Cephalometric Analysis And Synthesis

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It is with great humility that I stand before you today discussing a subject which Dr. William Downs pioneered to world recognition.

It was my good fortune to spend five years with Dr. Downs at the University of Illinois. The first year, I was a student and the remaining four an assistant under him, Dr. Brodie and the other staff members. That time afforded me the opportunity to appreciate the genius of Downs and grasp the vision of his thinking. He possessed the keenest insight for the use of the cephalometric tool in diagnosis, growth analysis and planning of treatment. Whatever fruit I have borne has been from the seeds of thought planted at that experience. That time was not without constant reminders by Dr. Brodie of the need for a continuous appreciation of the deep biologic aspects and the dangers of making dogmatic statements when considering the cephalometric film.

Only so few years ago, many men were utterly confused by the role cephalometrics was to occupy in their clinical practices. The question was frequently asked "What do you men get from the cephalometric film that we don't get from clinical examinations, models and photographs?" Even with all our training and appreciation of this tool, it was found difficult to answer in a cogent manner. I shared the deep conviction with Downs that cephalometrics had a great future for the clinical orthodontist. However, my thinking had to be clarified and several answers had to be found for myself for questions that arose from a practical viewpoint.

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After some years of deliberation and attempts to apply this tool, it finally crystallized, at least for teaching purposes, into five distinct aspects. These were (1) the equipment and technique, (2) radiographic interpretation, (3) cephalometric analysis or the survey, (4) evaluation of growth and the treatment results and (5) cephalometric synthesis or treatment planning. Each of these divisions, I thought, should be approached as a separate subject.

The intent of our exercise today is to review the purpose and usefulness of the cephalometric survey and to stress the use of this technique in treatment planning and estimating growth. We shall therefore delete the material on technique, interpretation and growth evaluation and concentrate on analysis and synthesis.

REASONS FOR ANALYSIS

Simply calling a dimension "large" or "small" or "good" or "bad" does not mean the same to everyone. In order to be *critical* and descriptive, it is more useful to express dimensions in terms of angles or linear measurements. Thus the purpose of analysis is *objective* and encompasses the four "C's" of cephalometrics. These are (1) to *characterize* or describe the conditions that exist, (2) to *compare* one individual with another or the same individual with himself at a later time, (3) to *classify* certain descriptions into various categories and (4) to *communicate* all of these aspects to the clinician, to a fellow research worker or to the parent.

In the final analysis, the orthodontist seeks a description of conditions as recorded in the film for the purpose of understanding and communicating the nature of a problem. As Downs stated, "These problems are sometimes skeletal and are sometimes dental and therefore an organization must be made of the factors to be described".

Many clinicians failed to grasp the significance of Down's method.[1,2,3] His primary intention was to describe facial and denture relationships. In the beginning even only ten measurements tended to be confused and complicated. Many looked toward simpler techniques in seeking guides, formulas for answers for their clinical problems. They often lost sight of the primary function of the method which was to interpret skeletal morphology.

Years of thinking went into Downs' analysis before it came to the attention of the profession. His work still stands as an accurate description of the skeletal and dental relationship in late adolescent children with normal occlusion. His nomenclature for classification is an outstanding and original contribution and rates, in my opinion, with Angle's original classification of dental relationship.

With the above observations in mind, we started with the Downs analysis, and, rather than casting it aside, tried to shorten and revise it for our own purpose as applied in a busy clinical practice. We felt that the reasons for each measurement needed clarification. Of primary concern for an interpretation of the orthopedic problems of the face were measurements of facial convexity and height or depth to the facial skeleton. Facial contour needed to be assessed first in terms of location of the chin and secondly, position of the maxilla to the profile. Simple denominators for these factors were sought, i.e., chin location and profile contour.

A meaningful and simple method of describing anterior tooth relationship was desired. In addition, communication of lip relationship needed implementation.

It was recognized that all orthodontic cases did not possess normal faces as described in many studies of normal individuals. Indeed, many cases would never, nor should they, display facial patterns falling in the range of normal samples. For that reason we set about to accumulate one thousand consecutive orthodontic cases in an effort to find the range of problems and characteristics of common problems that face the clinician. The author therefore refers to some of his previous studies for reference for the related material.[4,5,6] In essence these cases averaged about age nine years, were nearly sixty per cent female and were about sixty per cent Class II malocclusions.

