# A Longitudinal Study Of Anteroposterior Growth Of The Mandibular Symphysis

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## INTRODUCTION

Admittedly, cephalometric roentgenography is not an absolute science; however, clinicians and researchers, recognizing the value in information afforded by the lateral cephalometric head x-ray, have sought to expand the foundation of knowledge and areas of bona fide use.

No absolute recordings have been reported in the literature to date of the actual amount of change that does occur in the area of pogonion, and specifically during the circumpubertal growth period of both sexes. In addition, no attempt has been made to differentiate that change which occurs in the area of pogonion as a result of normal growth and modeling change, and that due to orthodontic treatment, if any.

This study was undertaken, therefore, to determine actual definitive standards as to the amount of change in the area of pogonion on a longitudinal basis in untreated orthodontic cases. In addition, an attempt was made to determine what effect, if any, orthodontic treatment had on the changes occurring in this area. If some valid conclusions could be drawn as to what effect treatment has on pogonion, and whether extraction influences the amount of change that occurs, perhaps the information gained therein would aid in future diagnoses.

## REVIEW OF LITERATURE

One of the most important uses of cephalometric radiographs is, of course, their ability to show us changes that have occurred over a period of time with a relative degree of accuracy. In the orthodontically treated cases these changes have been in the dento-alveolar areas, not necessarily due to growth alone. Broadbent,[1,2] in his original work, devised the so-called "R" or registration point technique for over-all superimposition. As a testimony to the reliability of this method, it is interesting to note that this is still the method of choice for many orthodontists today, a generation later.

Brodie,[3] in his original work in 1941, used another method of over-all superimposition, namely superimposition on the sella-nasion line at sella. The ease with which both of these landmarks can be identified has made this method popular with clinicians.

Recently, Bergerson[4] reported on the accuracy of a new method of superimposition, the "intersection point" technique which showed a still more accurate approach than previously seemed possible for over-all serial superimposition. No attempt was made to apply this technique or modification specifically to the maxilla or mandible.

These previously mentioned techniques attempt to give us generalized changes as they occur with time. The next logical approach would be to attempt to determine more accurately changes as they occur in specific areas. A desire to determine growth changes cephalometrically in the mandible and, more precisely, specific areas of the mandible, has interested many competent investigators. The validity of the conclusions can be and, in fact, has

been questioned by the investigators themselves.

Thurow[5] feels that serial cephalometric interpretation is valid, even in the face of limitations. Lundstrom,[6] however, cautions all who use cephalometric head films about unwarranted conclusions. With regard to the mandible, Lundstrom says that the forward growth of the mandible and the inclination of the mandibular plane in relation to prognosis in treating anteroposterior malocclusions cannot be considered sufficiently investigated.

In a lengthy article dealing with the nature of problems a clinician could encounter with cephalometrics in his practice, Graber[7] re-enforces the validity of the use of cephalometrics for serial study. He states that, in making interpretations from cephalometric roentgenograms, the film compresses a three-dimensional subject into one of two dimensions, and the ensuing limitations are obvious. In the area of the incisors as many as six teeth are superimposed on one another at any given time and, on occasion, the apical portion is seldom clear or not even readily observable.

In addition, Graber feels that reliability of measurements and interpretation can be expected when one wishes to observe changes in the maxilla and mandible induced by growth and development and by orthodontic treatment in comparison with the relatively stable cranial base. For accurate assessment of changes that occur in the mandible, he feels that by superimposing tracings of successive cephalometric roentgenograms using the mandibular symphysis as the constant area of superimposition ". . . actual mandibular growth changes and treament changes can be seen fairly well. The outline of the inferior border of the mandibular body reflects positional change which makes it imperative that the positioning factor in successive roentgenographic examinations be kept as constant as possible."

In a sequel to his original work of 1941, Brodie[8] in 1953, followed his original cases from the eighth to the seventeenth year.

In a discussion of the mandible, specifically, he found that ". . . the later stages of growth show a continuation of the forward and downward movement of pogonion, while the dental arch and its supporting bone tend to move more slowly and thus, drop behind." For specific mandibular superimposition he uses the lowest point on the mandibular symphysis.

It is interesting to note that these previously mentioned investigations rather indirectly confirmed what Sicher[9] maintained concerning mandibular growth. In his classic discussion on the growth of the mandible, Sicher states that condylar growth is of lesser importance to the growth of the length of the mandibular body than it is to overall length. Here appositional growth along the entire posterior border of the ramus is of prime importance. More definitely, apposition of bone at the lower border of the mandible is negligible. He also states that apposition in the region of the chin serves not so much in enlarging, as in modeling the the lower jaw.

