consisted of lateral cephalograms of 60 untreated subjects who were determined clinically to have normal Angle Class I occlusions. Of these 30 were males and 30 were females.

Tracings were made of the above cephalograms on

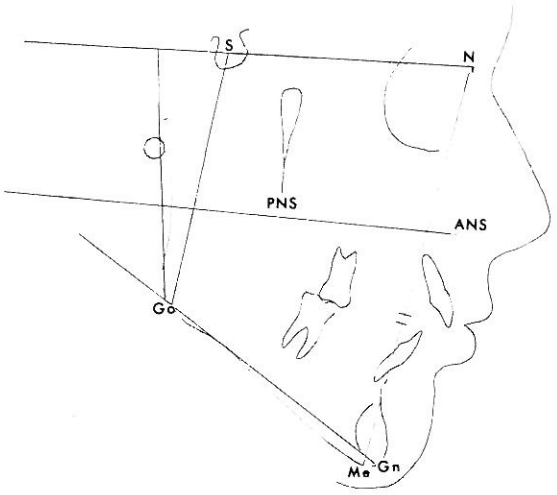


**Fig. 1.** Cephalometric tracing of landmarks and planes used in study.

8 × 10 inch translucent tracing acetate over a standard illuminated viewbox with a transparent metric rule. All angular measurements were made with a Baum cephalometric protractor. The linear measurements were made with a Keuffel and Esser straightedge to minimize error. Many of the angular measurements were checked with a Keuffel and Esser protractor, and the results obtained were essentially the same. All angular measurements were made to the nearest 0.5°, and all linear measurements to the nearest 0.5 mm.

The following landmarks were used and are defined according to the First Cephalometric Workshop held at Western Reserve University in Cleveland in 1958:

1. *Sella (S)*—The midpoint of the pituitary fossa of the sphenoid bone.
2. *Nasion (N)*—The intersection of the internasal suture with the nasofrontal suture in the midsagittal plane.
3. *Gonion (Go)*—The point on the jaw angle which is the most inferiorly, posteriorly, and outwardly directed.
4. *Gnathion (Gn)*—The most inferior point in the contour of the chin.
5. *Menton (Me)*—The lowermost point on the shadow of the symphysis.
6. *Anterior nasal spine (ANS)*—The tip of the anterior nasal spine.
7. *Posterior nasal spine (PNS)*—Tip of the posterior spine of the palatal bone.

Using these landmarks the following measurements were made:

*Posterior face height (PFH)*—From sella to gonion.

*Anterior face height (AFH)*—From nasion to menton.

*Upper face height (UFH)*—From nasion to the palatal plane.

*Lower face height (LFH)*—From the palatal plane to menton.

*Sn-GoGn*—The angle formed by the sella nasion line and the mandibular plane.

*Gonial angle*—The angle formed by the posterior border of the ramus of the mandible and the mandibular plane.

*SN-PP*—The angle formed by the sella nasion line and the palatal plane.

*PP-GoGn*—The angle formed by the palatal plane and the mandibular plane.

*Open bite*—Measured in millimeters.

Other methods for determining posterior face height have been used. However, it was thought that sella and gonion are much more reliable cephalometric landmarks than points on the condyle, such as articulare, which may be obscure and difficult to locate on many radiographs. A diagram which illustrates the points, planes, and angles used in this study is presented in Fig. 1.

## RESULTS

A summary of the results of the linear measurements for open bite and normal subjects is presented in Table I. The mean amount of open bite in the sample was 3.6 mm. It should be noted that the values for total posterior and anterior face height are greater in the normal than in the open-bite sample. This is because the open-bite sample is composed of 30 children 9½ to 12 years of age and 30 adults, while the normal sample is composed entirely of adults. These measurements may give us a clue to the specific area or areas responsible for open bite. The SN-GoGn angle may be an indication of the total anterior face height. In this study, it was found to be significantly greater for the open-bite group as compared to the normal group ($t = 7.802$, $P < 0.01$). The means were 38.3° for the open-bite subjects and 29.8° for the normal subjects. The gonial angle for the open-bite group was also found to be significantly greater, with a mean of 132.5° as compared to 123.9° for the normal group ($t = 8.252$, $P < 0.01$). The PP-GoGn angle, which could represent a tipping upward or downward of the palatal plane and/or the mandibular plane, was found to be greater in open bite, with means of 31.4° for open-bite patients and 21.9° for normal subjects ($t = 9.127$; $P < 0.01$). The mean SN-PP angles for open-bite and normal subjects were 7.1° and 8.2°, respectively (at df 118, $t = 1.719$, $P > 0.05$). This result is not statistically significant and indicates that in this sample, at least, the