Cephalometric Analysis

A. *Skeletal Relationship*

1. *Facial Convexity as Determined by Point A to the Facial Plane*

After many years of debate I concluded that a direct measurement of point A to the facial plane was a useful description of contour to the bony profile. Therefore, instead of Downs' angle of convexity expressed in degrees from a straight line, we made a direct measurement from a straight line (Figure 1). In the study referred to above the average orthodontic case fell 4.1 mm anterior to the facial plane with a standard deviation of $\pm$ 2.8 mm. This revealed that only seventeen per cent of the cases demonstrated from 7 to 12 mm of convexity to the facial profile or were cases severely convex. In spite of the argument of "chin buttons" and "secondary sex changes" at the chin, we agreed with Downs by employing pogonion for convexity. We felt

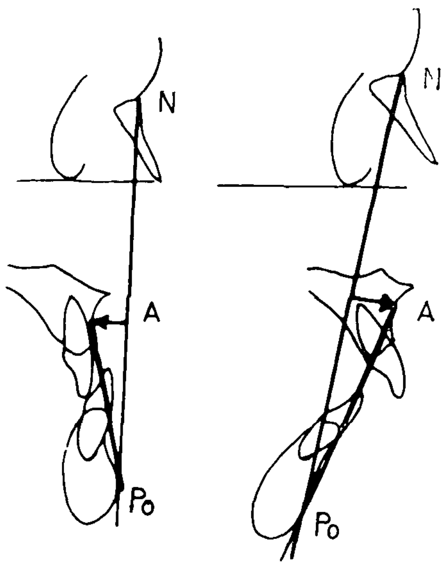

Fig. 1 Variation of bony convexity by direct point A to facial plane measurement. Mean was 4.1 mm with a standard deviation of ±3.0 in one thousand cases. Concave face on left is —8 mm, convexity on right is +10 mm. Note A to pogonion line, the variation of upper incisor relationship to the APo plane and similarity of lower incisor relationship to that line.

that measuring point A directly to the facial plane was a reliable method of expression of facial convexity in spite of size differences in facial height. Point B was not employed in the consideration of facial convexity because it was thought to represent an alveolar point on the mandible and was often misleading in the assessment of true basal convexity. Point A could be challenged for the same reason; however, it was the best representative anterior landmark for basal bone that we could consistently locate. Many orthodontists presently employ the SNA-SNB difference to describe convexity. Usually one degree is equal to about one millimeter on an arc at the distance from N to A.

2. *The X Y Axis Angle as an Estimation of Facial Height*

Downs employed the crossing of the Y axis to the Frankfort plane in typing the face. However, the entire reliance on one plane merely enforces an error if there is certain variation within the Frankfort plane. As an adaptation from midsagittal laminagraphic studies we therefore went back to basion (Figure 2), and to Huxley's basion-nasion plane and measured its crossing of the Y axis as a means of describing height to the face. We called this the X Y axis angle to distinguish it from the Y axis as measured from Frankfort plane. This seemed to be more critical and descriptive and more useful in *assessing facial height* and *prognosing the direction of growth of the face.* In the one thousand clinical cases the mean was +3° with a standard deviation ±3° (Figure 3). Thus, cases displaying angles less than 90° when measured at the crossing of the Y axis to the basion-nasion plane were suspected of possessing long faces or of being consistent with retrognathic patterns. The cases revealing readings

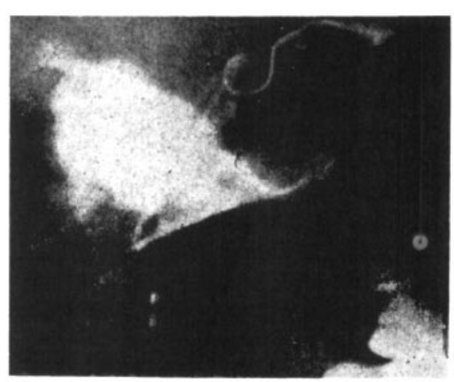

Fig. 2 Laminagraph of midsagittal section. Base of occipital bone narrows to point at the foramen magnum which is basion. Note the clivus and roof of nasopharynx converge at that point. The spheno-occipital synchondrosis is just closing in this thirteen year old girl. Note further the dens and cross section of the anterior arch of the atlas. Arrow is at basion.

greater than 90°, i.e., +6 to +10, showed more favorable characteristics. Cases yielding X Y axis angles greater than 10° to 12° were usually suggestive of closed bite tendencies in the face with short facial vertical dimension.

It should be remembered that an angle theoretically expresses proportion while direct measurements express direct comparisons. Therefore the X Y axis angle is only proportionate and does not measure true length of the face.

3. *The Facial Angle as an Expression of Facial Depth*

The facial angle is accepted as a sensible indicator of depth to the chin. Certain errors of interpretation should be avoided in cases having unusual locations of nasion, small orbital cavities or anomalies in the temporal bone.