Holdaway,[10] 1956, was the first to note the so-called modeling change in the area of pogonion and its relation to facial esthetics. In a subsequent presentation, Holdaway added that no matter what the definitive readings of the two measurements, the NB line to pogonion in millimeters and the lower incisor to NB line in millimeters, the relationship between the two, for good facial esthetics, should be as near a ratio of one to one as possible. This has come to be known as the "Holdaway Difference". In attempting to show

specific tooth changes in orthodontically treated cases, he superimposed on the symphysis and lower border of the mandible.

Steiner,[11] 1953, had long maintained that ". . . if we desire to read changes due to orthodontic treatment alone, we offset or at least, minimize the records of the changes that are due to growth in the areas we wish to judge." He, as many other clinicians had for many years, felt that in order to better assess how teeth have moved in the mandible, superimposition must be done on the mandible directly. For assessment of specific movement of mandibular teeth he strongly recommended superimposition of the cross section of the symphysis keeping the lower borders of the mandible parallel.

By 1959 however, Steiner[12] had modified his position somewhat. He felt that the lower border of the mandible, in the area of the symphysis, is often vague, many times a "gradual transition". He therefore created the point "D", the center of the cross section of the symphysis which can be used to determine changes in the position of the mandibular teeth within the mandible.

Lindquist,[13] 1958, reported on the lower incisor and its influence on treatment and esthetics. In order to attain more accuracy in serial interpretation, he went directly to the mandible. He superimposed the profile image of the symphysis and the lower border of the mandible.

Moore,[14] reporting his observations of facial growth in 1959, superimposed his serial cephalometric tracings by three methods. The first, or over-all method, was on the SN line, for over-all evaluation of the effects of growth. The other two were specific for the maxilla and the mandible. For the mandible he used what he termed the "standard mandibular registration", superimposing on menton and on a line connecting this point to the most inferior portion of the part of the mandibular body.

In the proceedings of the second session of the Workshop on Cephalometrics at the Bolton Foundation in 1959, Adams[15] superimposed tracings of the mandible to show typical growth and development and changes due to growth and resorption in the chin region of a child ten years of age, then sixteen years of age. He is of the opinion that superimposition is most accurate when the lingual outline of the symphysis is used with the outline of the mandibular plane.

In an extensive study of children from the Child Research Council in Denver, Bambha,[16] using serial cephalometric radiographs and superimposing on the SN line, concluded that a significant sex difference in absolute gain during the adolescent growth period of the face was in evidence, and that girls had smaller absolute measurements with a slower rate of growth and tended to mature about two to three years earlier than boys. It should be noted here that the entire study was a cephalometric one and tended to confirm previously held thoughts on sex differences related to facial growth.

In perhaps the most concentrated study to date, on the growth of the mandible as observed through cephalometric roentgenograms, Witsky,[16] 1961, showed that during the timing of the pubertal growth spurt the greatest variation could be anticipated, and the angulation of the mandibular incisor was easily the most variable of all the measurements under consideration.

The stability of the lingual contour of the mandibular symphysis was most impressive according to Witsky. Variation, when found, was located at the superior and inferior extremities of the curvature which outlines the lingual

aspect of the symphysis. ". . . It is not maintained that this lingual curvature is an absolutely stable point. Present knowledge dictates that such a point does not exist in the entire craniofacial skeleton. It is, however, maintained that the lingual contour is relatively the most stable area within the outline of the mandible".

Appositional growth was also seen in the area of pogonion. The area of the apical one-third of the mandibular incisor was found to remain relatively constant in its contour and anteroposterior dimension. Inferior and labial to this apical area, growth through apposition was evident in the development of the chin point. The amount of apposition seen at pogonion ". . . suggests factors of molding and strengthening rather than factors mainly active in the increase of size".

Thus, through the years, the orthodontist has become aware of the area of pogonion and its influence on esthetics. It has been stated that those who possess a good chin to begin with will continue to show an increase in the size area, both during and after treatment. Conversely, those who do not have the "strong" chin initially cannot be expected to attain a significant prominence subsequent to treatment. Thus, knowledge of both growth and treatment procedures becomes all the more important in understanding what is happening during the treatment process.

## Method and Materials

The sample used in this study consisted, in part, of 31 untreated orthodontic subjects from the Bolton Fund at Western Reserve University. This sample consisted of 16 males and 15 females observed from eight years of age to seventeen years. A total of 271 tracings were made from this portion of the sample.