**Table I.** Linea

| | |
|---|---|
| PFH (m | |
| Open | |
| Norm | |
| AFH (m | |
| Open | |
| Norm | |
| PFH/AF | |
| Open | |
| Norm | |
| UFH (m | |
| Open | |
| Norm | |
| LFH (m | |
| Open | |
| Norm | |
| UFH/LF | |
| Open | |
| Norm | |

*t 7.881, P < 0
**t = 5.142, P

**Table II.** Ang

| | |
|---|---|
| SN-GoC | |
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| Gonial ( | |
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| Norm | |
| SN-PP ( | |
| Open | |
| Norm | |
| PP-GoG | |
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**Table I.** Linear measurements and ratios of open-bite and normal subjects

| | *Mean* | *Range* | *Standard deviation* | *Difference of the means* |
|---|---|---|---|---|
| PFH (mm) | | | | |
| Open bite | 73.8 | 62-94.5 | 8.2 | 14.0 |
| Normal | 87.8 | 67-104.5 | 7.9 | |
| AFH (mm) | | | | |
| Open bite | 122.8 | 103-149 | 12.4 | 7.8 |
| Normal | 130.6 | 100-147.5 | 8.4 | |
| PFH/AFH (ratio) | | | | |
| Open bite | 0.602 | 0.494-0.696 | 0.044 | 0.067* |
| Normal | 0.669 | 0.510-0.733 | 0.049 | |
| UFH (mm) | | | | |
| Open bite | 51.9 | 45-60.5 | 4.7 | 6.7 |
| Normal | 58.6 | 49.5-64.5 | 3.6 | |
| LFH (mm) | | | | |
| Open bite | 70.8 | 54.5-90.5 | 9.0 | 1.7 |
| Normal | 72.5 | 60-90 | 6.5 | |
| UFH/LFH (ratio) | | | | |
| Open bite | 0.740 | 0.573-0.890 | 0.071 | 0.072** |
| Normal | 0.812 | 0.622-1.040 | 0.082 | |

*t 7.881, $P < 0.01$.
**t = 5.142, $P < 0.01$.

**Table II.** Angular measurements of open-bite and normal subjects

| | *Mean* | *Range* | *Standard deviation* | *Difference of the means* |
|---|---|---|---|---|
| SN-GoGn (degrees) | | | | |
| Open bite | 38.3 | 26-54.5 | 6.4 | 8.5* |
| Normal | 29.8 | 22-50 | 5.5 | |
| Gonial (degrees) | | | | |
| Open bite | 132.5 | 120-145 | 6.0 | 8.6** |
| Normal | 123.9 | 112-143 | 5.4 | |
| SN-PP (degrees) | | | | |
| Open bite | 7.1 | 1.5-19 | 3.7 | 1.1*** |
| Normal | 8.2 | 1.5-18 | 3.3 | |
| PP-GoGn (degrees) | | | | |
| Open bite | 31.4 | 19-44.5 | 5.8 | 9.5**** |
| Normal | 21.9 | 7.5-38.5 | 5.6 | |

*t = 7.802, $P < 0.01$.
**t = 8.252, $P < 0.01$.
***t = 1.719, $P > 0.05$.
****t = 9.127, $P < 0.01$.

increased value of the PP-GoGn angle seems to be due to a downward tipping of the mandibular plane.

In order to test the constancy of these ratios and angles with age, the open-bite group was further divided into 30 mixed-dentition subjects and 30 permanent-dentition subjects. The criterion for determining permanent dentition was that no remaining deciduous teeth were present and permanent teeth were fully erupted up to and including the second molars. The results of the linear measurements for mixed and permanent-dentition open-bite subjects are summarized in Table III. There is no significant difference in the ratio of posterior face height to anterior face height. It was 0.607 for the mixed-dentition group and 0.598 for the permanent-dentition group ($t = 0.783$, $P > 0.05$). However, the difference of the means for upper face height to lower face height was found to be 0.040, the ratio for the mixed dentition being 0.760 and for the permanent dentition 0.720 ($t = 2.26$, $P < 0.05$). This difference is significant at the 5% level and suggests