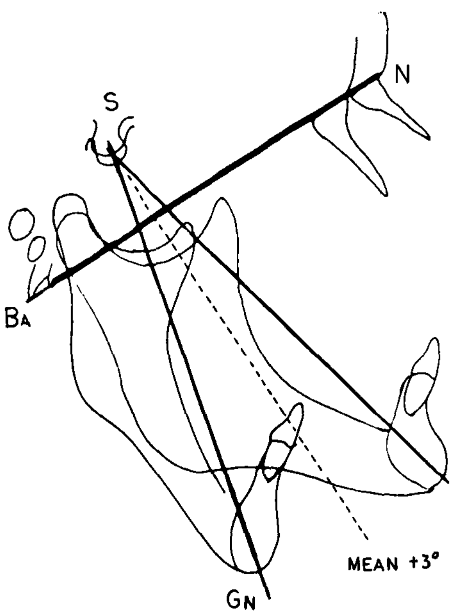

Fig. 3 The XY axis or growth axis. Location of the chin, upward and downward, is determined as SGn crosses the basion-nasion plane. Mean (dotted line) was +3 degrees of a right angle, S.D. ±3 degrees. Cases illustrated ranged from +14 degrees to —12 degrees. This parameter is excellent for typing relative length of the face.

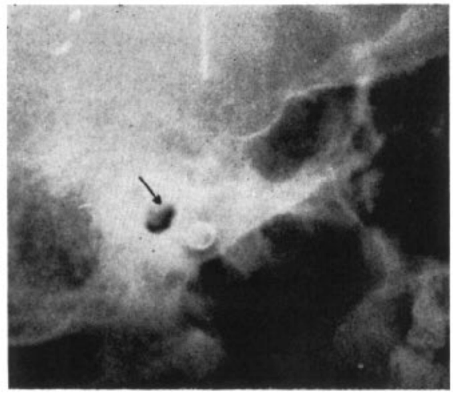

Fig. 4 Demonstration of an unusual downward and forward ear rod location to the ear canal. This was probably an error in positioning of the patient, however, a great variation has been observed. This has led the author to employ the superior point of the dark outline of the ear hole for the posterior limits of the Frankfort horizontal plane. This has therefore prevented the human error of using the machine porion. The ear rods are held in wooden upright supports which are almost radiolucent and help increase the visibility of the joint and basicranial elements.

However, any other measurement to represent facial depth would be fraught with the same anatomical variation and limited to the same degree but would not be as easy to visualize from a right angle and externally. One frequently expressed problem was the use of the machine ear post porion which could vary considerably. Therefore, as a carryover from laminagraphic studies we employed the true ear hole and located a point at the top of the external auditory canal as the posterior limit of the Frankfort horizontal plane (Fig. 4). This was essentially the only change made from Downs' method for this measurement.

The mean in one thousand clinical cases in facial angle was 85.4° with a standard deviation ±3.7. A facial angle near 80° or below suggests a weakness of the chin and possibly poor prognosis in growth. Facial angles 90° or greater suggest a strength to the chin with better growth prognosis. Thus, the facial angle provides a more *critical* estimation of chin position than could be gained by visual inspection or clinical examination at the chair.

4. The Breadth Angle and Mandibular Plane Angle in Judgment of Facial Width

Usually the combination of the facial angle and the X Y axis will locate the chin and suggest mandibular form, but an expression of breadth to the face must of necessity be proportional. After many years of deliberation and tracing of the frontal film, (Figure 5) a simple denominator for mandibular width has been used clinically to a limited degree. A point on the midsagittal plane between the two foramen rotundum was selected as registration point. Gonion and menton were marked and the angle R-Go-M was measured. The degree in this angle theoretically expresses proportional width at the gonial angle. Measurements near 80° were the average type of condition observed. In wide, square mandibles this reading might be as low as 70° while in narrow mandibles and long faces, this angle will be as high as 90°. Certain corrections can be made for this angle in order to over-