An additional sample of 91 treated orthodontic subjects was used from the author's own practice. This treated group was divided into 55 extraction cases and 36 nonextraction cases. Both extraction and nonextraction cases were further subdivided into 29 male and 26 female extraction cases, and 19 male and 17 female nonextraction cases. Two hundred thirty-eight tracings were made from this portion of the sample, making a combined total of 509 tracings for the entire study. Further requisites for the treated cases were that:

1) a period of no less than 36 months exist from the time of the original or beginning treatment radiograph and subsequent radiographs on the same individual;
2) the nonextraction cases consist of those in which full orthodontic appliances were placed and no permanent teeth were removed;
3) the extraction cases consist of those in which orthodontic appliances were placed and teeth were removed in the mandibular arch, either two premolars bilaterally, or a lower central incisor.

The appliance used in all treated cases was the edgewise mechanism.

Relationship between the untreated and treated groups was sought only where the subjects of the treated groups could be followed longitudinally in increments of three, four, or five years, and matched to similar age ranges in the untreated group.

All treated subjects were radiographed on the Broadbent-Bolton cephalometer at Northwestern University using the standard technique for lateral exposure, as advocated by Dr. Broadbent. The one exception to this was those subjects radiographed during 1962 when a General Electric model G.E. 90-II x-ray unit and Wehmer cephalostat were used.* A single lateral cephalometric roentgenogram was taken

with the subject either at rest or occlusal position.

Using a fine, hard pencil and .003 matte acetate tracing paper, the outline of the mandible was traced to include the following: mandibular central incisor, outline of the inferior border, ascending ramus (where two were visualized, the midpoint between the two was taken), and outline of the symphysis. The following cephalometric landmarks were identified: gonion (Go), menton (Me), pogonion (P), point B (after Downs) and SL, the most posterior point on the curvature of the outline of the lingual of the symphysis. The mandibular plane was then constructed by joining gonion and menton, and perpendiculars were drawn through pogonion, point B, and SL to the mandibular plane. Absolute millimetric readings were then made of the following projections to the mandibular plane (Fig. 1): SL' —P', SL' —B' and B' —P'. All subsequent reference to these measurements throughout this paper will omit the prime figure (').

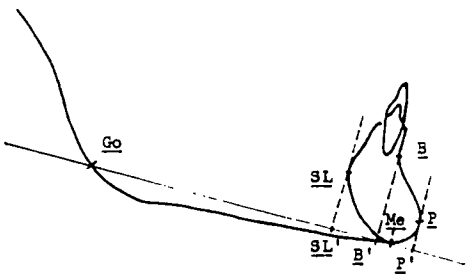


Fig. 1 Example of tracing with landmarks: Go — Gonion, SL' — Lingual of symphysis, Me — Menton, B' — Downs' Point B, P' — Pogonion. Millimetric recordings of the following were taken: SL'-P', SL'-B', B'-P'.

## Discussion

Though attempts have been made in the past to equate the amount of mandibular growth in the area of pogonion and orthodontic treatment procedures, little more than generalizations between the two have been in evidence. Of the many ways considered in approaching this subject, cephalometric interpretation seems bona fide; enough previous work has been done with serial cephalometric procedures that additional comment would seem redundant.

One would initially assume that to determine precise change in the mandible, one should go to the mandible, and specifically to that particular area where one wishes to assess change. Of the methods available for mandibular superimposition, the one chosen in this study, alignment on the lingual contour of the mandible and a mandibular plane of mid-gonion-menton, seemed to incorporate most of the stable components as well as the most popular among orthodontists employing this general method. This, plus the fact that the landmarks were easily identifiable, and a rather precise tracing technique was employed, made for reliability and validity.

The first approach to the problem involved setting up a controlled, untreated, longitudinal sample that would appear large enough over a sufficient period of time; this sample was then divided into male and female. As it

* The use of the second cephalometric x-ray unit for the treated subjects necessitated the introduction of a conversion factor, for the target-film distance was not identical in the two instances. This conversion factor was obtained by having five different subjects radiographed on the original Broadbent-Bolton cephalometer and then having them radiographed once again within 48 hours on the General Electric-Wehmer cephalometer. The ten radiographs obtained were then traced three times each with the result that those absolute measurements taken on the Wehmer unit showed an average 6 per cent decrease. This conversion factor was therefore taken into account and all recordings taken on the Wehmer unit were modified accordingly.

subsequently evolved, this constituted the major portion of the study as well as that portion of the study through which the most valid conclusions could be drawn. A discussion of the findings of the measurements within this sample would seem to be in order.