**Table III.** Linear measurements of open-bite subjects divided into mixed and permanent dentitions

| | *Mean* | *Range* | *Standard deviation* | *Difference of the means* |
|---|---|---|---|---|
| PFH (mm) | | | | |
| Mixed | 69.5 | 62-94.5 | 6.5 | 8.6 |
| Permanent | 78.1 | 66.5-89.5 | 7.5 | |
| AFH (mm) | | | | |
| Mixed | 113.8 | 103-131.5 | 7.3 | 17.0 |
| Permanent | 130.8 | 103.5-149 | 10.9 | |
| PFH/AFH (ratio) | | | | |
| Mixed | 0.607 | 0.536-0.719 | 0.045 | 0.009* |
| Permanent | 0.598 | 0.494-0.737 | 0.044 | |
| UFH (mm) | | | | |
| Mixed | 49.4 | 41.5-57.5 | 3.7 | 5.1 |
| Permanent | 54.5 | 46-64 | 4.7 | |
| LFH (mm) | | | | |
| Mixed | 65.2 | 54.5-76.5 | 5.4 | 11.2 |
| Permanent | 76.4 | 57.5-90.5 | 8.4 | |
| UFH/LFH (ratio) | | | | |
| Mixed | 0.760 | 0.624-0.890 | 0.061 | 0.040** |
| Permanent | 0.720 | 0.573-0.854 | 0.075 | |

*t = 0.783, P > 0.05.
**t = 2.26, P < 0.05.

**Table IV.** Angular measurements of open-bite patients divided into mixed-dentition and permanent-dentition groups

| | *Mean* | *Range* | *Standard deviation* | *Difference of the means* |
|---|---|---|---|---|
| SN-GoGn (degrees) | | | | |
| Mixed | 37.3 | 27-50 | 5.4 | 1.9* |
| Permanent | 39.2 | 26-54.5 | 7.3 | |
| Gonial (degrees) | | | | |
| Mixed | 132.9 | 123-143 | 5.6 | 0.8** |
| Permanent | 132.1 | 120-145 | 6.4 | |
| SN-PP (degrees) | | | | |
| Mixed | 6.4 | 1.5-18 | 3.5 | 1.4*** |
| Permanent | 7.8 | 2.5-19 | 3.8 | |
| PP-GoGn (degrees) | | | | |
| Mixed | 31.3 | 20-40.5 | 5.0 | 0.2**** |
| Permanent | 31.5 | 19-44.5 | 6.6 | |

*t = 1.146, P > 0.05.
**t = 0.515, P > 0.05.
***t = 1.484, P > 0.05.
****t = 0.132, P > 0.05.

that lower face height increased with age in open-bite subjects.

Table IV summarizes the results of angular measurements of open-bite subjects divided into mixed- and permanent-dentition groups. From the data, it appears that there is no significant difference with age in the angular measurements of open-bite subjects for the four angles that were measured.

In order to get a more accurate picture of skeletal open bite, an attempt was made to divide the open-bite sample into skeletal and dentoalveolar groups. In order to do this, some arbitrary judgment as to what constitutes a skeletal open-bite had to be made. For the purposes of this study, the following criteria were used: If four of the six values recorded were within one standard deviation from normal and the other two were between one and two standard deviations from normal, the open bite was considered to be dentoalveolar in nature. Of the 60 open-bite subjects studied, 17 fit into this category, leaving a total of 43 who were considered

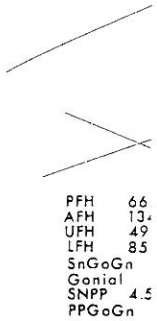


**Fig. 2.** Tracing a
open bite.

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## DISCUSSION

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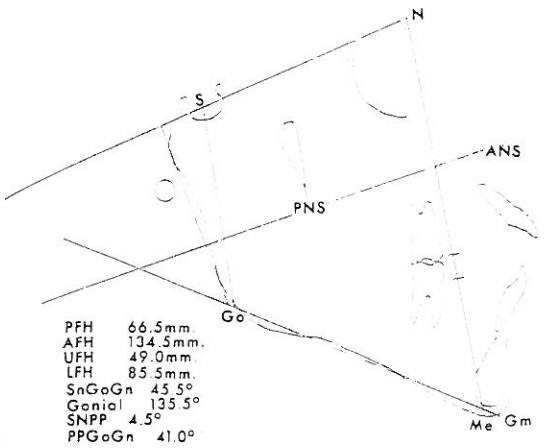