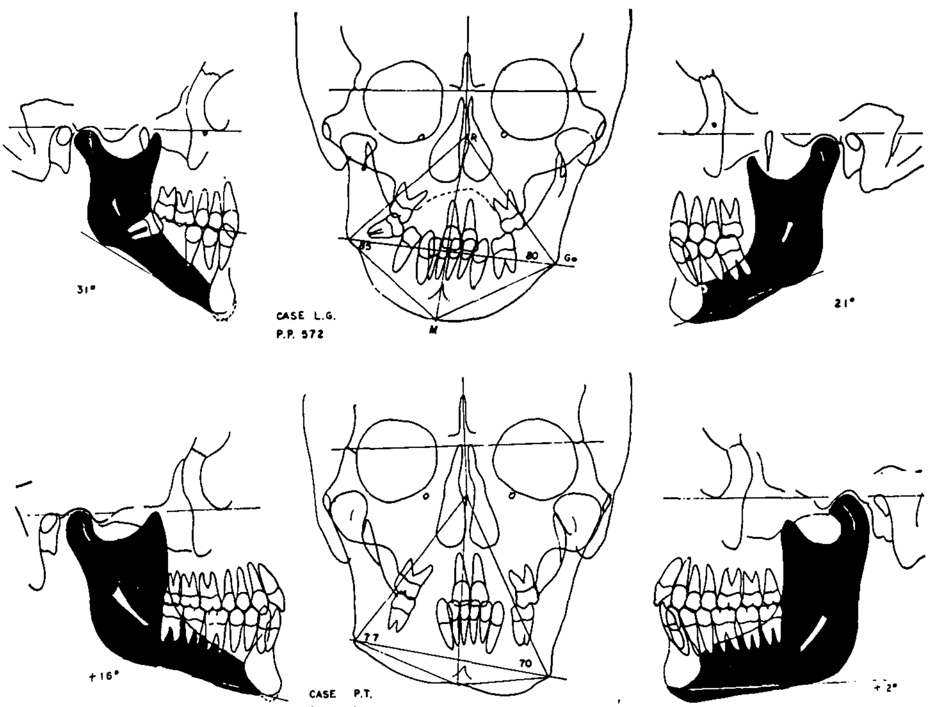

Fig. 5 Tracings of the frontal film and right and left laminagraphs of joint and mandible. Shows measurement of facial form and asymmetry in the frontal film and demonstrates factors in mandibular growth and form. Above — angle RGoM is 85 on left (undergrowth) and 80 on right (normal). Mandibular plane angle on left is high at 31 degrees, on right it is low, 21 degrees. Note the posterior tilt of the condylar neck and head in the upper left figure.

Below — angle RGoM is 77 degrees on left (normal) and 70 degrees on right (overgrowth.) Note the difference in the mandibular plane and condylar form in the two tracings. The condylar neck is upward and forward and thick and heavy in the lower right figure.

come an error of tipping of the head at the x-ray exposure if one was noted.

A secondary representation for facial width is seen in the mandibular plane angle. The mean in the one thousand cases was 25.7 with a standard deviation of ±5.9°. Low mandibular plane angles (20° or less) usually suggest closed bite tendencies with forward growing tendencies while high mandibular plane angles (38° or more) are usually consistent with patients showing vertical expression in growth.

B. *Dental Relationship*

1. *Denture Plane—Reciprocal Relationship of the Lower Incisor*

Probably the greatest controversy with the use of cephalometrics has been its use as a guide in evaluating the relationship of the incisor teeth. Downs selected the A-pogonion plane as the line connecting the most anterior limits of basal bone of the maxilla and the mandible (Figure 1). He measured the upper incisor from this line, a method which we have not changed. However, a more useful and descriptive capacity for the A-pogonion plane is the measurement from the lower incisor. Downs measured the lower incisor to the A-pogonion plane in his normal group and found it to be located in a range from 2 mm backward to 3 mm forward of the plane. Its average axial inclination was 23° with a standard deviation of ±3°. In the one thousand case study referred to above we found the mean to be almost +0.5 mm forward of the A-pogonion plane with a standard deviation of about 2.5 mm[4]. This orthodontic sample thus spread with one standard deviation the entire range of Downs' normal sample. It averaged almost an identical position in spite of our sample being orthodontic and his being selected normals (Figure 6, above). Other samples studied at our suggestion were the fifty normals from

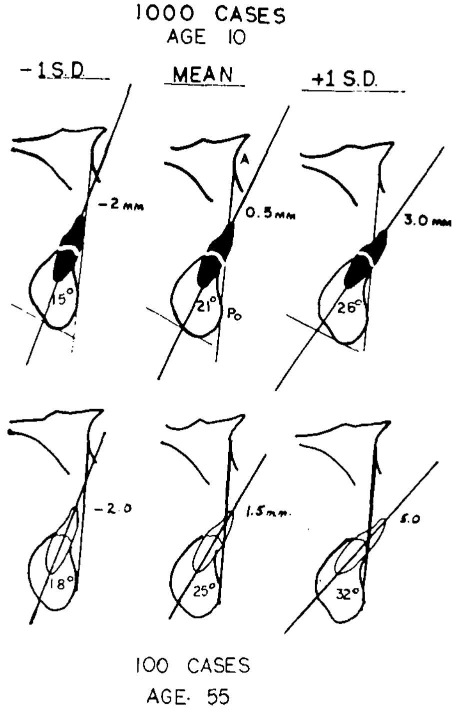

Fig. 6 Studies of the position and angulation of the lower incisor.

Above — Mean and variation of one thousand cases which are almost identical to Downs' normals. Lower incisor average is .5 mm ahead of APo plane at 21 degrees, standard deviations of ± 2.5 mm and ±5 degrees respectively yield —2 mm at 15 degrees to +3 mm at 26 degrees as range of objectives in treatment.

Below — Findings on one hundred untreated cases at age fifty-five. Note more forward position of 1.5 mm at 25 degrees. The range of acceptable relationship here would yield —2 mm at 18 degrees to +5 mm at 32 degrees. This is consistent with range of treated cases in the author's practice.

In treatment the upper incisor is related from the lower incisor to a normal overbite and overjet at 130 degrees to 145 degrees depending upon age and type.

Indiana University (Shudy[7]) and a sample of thirty prize winners in "Smile of the Year Contests" in Los Angeles city schools (Hopkins[8]). These groups displayed lower incisors averaging 1.6 and 2.3 respectively, forward of the A-pogonion plane.

