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Assessment of symphysis morphology as a predictor of the direction of mandibular growth

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Abstract

The purpose of this study was to determine whether symphysis morphology could be used as a predictor of the direction of mandibular growth and to assess growth changes of the symphysis. Cross-sectional data included lateral cephalometric radiographs of 115 adults (58 women, 57 men) with the longitudinal sample a subset of 62 subjects (30 females, 32 males) at four age groups. The direction of mandibular growth was evaluated with seven cephalometric measurements that included Y-axis, SN to mandibular plane, palatal plane to mandibular plane, gonial angle, sum of saddle, articulare and gonial angles, percentage lower facial height, and posterior/anterior face height. The mandibular symphyseal dimensions studied were height, depth, ratio (height/depth), and angle. Symphysis morphology was found to be associated with the direction of mandibular growth, especially in male subjects with symphysis ratio having the strongest relationship. A mandible with an anterior growth direction was associated with a small height, large depth, small ratio, and large angle of the symphysis. Conversely, a posterior growth direction was associated with a large height, small depth, large ratio, and small angle of the symphysis. Symphysis dimensions continued to change until adulthood with male subjects having a greater and later occurring change compared with female subjects. (AM J ORTHOD DENTOFAC ORTHOP 1994;106:60-9.)

Article outline

In orthodontics, knowledge of mandibular growth is highly beneficial in diagnosis and treatment planning and is critical in the development of balanced dentofacial structures. Various parameters have been used to predict mandibular growth with varying success.1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Ricketts[8] stated that symphysis morphology may be used to predict the direction of mandibular growth. On a qualitative basis, he associated a thick symphysis with an anterior growth direction. Likewise, other investigators reported similar observations.2, 4

Björk,[2] with his implant studies, described multiple structural signs seen in extreme types of mandibular rotators. The forward inclination of the condylar head was associated with forward mandibular rotators, along with a greater curvature of the mandibular canal than the mandibular contour. A tendency toward backward mandibular rotation is associated with a pronounced apposition below the symphysis with more overall concavity of the lower mandibular border. An inclination of the symphysis with proclination is an indicator of a backward rotating mandible.

Jarabak's cephalometric analysis[13] predicted the direction of mandibular growth from a facial polygon, including the saddle angle (N-S-Ar), articular angle (S-Ar-Go), and gonial angle (Ar-Go-Me). With sums of these three angles greater than 396°, posterior mandibular growth patterns were predicted while less than 396° was associated with anterior mandibular growth. Also, a ratio of posterior (S-Go) to anterior face height (N-Me) of 56% to 62% indicated a posterior growth pattern, whereas a ratio of 65% to 80% indicated an anterior growth tendency.

Although many cephalometric measurements have been used, it has been shown that it is still very difficult to accurately predict the direction of mandibular growth. Baumrind et al.[15] conducted a study with five clinicians, who were considered experts, and attempted to predict the direction of mandibular growth. The results were that these clinicians performed no better than chance and hence concluded that prediction of the direction of mandibular growth by lateral cephalometrics was poor. Similarly, Lee et al.[4] studied the reliability of the Skieller et al.[12] prediction methods. Although Skieller's four variables accounted for 86% of the variability in change in the direction of mandibular growth (mandibular inclination, intermolar angle, shape of the lower border of the mandible, and inclination of the symphysis), it accounted for only 8% in Lee's study. Thus, it was concluded that predicting the direction of mandibular growth was a very complex and difficult problem.

Lundstrom and Woodside" have criticized the use of SN base line reference to determine growth in the maxilla or the mandible, stating that growth direction for each jaw was due to independent factors with only 25% to 40% of the variability due to common factors. Superimposed serial tracings were so error prone that prediction or illustration of growth was hazardous.

The purpose of this study was to assess if a relationship exists between symphysis morphology and the direction of mandibular growth. Further, age related changes in symphyseal dimensions were evaluated.

Materials and methods

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The sample

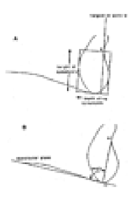
Lateral cephalometric radiographs of persons of white, North European ancestry from the Child Research Council in Denver, Colo. were used. The first part was a cross-sectional study that consisted of 115 adults (58 women, 57 men) between the ages of 17 to 30 (mean 20.9) years. The second part was a longitudinal study based on a subset of part one and included 62 subjects (30 females, 32 males) with lateral cephalometric radiographs at four age groups: 4 to 6 years, 8 to 10 years, 12 to 14 years, and 17 to 30 years. All subjects used in this study fulfilled the following criteria: (1) No orthodontic treatment and (2) all landmarks were readily identifiable on the lateral cephalometric radiographs.

Cephalometric measurements to assess the direction of mandibular growth

The following seven cephalometric measurements were used to assess the direction of mandibular growth: (1) SN to Y-axis angle, (2) SN-MP angle, (3) palatal plane-mandibular plane angle (ANS-PNS to mandibular plane), (4) gonial angle (Ar-Go-Me), (5) sum of saddle (N-S-Ar), articulare (S-Ar-Go), and gonial (Ar-Go-Me) angles, (6) percentage of lower face height (ANS-Me) to total face height (N-Me), and (7) posterior to anterior facial height (S-Go/N-Me).