**Fig. 2.** Tracing and measurements of a subject with skeletal open bite.

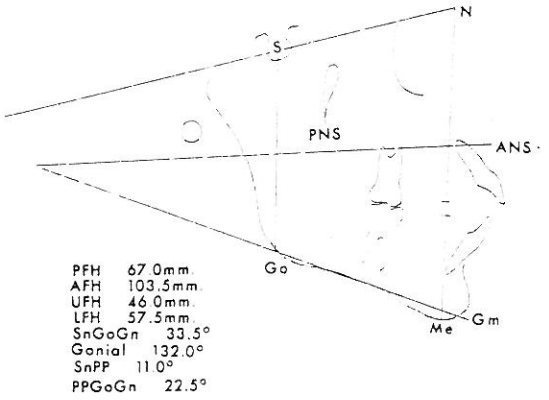


**Fig. 3.** Tracings and measurements of a habitual dentoalveolar open bite.

to have true skeletal open bites. The means of the measured values were then calculated for this group. The differences between the groups designated as skeletal and the entire open-bite sample were found to be as follows: The ratio of posterior to anterior face height decreased from 0.602 to 0.583. The ratio of upper face height to lower face height decreased from 0.740 to 0.724. The SN-GoGn angle increased from 38.30° to 40.97°. The gonial angle increased from 132.5° to 134.9°. The SN-PP angle increased from 6.67° to 7.4°. The PP-GoGn angle increased from 31.4° to 33°.

## DISCUSSION

The data obtained in this study indicate that there are, indeed, great differences in the skeletal patterns of normal and open-bite subjects. Figs. 2 and 3 show tracings and values for a skeletal open bite and for a habitual dentoalveolar open bite. While there is considerable anterior opening in both, the great variation in skeletal morphology is apparent. In addition to the skeletal pattern, the amount of eruption of the teeth is also useful in distinguishing between the two. In skeletal open bite the anterior teeth are likely to be normally erupted or even overerupted, whereas in habitual open bite they are undererupted because of the presence of some object (tongue, thumb, pencil, etc.).

Moss and Salentijn's[16] concept of logarithmic growth seems to be supported by this study. Anything that grows logarithmically can be said to grow gnomically; that is, there is a change in size but no alteration in shape. Moss and Salentijn have postulated that after closure of the palatal processes takes place, growth proceeds by change in size only, with no change in shape. If this is correct, the proportionality of the human face should remain constant from that time on. The data from this study suggest that this concept of gnomic growth is correct, since the ratios and angles measured remained relatively constant with age. Nahoum[17] has also stated that a child with a typical closed-bite skeletal pattern will continue to grow in a closed-bite pattern and a child with an open-bite skeletal pattern will continue to grow in an open-bite pattern.

It is interesting to note that the values for the group designated as having skeletal open bites were all close to Nahoum's values except for the Sn-PP angle, which was not significantly different from normal in either the overall sample or the skeletal sample. Therefore, it appears that in the open-bite sample used in this study, both overall and skeletal, the increase in the PP-GoGn angle resulting in greater lower anterior face height is caused by a downward tipping of the mandibular plane. In the sample used by Nahoum, no distinction was made cephalometrically between skeletal and dentoalveolar open bite; however, the mean amount of open bite was 5.0 mm as compared to 3.6 mm in this study. This may account for the somewhat higher values in Nahoum's study.

If one were to look at a table which shows every value for each subject in the sample, it becomes readily apparent that there is great variability as well as an almost infinite number of combinations of dental and skeletal patterns in open bite subjects (Table V). Richardson,[10] using a multiple regression analysis, attempted to correlate ten variables in open bite but found the relationships to be not highly significant.

The difficulties in separating skeletal and habitual or dentoalveolar open bite are accentuated by this study. It is apparent that most open bites have elements of both skeletal and dental dysplasia. This study also