Ricketts and Chase[9] investigated a

cross section of one hundred patients at the Los Angeles Veterans Hospital in order to determine the position of the lower incisors in patients retaining their teeth to the sixth decade of life. (Figure 6 below) The lower incisor in that sample of older age was strikingly similar to normal samples of Shudy and Hopkins. The mean lower incisor was found at —1.4 mm to the A-pogonion plane with S. D. of ±3.4. The average inclination of the incisor was 25.4° ± 6.8°.

These findings certainly cast doubt on the validity of samples selected for esthetic purposes only which locate the lower incisors backward of the A-pogonion plane. Normal cases thus can be observed with a backward relationship of the denture. Prominent dentures "attract" attention and are attractive. It should not be inferred that these prominent teeth are unstable; in fact this is an oft-repeated assertion without apparent documentation. Possibly this idea stems from experiences of over expansion but is not applicable to non-treated cases.

It should be borne in mind that with greater convexity of the face, the inclination of the A-pogonion plane is forward. The lower incisor tooth often tilts forward in compensation, hence the "reciprocal plane". It is therefore our opinion that, for purpose of analysis, the A-pogonion plane serves as the best reference line for describing the position of the incisors that is available because it *relates teeth to the composite bases.* Measuring to the NB line in effect is relating the lower incisor to itself because the position of B is determined by the lower incisor in the first place. A measure of the axial inclination to Frankfort horizontal does not describe its spatial relationship but only its uprightness to a straight profile and does not consider convex or concave faces which are often experienced. Also, a relation of the teeth to the line NB or to NA does not take into account facial configuration nor age of the patient. Thus compromises must be made which become confusing and involved. The use of the A-pogonion plane as a reference plane satisfies the requirements for facial types and provides for the difference in the growing individual, i.e., the lower incisor tends to retract at the same rate that the profile straightens.

The only objection to the use of A-pogonion is the so-called "chin button" case. These are overrated in frequency and can easily be dealt with by simply considering the chin and maintaining a posterior relation of the tooth if necessary.

2. *Esthetic Relationship as Evaluated from the Esthetic Plane*

It was recognized some years ago that some criteria were needed to communicate differences in the relationship of lips to contiguous structures. Therefore a line similar to the anterior limits of the basal bone was selected in the soft tissue, namely, the end of the nose and the end of the soft tissue of the chin (Figure 13). This line was termed by us[10] to be the "esthetic plane" and was employed only for the purpose of describing the relationship of the mouth to other structures. Due to anatomical variation and age differences no fixed requirements have been laid down. However, it has been observed that patterns revealing lips protruding ahead of this line have been evaluated by most orthodontists to be disproportionate and fraught with facial disharmony. It is our feeling that by adulthood the lips should be contained within the nose-chin line for cosmetic purposes. In addition, this line is useful in evaluating the functional abnormalities of the lip which have been described by us.

C. *Deep Structures Explain Profile Variation*

Deep structural analysis includes (1) the cranial base, (2) the temporomandibular joint and mandibular ramus, and (3) the nasopharyngeal framework together with the pterygoid plates.

Cephalometric Synthesis

Probably the greatest difficulty in the understanding of cephalometrics has come regarding its use in treatment planning. It must be emphasized that the description, classification and communication of the problem is one subject, that of diagnosis. Treatment planning is an entirely different subject. When treatment is planned the clinician must take into account a knowledge of growth and alteration of structure. He also needs familiarity with the possibilities of tooth movement together with a comprehension of the anchorage values of teeth. Finally, he must anticipate the changes of soft tissues that accompany changes in the teeth in order to perceive the functional and esthetic end result.

It is evident, therefore, that treatment planning should take into consideration many changes, and these be predicted by the clinician if he is to fully appreciate the possibilities that are at his disposal by various mechanical or functional techniques. Any treatment plan constitutes a prediction of change whether the orthodontist likes to admit it or not.

A. *The Static Synthesis — (No Growth)*

When no growth is anticipated, the estimation is made almost entirely for the movement of the teeth and changes in lips. The headplate tracing is employed as an instrument to visualize estimated tooth movement. The desired and expected changes are synthesized in a new tracing. A useful guide for envisioning changes of the anterior teeth is the A-pogonion plane or the "reciprocal denture plane". The teeth are planned to be placed according to the forces or oral environment that create balance, i.e., the tongue and the lips. A requirement for final lip relationship is that the lips fall within the esthetic plane, that the lips are smooth in contour and that the mouth can be closed with little or no strain. Remember the static case is not expected to grow out of a lip imbalance.