Method of calculating symphysis dimensions

Determination of symphysis height and depth was done as shown in Fig. 1, A.



. **Fig. 1.** Cephalometric measurements used to quantify symphysis morphology. **A** , Linear measurement. Illustration shows the tangent drawn at point B and parallel and perpendicular lines to this tangent line. The method of measuring height and depth measurements are also shown. **B** , Angular measurements. Symphysis angle measured as the posterior-superior angle between lines Me-B point and the mandibular plane.

A line tangent to point B was used as the long axis of the symphysis, and a grid was formed with the lines of the grid parallel and perpendicular to the constructed tangent line. The superior limit of the symphysis was taken at point B with the inferior, anterior, and posterior limits taken at the most inferior, anterior, and posterior borders of the symphysis outline, respectively. The symphysis height was defined as the distance from the superior to the inferior limit on the grid. The symphysis depth was defined as the distance from the anterior to the posterior limit on the grid. Symphysis ratio was calculated by dividing symphysis height by symphysis depth. The symphysis angle was determined by the posterior-superior angle formed by the line through menton and point B and the mandibular plane. See Fig. 1, B.

Landmark location and digitizing error was found to be under 0.75 mm and 0.96° for all measurements used in this study.

Statistical analysis

The 115 adults were separated into female and male groups. The four symphysis measurements were then divided into small, average, and large groups. The average group was one standard deviation around the mean. The small group was less than that, and the large group greater for each of the female and male samples. Means and standard deviations for the seven cephalometric parameters were determined for each group. An analysis of variance test was performed to determine whether at least one of the groups was different from the other two. In this event, a Duncan's multiple range test was performed to determine significant difference among the three groups.

To study the growth changes of the symphysis, the means and standard deviations of each symphysis measurement at the four age groups were plotted to assess the growth progress.

Results

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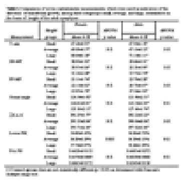
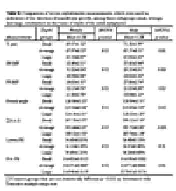
The adult sample that had been subdivided on the basis of small, average, and large with respect to each of the four symphyseal measurements was compared with the seven selected cephalometric parameters representing the direction of mandibular growth. Table I shows the comparison based on symphysis height.



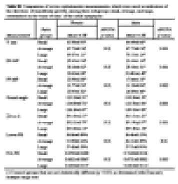
In the female sample, only the percentage lower facial height showed significant differences ($p < 0.005$) between small, average, and large symphysis height. In the male sample, four of the seven measurements, i.e., angles Y-axis, SN-MP, PP-MP, and the sum of saddle, articulare, and gonial angles, had statistically significant differences ($p < 0.05$) among the three subgroups.

Table II shows the comparison based on symphysis depth.



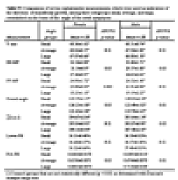
For all the seven measurements, the female sample did not show any statistically significant differences in the three subgroups. However, in the male sample, statistically significant differences ($p \leq 0.05$) were seen for all but one measurement, which was the percentage lower facial height.

Table III shows the comparison based on symphysis ratio for the three subgroups.



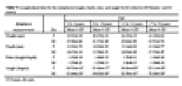
In the female sample, there was no significant difference ($p < 0.05$) for any of the seven measurements. Among the male subjects, there were highly statistically significant differences ($p \leq 0.005$) among all the measurements, again with the exception of percentage lower face height.

Table IV shows the comparison based on symphysis angle.

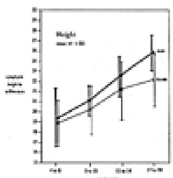


Both female and male samples showed significant differences ($p \leq 0.05$) for four of the seven measurements among the small, average, and large subgroups. However, they were not the same four measurements for each sex. Both had significant measurements for the angle SN-MP, gonial angle, and ratio of posterior facial height to anterior facial height. Only the female sample had a significant measurement for the angle PP-MP, and only the male sample had a significant measurement for the sum of saddle, articulare, and gonial angles.

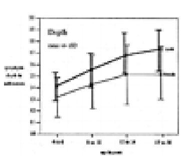
The second part of this study evaluated the growth changes in the symphysis in the longitudinal sample of 30 females and 32 males. The means and standard deviations of the measurements of the symphysis taken at four periods during growth are shown in Table V.



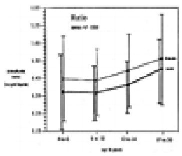
There are four age groups: 4 to 6, 8 to 10, 12 to 14, and 17 to 30 years. The mean values for each measurement from Table V were plotted, and the growth curves are presented in Figs. 2, 3, 4, and 5.



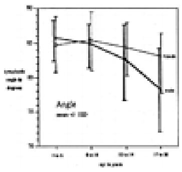
. **Fig. 2.** Symphysis height measurements plotted at four age groups for female and male samples. *Vertical bars* give the distribution at one standard deviation above and below the mean at each age.