*LS-P*

This measurement included the overall anteroposterior dimension of the symphyseal outline. In the male the absolute increase from 8 years to 17 years was 3.66 mm, and in the female, 1.93 mm. By itself, this would merely enable one to say that the male increase, overall, was almost twice that of the female. However, it is also important to know when this increase occurred and how it was maintained. On a yearly incremental basis (Fig. 2), it is interesting to note that on all occasions the absolute millimetric reading of this measurement always showed the male larger at any given age. At 13 years of age, the two measurements

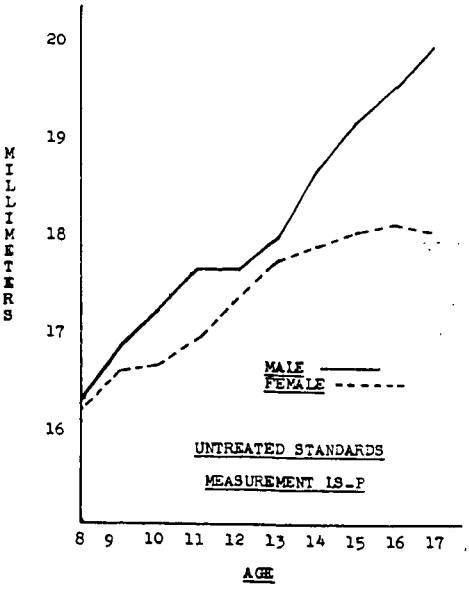


Fig. 2 Graphic interpretation of measurement *LS-P* in untreated sample.

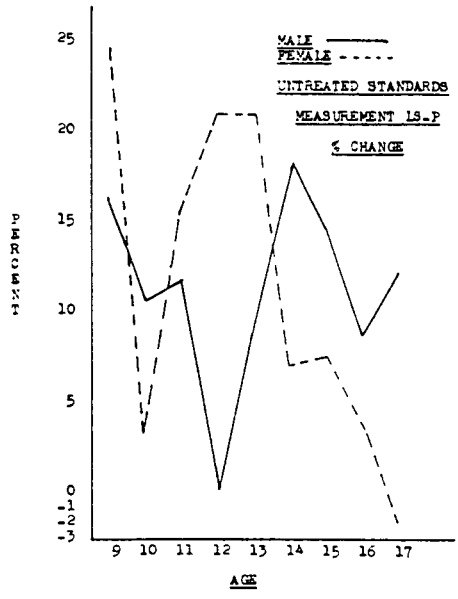


Fig. 3 Graphic interpretation of % change of measurement *LS-P* in untreated sample.

(male and female) were approximately the same; thereafter, the female seemed to plateau out and the male incurred a rapid increase suggesting more actual latent growth or modeling in the male and a leveling off in the female.

In terms of percentage change for this measurement (Fig. 3), the greatest percentage of total increase for girls appeared at 12 and 13 years of age, and thereafter was negligible. For boys, there appeared no absolute percentage increase at 12 years of age.

In viewing the same measurement in three year increments (Tables I and II) the females showed the two highest percentage groups to be 10 years to 13 years (57%) and 11 years to 14 years (48%). The males, however, showed the two highest percentages in the 12th year to 15th year (42%) and 13th year to 16th year (41%) age groups, or about two years later*

* Longitudinal mean change tables in 4 and 5 years increments, available upon request.

TABLE I

UNTREATED MALES, MEAN CHANGE IN THREE YEAR INCREMENTS

| Age | *LS-P* | | *LS-B* | | *B-P* | |
|---|---|---|---|---|---|---|
| | mm | % | mm | % | mm | % |
| 8-11 | 1.4 | 38.2 | —0.5 | —24.3 | 1.8 | 32.7 |
| 9-12 | 0.8 | 21.6 | —0.5 | —22.3 | 1.2 | 22.1 |
| 10-13 | 0.7 | 20.5 | —0.4 | —18.4 | 1.2 | 21.0 |
| 11-14 | 1.0 | 26.8 | —0.5 | —25.7 | 1.5 | 26.5 |
| 12-15 | 1.5 | 41.8 | —0.2 | —12.1 | 1.8 | 32.0 |
| 13-16 | 1.5 | 41.0 | —0.5 | —24.3 | 1.9 | 34.3 |
| 14-17 | 1.3 | 35.0 | —1.0 | —50.0 | 2.3 | 40.8 |
| Total mm change | +3.66 | | —2.06 | | +5.66 | |