Esthetics is considered an integral part of orthodontic planning; usually, when the requirements for esthetics are satisfied, the teeth will be in good functional relationship. Contrarywise, when the teeth are well related, the lips will fall into good esthetic and functional harmony. Therefore we try to place the lower incisor within one standard deviation of the normal to the APo line depending upon oral and environmental factors, i.e., 0.5 mm. ±2.5 mm. However, we may intentionally err toward protrusive relationship in some patients due to expected late growth changes. The upper incisor is then adjusted to it with normal overbite and overjet. Common sense and clinical acumen are the final guides. After determining the desired changes in position of the anterior teeth the necessary anchorage can be envisioned by movement of the posterior teeth. Anchorage factors and treatment techniques constitute separate subjects and will not be discussed here.

B. *The Dynamic Synthesis — (for the Growing Child)*

When growth is anticipated the synthesis is dynamic. Growth of the chin in direction and amount is a foremost consideration. However, cranial areas are employed for basal references.

1. *Cranial Behavior*

SN change has been found useful because the maxilla seemed to grow forward at almost an identical rate with nasion[5]. The angle SNA changed very little in one hundred observed Class I and Class II cases with no orthodontic treatment (Figure 7). Our findings further revealed that approximately one mm per year of growth on the sella nasion plane can be expected and sella basion is usually about two-thirds of that amount. Variations showed that some cases expressed no growth, particularly girls after puberty, while others grew more than one mm per year. Although slight errors in prediction frequently were noted, the long, upturned anterior cranial base (obtuse BaSN) seemed to increase most rapidly. At any rate, anticipation on the basis of the constitution, age and sex is better than leaving everything strictly to chance and without consideration for natural development.

2. *Mandibular Behavior*

The next step is estimating the change in the chin by the *direction* of the Y axis or growth axis of the face. The basion nasion plane is more critical

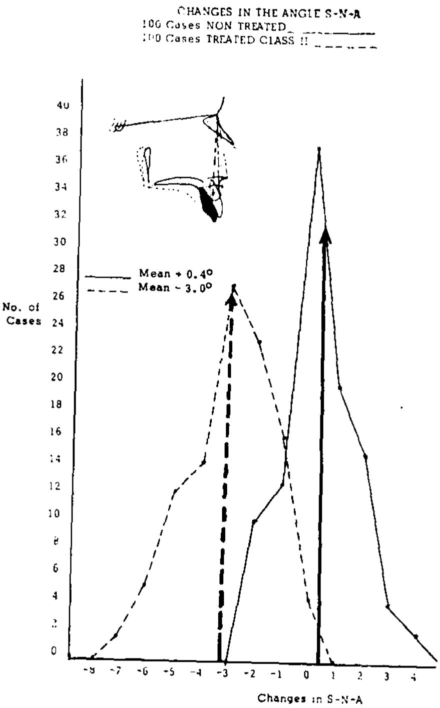

Fig. 7 A comparison of SNA behavior in one hundred untreated cases over three years observation with a similar sample of one hundred cases treated by headgear alone or together with intermaxillary elastics. The solid arrow on right shows the mean tendency without treatment of +0.4 degrees. Treatment seems to effect a shift of the entire sample. Note the dotted arrow at about —3.0 degrees to the left. The insert shows a case of palatal plane tipping, retraction of ANS and point A of about 5 degrees. Note the lingual torque of the upper incisor root.

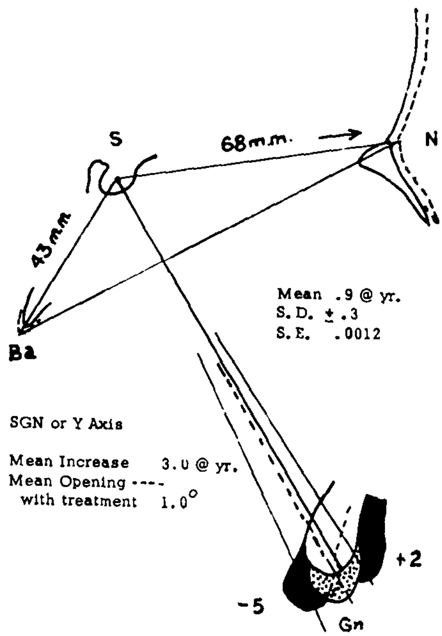

Fig. 8 Findings on changes of SN, SBA and SGn during growth and treatment. Note SN increase about 1 mm per year. The typical change in the Y axis was about 1 degree opening with treatment, see hashed line and dotted chin. Average increase in length of SGn was about 3 mm per year. Note variation of +2 degrees to —5 degrees change in Y axis observed during treatment in individual cases. These findings are employed for estimation in treatment planning.

but sella nasion line can be employed by those not able to find basion on the film (Figure 8).

In the average Class II case the Y axis tended to open about one degree during a two year period while the patient was undergoing orthodontic treatment. In prognathic patterns or strong mesognathic patterns the chin tended to come forward or the Y axis closed one degree or more during orthodontic treatment. In some severe retrognathic patterns, accompanied by distal positional changes of the condyle, two to four degrees opening of the Y axis was not uncommon. When this opening was due to mandibular rotation, it was thought some could be avoided by orthodontic forces which intruded the teeth. Rotation here is meant the rotation of the condyle in the fossa as the chin swings in a downward and backward arc as the bite is opened.