. **Fig. 3.** Symphysis depth measurements plotted at four age groups for female and male samples. *Vertical bars* give the distribution at one standard deviation above and below the mean at each age.



. **Fig. 4.** Symphysis ratio measurements plotted at four age groups for female and male samples. *Vertical bars* give the distribution at one standard deviation above and below the mean at each age.



. **Fig. 5.** Symphysis angle measurements plotted at four age groups for female and male samples. *Vertical bars* give the distribution at one standard deviation above and below the mean at each age.

It is apparent from , that the symphysis height and depth increased with age and experienced an accelerated growth rate during puberty. The mean values for the female subjects showed a small increase (0.91 mm) in height between the 12- to 14-year and 17- to 30-year age groups as compared with a 1.29 mm increase in the male subjects. The depth measurement reached its adult size in the female subjects at age 12 to 14 years; however, in the male subjects, it showed a small increase (0.53 mm) between the 12- to 14-year and 17- to 30-year age groups as seen in Fig. 4. The ratio of height to depth did not change in the 4- to 10-year age group. However, during and after adolescence, the ratio continued to increase reflecting large increases in height as compared with the depth of the symphysis. The means of the symphysis angle showed a consistent decrease. See Fig. 5. The mean total decrease in angle over the period of study was 1.62° for the female subjects and 7.44° for the male subjects.

Discussion

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The size and shape of the mandibular symphysis is an important consideration in evaluation of orthodontic patients. With a larger symphysis, more protrusion of the incisors is esthetically acceptable[17] and therefore a greater chance of a nonextraction approach to treatment. Conversely, persons with greater symphysis height and a small chin would be candidates for an extraction treatment plan to compensate for arch length discrepancies. Many clinicians classify the growth pattern of the mandible anteriorly or posteriorly based on the shape and size of the symphysis. An anterior growth pattern is favorably associated with an orthognathic facial growth as contrasted to a posterior growth pattern, which is associated with a retrusive mandible.

To define the anteriorly and posteriorly directed growth patterns, several parameters used on cephalometric analyses have been identified.1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 It is believed that a large symphysis ratio (height/depth) is associated with a receding chin, high mandibular plane, high angle SN-MP, large saddle, articulare and gonial angles, large anterior facial height, and a large percentage lower facial height. In the case of a small symphysis ratio, there is a large chin, low mandibular plane, low angle SNMP, low saddle, articulare and gonial angles, small anterior facial height, and a small percentage lower facial height. Ricketts has used the terms *dolicofacial* and *brachyfacial* growth patterns.[8] By whatever name it is called, the axiom about the chin is that those children who have, will get more with growth, whereas those who do not will not get much growth at the chin. This is used in clinical practice by many orthodontists.

The data obtained on symphyseal height, depth, ratio (height/depth), and angle (point B-menton to the mandibular plane) were compared with seven cephalometric parameters commonly used in assessing anterior or posterior growth patterns. It was found that there was a sexual dichotomy with the mean symphyseal height and depth in the female sample being smaller than in the male sample. The symphysis ratio was larger in the female sample indicating that the mean symphysis depth was less in the female subjects than in the male subjects.

The data for the adult sample was divided into small, average, and large for each of the symphyseal measurements based on the mean plus or minus 1 standard deviation. The purpose of making these subgroups was to determine whether the cephalometric parameters selected for differentiating between anterior and posterior growth directions could in fact be associated with small or large symphysis measurements. The analysis of variance tests revealed (,) that there was a general trend showing differences among small, average, and large symphyseal measurements. Not all of the cephalometric measurements were significantly different for the small, average, and large subgroups. However, on the basis of these observations, it was noticed that most of the measurements were significantly different in the male sample. This should be expected, because the male subjects have a larger symphysis depth and a smaller symphysis ratio. The deposition of bone at the pogonion is highly variable and appears to be sex linked.[18]

The growth changes in the symphysis measurements from the study of the longitudinal sample showed that there were adolescent growth spurts in both symphysis height and depth. There was greater increase in the male subjects as compared with the female subjects. The symphysis ratio also increased but the symphysis angle decreased with age. The latter showed a much larger decrease in the male subjects than in the female subjects.

Conclusions

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1. Men possess a stronger relationship between symphysis morphology and the direction of mandibular growth as compared with women.

2. Symphysis ratio was strongly related to the direction of mandibular growth in men.

3. For men, the symphysis with an anterior growth direction of the mandible had a short height, large depth, small ratio (height/depth), and large angle. In contrast, a symphysis with a large height, small depth, large ratio, and small angle demonstrated a posterior growth direction.

4. Women showed the same relationship as the men between symphysis height, depth, ratio, and angle to the direction of mandibular growth.

5. There was continued change in the symphysis up to adulthood in both female and male subjects, with the female subjects having a smaller and earlier occurring change compared with the male subjects. Symphysis height, depth, and ratio increased while symphysis angle decreased with age.

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results list