TABLE II

UNTREATED FEMALES, MEAN CHANGE IN THREE YEAR INCREMENTS

| Age | *LS-P* | | *LS-B* | | *B-P* | |
|---|---|---|---|---|---|---|
| | mm | % | mm | % | mm | % |
| 8-11 | 0.8 | 43.0 | —0.4 | —49.4 | 1.2 | 44.4 |
| 9-12 | 0.8 | 39.4 | —0.4 | —44.9 | 1.2 | 41.6 |
| 10-13 | 1.1 | 57.0 | —0.7 | —82.0 | 1.9 | 67.0 |
| 11-14 | 0.9 | 48.2 | —0.4 | —47.2 | 1.4 | 50.9 |
| 12-15 | 0.7 | 34.7 | —0.5 | —61.8 | 1.2 | 43.7 |
| 13-16 | 0.3 | 17.6 | —0.2 | —19.1 | 0.4 | 15.4 |
| 14-17 | 0.2 | 8.8 | —0.0 | — 3.4 | 0.1 | 4.7 |
| Total mm change | +1.93 | | —0.89 | | +2.79 | |

Thus, one could say that for the measurement *LS-P,* in this sample of 16 males and 15 females, the males increased overall almost twice as much as the females and attained the greatest percentage of their over-all increase later than the females.

*LS-B*

This measurement attempted to show the over-all change that occurred from the lingual contour of the symphysis to Downs' point B. By superimposing upon the extremely stable outline of the lingual of the symphysis, any change that occurred could be interpreted as a movement of point B.

The female sample showed a mean total absolute loss of 0.89 mm from 8 years to 17 years; the males, 2.06 mm, or once again approximately twice as much. The interesting feature here, however, would seem to be that from age 8 when the absolute mean readings were approximately the same, (male 9.94 mm, female 9.97 mm) to age 13 (Fig. 4) the female absolute reading was always less than the male. At age 13 they were approximately identical

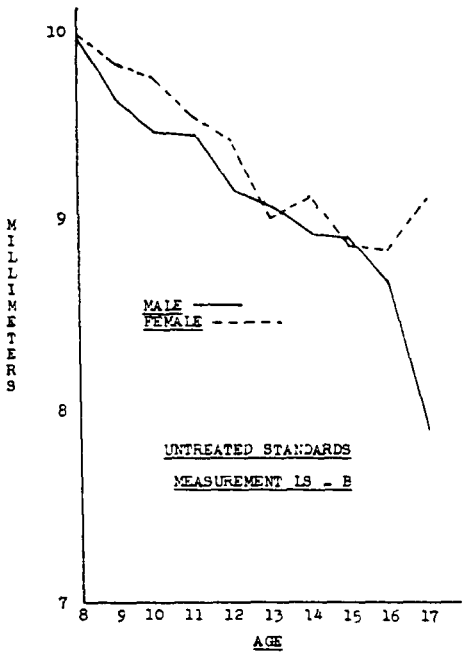


Fig. 4 Graphic interpretation of measurement *LS-B* in untreated sample.

again, and the same held true at 15 years. Subsequent to this age the female and male readings for this measurement differed markedly. The female reading plateaued out and even increased in size to 17 years of age while the male dropped dramatically.

If he so wished, one could begin then to see definite sex differences at specific ages. Since the over-all measurement *(LS-P)* showed a male increase of approximately twice that of the female and was obtained later, one should note that a specific portion of that measurement *(LS-B)* showed extensive absolute change between the male and female after 15 years of age. Keeping in mind that this sample was not treated orthodontically, this specific difference between the sexes at this specific time can readily be attributed to growth.

The question certainly then might be raised: how was this accomplished? Had point B moved lingually more in one case than the other? A partial answer might be found in noting the percentage change in yearly increments (Fig. 5). From 15 years of age on, the percentage change for the females was on the positive side, meaning the mean value of the measurement actually increased. For the male however, the two greatest percentage increment changes were from 15 to 16 years and from 16 to 17 years, meaning in effect, point B actually moved lingually an appreciable amount during this time.