**Table V.** Individual angular measurements and ratios of the open-bite sample

| *Case No.* | *PFH/AFH* | *UFH/LFH* | *SN-GoGn* | *Gonial* | *SN-PP* | *PP-GoGn* |
|---|---|---|---|---|---|---|
| 1 | 0.570 | 0.780 | 41.5 | 139.0 | 6.5 | 35.0 |
| 2 | 0.576 | 0.755 | 40.5 | 137.0 | 7.5 | 33.5 |
| 3 | 0.536 | 0.750 | 39.5 | 129.0 | 9.5 | 32.0 |
| 4 | 0.620 | 0.778 | 34.0 | 132.5 | 7.5 | 26.5 |
| 5 | 0.603 | 0.713 | 37.0 | 135.0 | 4.0 | 33.5 |
| 6 | 0.586 | 0.703 | 39.0 | 133.5 | 6.0 | 34.0 |
| 7 | 0.593 | 0.624 | 37.5 | 131.0 | 5.5 | 32.0 |
| 8 | 0.637 | 0.777 | 36.5 | 134.5 | 5.5 | 31.0 |
| 9 | 0.586 | 0.769 | 40.5 | 123.0 | 10.0 | 31.0 |
| 10 | 0.622 | 0.748 | 33.5 | 134.0 | 2.0 | 32.0 |
| 11 | 0.628 | 0.664 | 32.0 | 126.5 | 3.0 | 29.0 |
| 12 | 0.585 | 0.769 | 50.0 | 139.0 | 9.5 | 40.0 |
| 13 | 0.552 | 0.706 | 41.5 | 141.5 | 5.0 | 37.0 |
| 14 | 0.561 | 0.742 | 41.5 | 138.0 | 6.0 | 36.5 |
| 15 | 0.643 | 0.778 | 37.0 | 137.0 | 5.0 | 32.0 |
| 16 | 0.618 | 0.832 | 34.0 | 129.0 | 7.5 | 26.5 |
| 17 | 0.654 | 0.773 | 32.0 | 123.5 | 8.0 | 23.5 |
| 18 | 0.618 | 0.793 | 34.5 | 124.5 | 6.5 | 28.5 |
| 19 | 0.696 | 0.851 | 28.0 | 130.0 | 2.0 | 26.5 |
| 20 | 0.665 | 0.890 | 27.5 | 130.0 | 8.0 | 20.0 |
| 21 | 0.574 | 0.781 | 43.0 | 135.0 | 18.0 | 25.0 |
| 22 | 0.591 | 0.741 | 40.5 | 136.0 | 2.5 | 38.0 |
| 23 | 0.585 | 0.707 | 41.5 | 143.0 | 3.0 | 39.0 |
| 24 | 0.688 | 0.709 | 32.5 | 130.0 | 5.0 | 27.5 |
| 25 | 0.569 | 0.700 | 40.5 | 139.0 | 12.0 | 28.5 |
| 26 | 0.586 | 0.863 | 36.0 | 126.5 | 9.0 | 27.5 |
| 27 | 0.611 | 0.833 | 33.5 | 132.5 | 2.5 | 31.0 |
| 28 | 0.547 | 0.709 | 45.0 | 139.5 | 4.0 | 40.5 |
| 29 | 0.719 | 0.713 | 27.0 | 123.5 | 1.5 | 26.5 |
| 30 | 0.580 | 0.719 | 43.0 | 135.5 | 9.5 | 34.0 |

Means and standard deviations for the above measurements may be found in Tables I and II.

points out that many persons with open-bite have certain characteristics in common which can aid in diagnosis and treatment planning.

A thorough knowledge of skeletal morphology can have great therapeutic implications. If the morphology of the face remains relatively constant from early age to maturity, these measurements could be very important diagnostically from the standpoint of instituting interceptive treatment. Graber[18] has successfully used chin cups for intercepting or correcting early open bites and Class III malocclusions. Although there is still considerable controversy surrounding the field of dentofacial orthopedics, there are indications that the use of vertical pull on a chin cup, in conjunction with posterior bite blocks to prevent further eruption of posterior teeth, may cause a closing or reduction of the gonial angle. There are also indications that certain functional appliances[19, 20] may be useful in intercepting or correcting open bites at an early age.

A knowledge of the differences in skeletal morphology in persons with open bite and normal persons is also helpful in planning treatment for the mature patient. It enables the orthodontist to avoid the use of any mechanics which may tend to rotate the mandible downward and backward, increasing anterior face height and decreasing the ratio of posterior to anterior face height. It can also help in determining those cases that will require a combination of orthodontics and surgery to obtain a satisfactory functional and esthetic result. Nahoum[21] stated that patients with an UFH/LFH ratio below 0.650 are poor risks for conventional orthodontic treatment and that a surgical procedure should be considered in these cases.