The final consideration for estimation of change in the direction of the Y axis therefore revolves around the original facial pattern, the manner in which the mandible is related to the remaining skeletal structures and the growth characteristics of the mandible itself. In Figure 9 are listed ten characteristics of the mandible which seem to be related to its eventual form, size and proportion.

MANDIBULAR FORM AND DEVELOPMENTAL BEHAVIOR

Mandibular Characteristic	Tendency on Ramus	Tendency on Chin
1. Mand. Plane Angle Low High	> V	> V
2. Gonial Angle Acute Obtuse	> V	> V
3. Width of Ramus Wide Narrow	> V	> V
4. Thickness of Condyle Wide Narrow	> V	> V
5. Width of Symphysis Wide Narrow		> V
6. Inclination of Condyle Forward Backward	V	> V
7. Corpus Length Long Short		> V
8. Coronoid Height Low High	> V	> V
9. Occlusal Plane Parallel Divergent	> V	> V
10. Ante-gonial Notching Normal Notched	Λ	V

Fig. 9 Ten characteristics which give clues to the development of the lower face. The growth of the condyle affects growth of the ramus, the body and the chin. Please compare this table with cases illustrated in Fig. 5. The proper evaluation of these factors helps predict mandibular form and facial development.

The *amount* of growth of the mandible is difficult to determine. However, the knowledge of the average case is a starting point. The average yearly expectancy is about 2.5 to 3 mm of growth on the Y axis. Five to six mm increase in length of the Y axis is the typical expression of two years growth during treatment for children at the mixed dentition and girls at puberty. Boys tend to grow at a slightly greater rate than girls except during their pubertal ages. After puberty some boys will grow at almost twice the rate of girls. Boys sometimes grow 8 to 12 mm during the two year period from age 12.5 to 14.5 or at the time they are undergoing a pubertal spurt. In functional orthopedic techniques a slight forward positioning of the condyle, and hence the chin, will confuse the picture. After a time (growth) these usually are of minor effect in most cases.

Change the Y axis and lengthen it for estimated growth, draw the symphysis and establish the mandibular plane backward from the symphysis consistent with tilt of the mandible.

The knowledge of the behavior of the chin has much to do with the eventual outcome of the case in spite of the frequently heard expression that "all growth is good — no matter what direction it takes". All growth probably is good. However, when Class II conditions are being corrected, growth in the forward direction is unquestionably of much greater benefit than predominantly vertical development.

3. *Maxilla Behavior*

The behavior of point A from a vertical and horizontal standpoint is estimated. Point A and the anterior nasal spine usually drop vertically about one-third the total facial height increase during treatment. The contour at point A is modified by the use of extraoral traction and to a lesser amount by the use of intermaxillary elastics when accompanied by torquing action to the upper incisor teeth. Normal cases have been observed to display an SNA angle decrease of up to two degrees during an observed growth period similar to that occurring during treatment (Figure 7). These same patients treated with strong cervical anchorage have been noted to decrease seven to eight degrees during orthodontic treatment. Many cases of good prognathic growth patterns will frequently reveal an SNA angle increase of one to two degrees during a two year period. With Class II treatment as outlined above in these cases the angle SNA will not change or will decrease up to two or three degrees depending upon the forces employed.

Draw the palatal plane and point A contour behavior. This completes basal skeletal alteration in the profile (Figure 10).

Fig. 10 Approximately one-third height increase of the face during treatment is registered in the upper face, N to ANS. About two-thirds height increase is measured in the denture area or lower face. The palatal plane usually tilts under the influence of cervical traction and the whole nasal floor seems to be altered. Maxillary changes are estimated by superimposing on the facial plane and then SN or other cranial references.

Cephalometric Tooth Set Up

The desired relationship of teeth is established in the synthesized skeletal pattern (Figure 11A). Point A is connected with a line to pogonion; remember point A has been changed and the chin has grown. The lower incisor is related to this new reciprocal plane in the manner desired depending upon the *environmental* forces operating on the denture and the *age* of the patient (Figure 11B). Following the location and inclination of the lower incisor from the A-pogonion plane the upper incisor is erected to that determined best for the stability of the denture and for later growth experience (Figure 11C).