In viewing the same measurement in three year increments (Tables I and II), the females showed the greatest percentage change (—82%) from 10 to 13 years. The males showed a relatively stable percentage change throughout except the last, 14 years to 17 years,

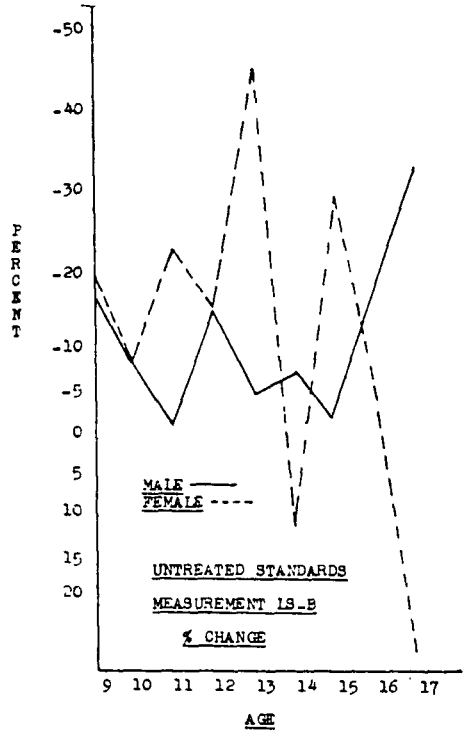


Fig. 5 Graphic interpretation of % change of measurement *LS-B* in untreated sample.

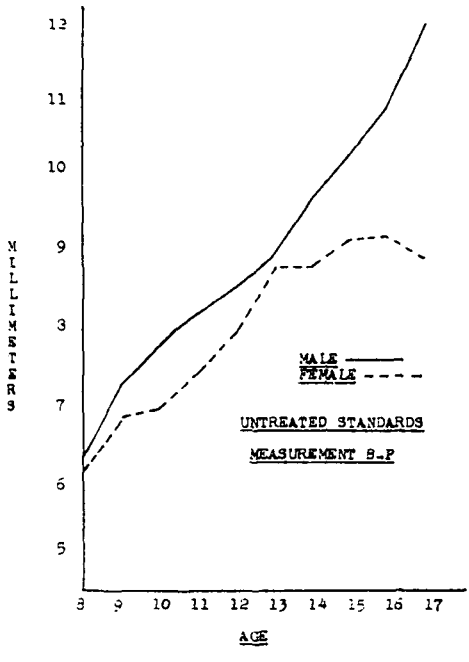


*Fig. 6* Graphic interpretation of measurement *B-P* in untreated sample.

when they showed twice as much change as any other three year span (—50%).

Thus, one might say for the measurement *LS-B* in this sample of 16 males and 15 females, the males showed over twice as much decrease as the females and this decrease in absolute measurement in the males was obtained primarily from 15 years of age to 17 years, and that due to growth, and/or modeling change, point B moved lingually.

*B-P*

This measurement attempted to show the over-all change that occurred from point B to the most anterior point on the anterior outline of the contour of the symphysis.

The female sample showed a mean increase of 2.79 mm from 8 years to 17 years; the males showed 5.66 mm, again approximately twice as much (Fig. 6). At age eight when the absolute readings were approximately the same for both male and female, the increase in measurement remained relatively constant with the female reading always less than the male until about age 13. At this age an interesting change occurred relative to the sexes. The over-all millimetric increase for the female subsequent to this time was, for all practical purposes, negligible, increasing from 8.77 mm at 13 years to 8.92 mm at 17 years. For the male however, the story was somewhat different, for at this time the male millimetric reading increased dramatically from 8.94 mm at 13 years to 12.00 mm at 17 years.

In lieu of the findings for the previous measurement *LS-B*, this is not too difficult to understand. It is the dramatic suddenness with which this occurs subsequent to 13 years of age that warrants comment. Converting the absolute change to yearly percentage increments we find that on a yearly basis (Fig. 7) the largest percentage change occurred from 12 years to 13 years in the female (30%) and from 16 to 17 years in the male (20%).

On a three year basis, the increment showing the greatest increase change in the female was from 10 to 13 years (67%) and 14 to 17 years (41%) in the male (Tables I and II).