## SUMMARY AND CONCLUSIONS

Linear and angular measurements were made on the lateral cephalometric films of 60 normal persons and 60 persons with open bite. The purposes of this study were to compare the results of the measurements with those of previous studies, to test the constancy of facial pro-

**Table V** (Cont'

| *Case No.* |
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**Table V** (Cont'd)

| *Case No.* | *PFH/AFH* | *UFH/LFH* | *SN-GoGn* | *Gonial* | *SN-PP* | *PP-GoGn* |
|---|---|---|---|---|---|---|
| 31 | 0.623 | 0.852 | 35.0 | 132.0 | 2.5 | 32.5 |
| 32 | 0.494 | 0.703 | 45.5 | 135.5 | 4.5 | 41.0 |
| 33 | 0.557 | 0.573 | 47.5 | 133.5 | 19.0 | 28.6 |
| 34 | 0.642 | 0.752 | 33.5 | 123.5 | 2.5 | 32.0 |
| 35 | 0.539 | 0.619 | 53.0 | 136.5 | 8.0 | 44.5 |
| 36 | 0.611 | 0.699 | 43.0 | 132.0 | 6.0 | 38.0 |
| 37 | 0.589 | 0.636 | 38.0 | 136.0 | 5.0 | 33.0 |
| 38 | 0.609 | 0.737 | 38.0 | 126.0 | 8.5 | 30.0 |
| 39 | 0.605 | 0.753 | 42.5 | 129.5 | 11.5 | 31.5 |
| 40 | 0.622 | 0.762 | 35.0 | 130.0 | 6.5 | 29.0 |
| 41 | 0.545 | 0.854 | 48.0 | 145.0 | 12.5 | 35.5 |
| 42 | 0.585 | 0.583 | 34.0 | 130.0 | 10.0 | 25.0 |
| 43 | 0.571 | 0.784 | 48.5 | 145.0 | 9.5 | 38.5 |
| 44 | 0.541 | 0.611 | 41.5 | 136.5 | 2.5 | 38.5 |
| 45 | 0.645 | 0.658 | 29.5 | 128.0 | 6.5 | 23.0 |
| 46 | 0.635 | 0.734 | 34.5 | 127.5 | 10.0 | 24.5 |
| 47 | 0.614 | 0.787 | 40.0 | 130.0 | 4.0 | 35.0 |
| 48 | 0.556 | 0.677 | 41.0 | 142.0 | 7.5 | 34.0 |
| 49 | 0.684 | 0.734 | 27.0 | 122.0 | 6.5 | 20.5 |
| 50 | 0.628 | 0.698 | 47.5 | 135.5 | 15.0 | 32.0 |
| 51 | 0.587 | 0.738 | 35.5 | 131.0 | 7.0 | 28.5 |
| 52 | 0.558 | 0.739 | 42.5 | 135.5 | 9.5 | 33.0 |
| 53 | 0.594 | 0.734 | 36.5 | 129.5 | 11.5 | 26.0 |
| 54 | 0.647 | 0.843 | 33.5 | 132.0 | 11.0 | 22.5 |
| 55 | 0.590 | 0.800 | 38.0 | 131.0 | 7.0 | 31.5 |
| 56 | 0.649 | 0.838 | 33.5 | 125.5 | 4.0 | 29.5 |
| 57 | 0.527 | 0.667 | 54.5 | 143.0 | 10.5 | 44.5 |
| 58 | 0.654 | 0.656 | 30.0 | 123.5 | 4.0 | 26.0 |
| 59 | 0.591 | 0.688 | 42.5 | 136.5 | 4.5 | 38.0 |
| 60 | 0.642 | 0.702 | 26.0 | 120.0 | 6.5 | 19.0 |

portions with age, and to attempt to differentiate cephalometrically between skeletal and dentoalveolar open bite.

The following conclusions were reached:

1. Posterior face height is shorter and overall anterior face height is greater in open-bite subjects.
2. Lower face height is greater in relation to upper anterior face height in persons with open bite.
3. The mandibular plane angle and the gonial angle are larger in persons with open bite.
4. The PP-GoGn angle is greater in persons with open bite, and this is due mostly to downward tipping of the mandibular plane in this sample.
5. Ratios and angles measured remained relatively constant in both mixed- and permanent-dentition groups, indicating that only size (but not facial proportion) changes with age.
6. Measurements made on the group designated as having skeletal open bites were significantly different from those of the subjects with dentoalveolar open-bites and from the open bite sample as a whole, except for the Sn-PP angle.

The phenomenon of anterior open bite is multifactorial, and there is an almost infinite variety to the dentoskeletal configuration and the magnitude of dysplasia associated with it.

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