Because the previous measurement, *LS-B*, showed some lingual movement of point B, next one would have a right to ask if the change occurring in the measurement *B-P* was solely to point B moving, or possible growth at P, or perhaps a combination of both. It should be remembered too, that the reading for the over-all measurement *LS-P* showed some absolute increase for females right up to 17 years of age. Thus, one might feel safe in assuming that the change in *B-P* on a longitudinal basis for this sample could be attributed to both lingual movement of

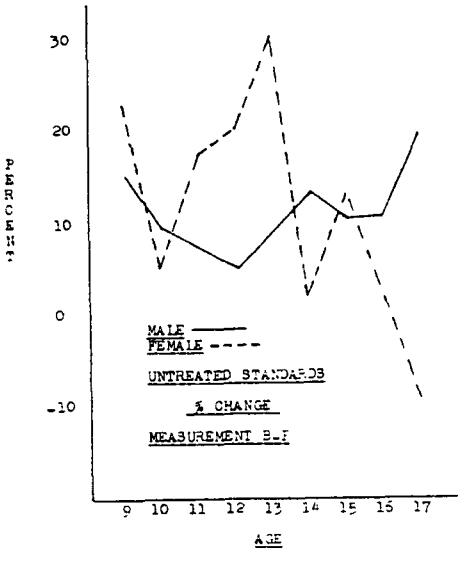


Fig. 7 Graphic interpretation of % change of measurement *B-P* in untreated sample.

point B and apposition at point pogonion. In addition, the over-all male increase was approximately twice that of the female and was realized subsequent to the time that the female had attained most of her increase.

In a sense it is somewhat academic how the increase occurred for this measurement. The important thing for one to remember is that it did occur. Here is evidence to the extent that there is appreciable absolute change in the area of pogonion, that this change occurs for all practical purposes in females before a similar but greater change occurs in the male.

Once the standards had been obtained from the nontreated individuals an attempt was made to gather a sufficiently large sample of treated individuals, followed longitudinally, so that they in turn could be compared with the untreated standards. If such a sample could be obtained, it would have to be divided not only into male and female, but also into extraction and nonextraction cases, if it were to carry some degree of authenticity.

Accordingly, records from treated cases from the author's practice were studied and over 100 cases were chosen (Table III) which could be followed over at least a three-year period. Attempts to compare the treated and untreated samples were planned only where the treated cases could be followed for at least three years and compared with a similar age span and sex. By the time this treated sample was broken down into male and female, extraction and nonextraction, it was found that the total number for any one group was pitifully small. In all instances, except five, the treated sample was less than five in number, which in itself seemed to rule out comparison with the nontreated due to a real defi-

TABLE III

TREATED CASES

| *Age* | *Extraction* | | *Nonextraction* | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| *Three Year Inc.* | | | | |
| 8-11 | 1 | none | none | 1 |
| 9-12 | none | none | 1 | none |
| 10-13 | none | 2 | 2 | 5 |
| 11-14 | 3 | 9* | 3 | 1 |
| 12-15 | 6* | 3 | 2 | 3 |
| 13-16 | 5 | 1 | 2 | 2 |
| 14-17 | 2 | 2 | 1 | none |
| *Four Year Inc.* | | | | |
| 8-12 | 1 | 1 | 1 | none |
| 9-13 | 1 | 2 | none | none |
| 10-14 | 1 | 2 | 1 | 3 |
| 11-15 | 5 | 1 | 1 | 4 |
| 12-16 | 2 | 1 | 1 | 2 |
| 13-17 | 2 | none | 1 | 1 |
| *Five Year Inc.* | | | | |
| 8-13 | none | none | 1 | none |
| 9-14 | 1 | 3 | none | none |
| 10-15 | 1 | 2 | 1 | none |
| 11-16 | 2 | 2 | none | 1 |
| 12-17 | 2 | 2 | 2 | none |

* $P > .05$ (not significant)

ciency in sample size.

In addition, since the standard deviations between the samples were greater than the difference between the means in just about every instance of treated vs. untreated, it would appear useless to run "t" or "f" ratio equivalents to determine any significance between the samples and still remain within a reasonable level of confidence ($t < 5\%$).

Nevertheless some "t" ratios were attempted where it seemed the standard deviations, or the sample size warranted it. In the first instance the standard deviations seemed sufficiently close and the sample size large enough in comparing male extraction cases in a three year increment from 12 years to 15 years (sample size 6) to the male untreated standards. "t" ratios were done on all three measurements and in no instance was the level of confidence less than the 5% level.

In the second instance the sample size (9) seemed large enough for female extraction cases in three year increments from 11 years to 14 years to be compared with female untreated standards for the same time period. Once again the level of confidence exceeded the 5% level, even though differences in the absolute measurements between the two samples did exist.

Though one could draw no significant conclusions from the foregoing comparisons, one is not prohibited from comparing the samples to denote trends. Thus for the sake of discussion, if one postulated extraction could create more chin, more substance in the area from B to P, the absolute reading for this measurement should consistently be higher in extraction cases followed longitudinally than for either the nontreated standards and/or nonextraction standards.

And so it was. In the untreated standards, male, 12 years to 15 years, the readings were:

| | *LS-P* | *LS-B* | *B-P* |
|---|---|---|---|
| Untreated male | 1.53 mm | —0.25 mm | 1.81 mm |
| Treated male ext. | 2.50 mm | —0.58 mm | 3.08 mm |

In another instance from eleven to fourteen years, the readings were as follows:

| | | | |
|---|---|---|---|
| Untreated female | 0.93 mm | —0.42 mm | 1.42 mm |
| Treated female ext. | 1.28 mm | —0.33 mm | 1.61 mm |

These two particular instances are singled out for they would seem to be more reliable than any other longitudinal comparisons between the treated and untreated samples. Other comparisons could be made, which would possibly be more dramatic, but because of the treated sample size, would be even less valid. Thus, for this study, differences between the treated and untreated samples on a longitudinal basis did exist and, though trends might possibly exist, they are not statistically significant; therefore, the results remain inconclusive.

In addition to longitudinal comparisons an attempt was also made to compare the treated and untreated sample cross-sectionally. On occasion the treated sample was approximately the size of the untreated one.

As an example, in comparing cross-sectionally the male at 12 years of age, the readings were as follows:

| No. | *LS-P* | *LS-B* | *B-P* |
|---|---|---|---|
| 16 Untreated | 17.6 mm | 9.1 mm | 8.5 mm |
| 10 Ext. | 18.2 mm | 9.4 mm | 8.8 mm |
| 9 Nonext. | 18.2 mm | 10.2 mm | 8.0 mm |

Here it is interesting to note that in the two treated samples, though the

over-all *LS-P* measurements were approximately the same, the *B-P* measurement averaged out almost 1 mm greater in the extraction sample.

In the case of the female samples, the treated samples were sufficiently large to warrant comparison cross-sectionally at age 14. The readings were:

| No. | *LS-P* | *LS-B* | *B-P* |
|---|---|---|---|
| 14 Untreated | 17.9 mm | 9.1 mm | 8.8 mm |
| 17 Ext. | 17.8 mm | 7.5 mm | 10.3 mm |
| 6 Nonext. | 17.3 mm | 8.7 mm | 8.7 mm |

Here it is rather obvious that while the over-all absolute measurement *LS-P* was approximately the same in all cases, the *B-P* reading was dramatically different. In the treated extraction sample, it was almost 2 mm more than the untreated and treated nonextraction samples which were approximately the same.

Did extraction procedures have anything to do with the aforementioned? It is still very difficult to say and any conclusions would be pure conjecture and not substantiated by statistical facts. It would appear, though, that in those instances where the sample size was large enough to warrant comparison, both longitudinally and cross-sectionally, definite trends could be observed. There was something obviously "different" in the *B-P* readings between the extraction cases and the others.

Objectively, one should also still feel hesitant to say unqualifiedly that extraction procedures "create more chin". There certainly appears to be ample justification for further research along these lines. Standards for untreated individuals have now been presented. Further studies involving larger samples of treated cases followed longitudinally would now seem to be in order for true statistical comparisons and conclusions.

## Summary and Conclusions

A study of the mandibular symphysis in lateral aspect has been undertaken. This study involved cephalometric roentgenograms taken on a series of 16 males and 15 females followed longitudinally from 8 years to 17 years, who were not treated orthodontically. An additional group of treated individuals was also studied: they were divided as to sex and treatment procedures involving extraction and nonextraction of mandibular dental units. Where applicable, comparisons were made, both longitudinally and cross-sectionally between the samples. The following conclusions seem to be warranted:

1. Standards regarding change in this contour have been established and are for the measures-*LS-P, LS-B,* and *B-P.*
2. Various sex differences for these standards were observed. All measurements followed approximately the same course, namely, the absolute readings in the male were approximately twice those of the female, and change (either increase or decrease depending upon the measurement) was realized later in the male by two to three years.
3. No statistically significant conclusions may be drawn from longitudinal comparisons of the untreated standards and treated sample used in this study.
4. Trends, however, could be observed in both longitudinal and cross-sectional comparisons between samples in certain instances. Most dramatic was the measurement *B-P* as it appeared larger in the extraction sample when compared with the nonextraction and untreated samples.
5. Further studies involving larger

samples of treated cases, followed longitudinally, would now seem warranted for statistical comparison to the untreated standards now presented.

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