Movement of the posterior teeth is

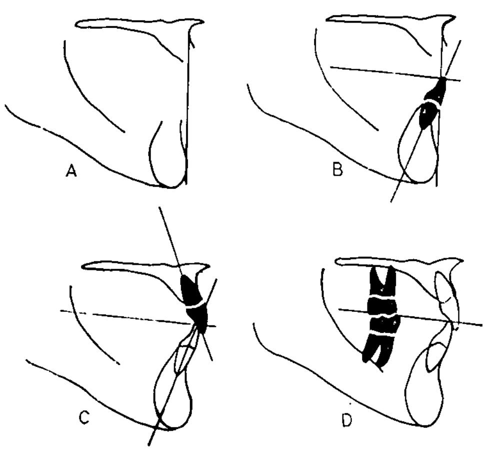

Fig. 11 Sequence of steps in establishing objectives of tooth position. A— Draw the new APo plane to establish a reciprocal line. B— Set up the lower incisor to vary from the mean depending upon individual needs. C— Locate the upper incisor from the lower, i.e., normal overbite and overjet at 130 to 145 degrees depending upon age and facial type. E— Figure anchorage on possibilities of treatment after having established the necessary anterior changes.

visualized in the projected tracing. The judgment of necessary molar behavior follows a thorough analysis of treatment of many cases treated by different methods (Figure 11D).

Finally, the estimation of the growth of the nose can be made together with the alteration of the soft tissue of the chin and the adaptation of the lips to the new position of the teeth. Here an awareness of nose growth and lip alteration with treatment and growth to fully conceived esthetic changes is necessary. The estimation of lip changes is probably the most difficult factor to master in the whole technique (Figure 12).

The study of the synthesized tracings superimposed over the original reveals the possibilities of treatment with or without extraction (Figure 13). The more accurate the technique and the more knowledge that was carried to the synthesized case, the better the treatment plan. Thus the total change in the case is demonstrated and understood (Figure 14).

Summary and Conclusions

An attempt has been made to simplify and crystallize certain ideas with regard to *clinical* cephalometrics as practiced and conceived by the author. It was speculated that much of the confusion of cephalometrics has been due to the fact that clinicians have failed to segregate different aspects of the subject. Analysis in the past has been viewed as an entanglement of angles and lines with a vague or complex application to routine problems. The purpose of a cephalometric survey, as explained, was to describe, classify and communicate the nature of skeletal orthopedic problems or dental malformations. By this means an accurate diagnosis of the case could be gained. The facial plane, the reciprocal denture plane or APo plane and the esthetic plane were shown to be useful.

One misuse of cephalometric analysis has been the error in the interpretation of standards. The tendency has been to view the headplate and attempt to determine what should be done by rearranging the teeth following a formula worked out from normals or ideal cases. Such a static concept neglects to recognize the influences of growth and alteration of structures. Thus, analysis has been mistakenly linked to treatment planning.

The ideal for the individual is simply the best that can be achieved with treatment under a given pattern and set of growth circumstances. What is ideal for one is not ideal for another. No concern was given for a case that did not fit a "normal" in every respect, indeed, that was impossible. Means, ranges of variation, conceived standards or "ideal" objectives merely formed a basis for comparison or a guide to

Fig. 12 Photographs before and after treatment of the case illustrated in Figs. 13 and 14. A— Severe lip strain and protrusion with lip closure before treatment. B— Lips normal after treatment, closed with no strain, smooth in contour, contained within the E plane (tip of nose and front of chin) and lower slightly forward of upper when related to the E plane. C— Case superimposed on E plane. D— Superimposed on cranial elements to show growth changes of the chin and the nose. See Fig. 14 for analysis of growth and treatment changes.

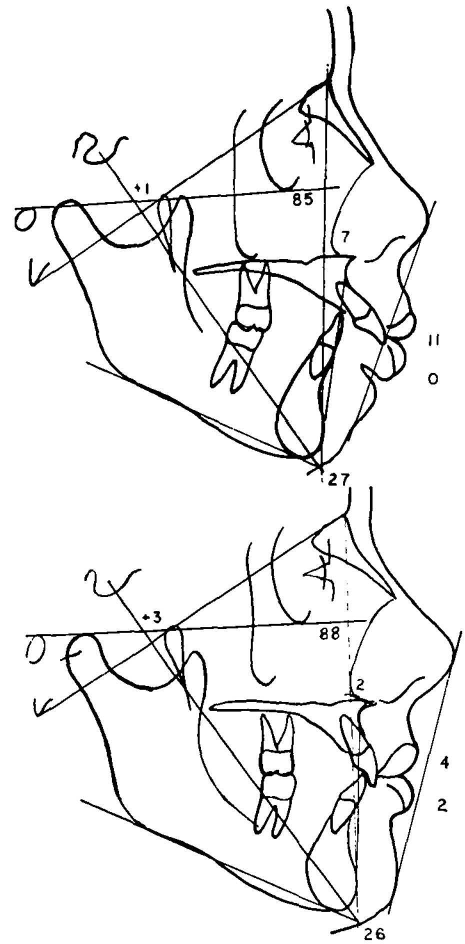

Fig. 13 Before and after tracings of the case illustrated in Figs. 12 and 14. Note the convex mesognathic pattern with severe dental and alveolar protrusion of the maxillary arch. Extraction of four first bicuspids was employed as a measure of treatment for this fourteen year old male. Notice the upper incisor protruded 11 mm anterior to the APo plane and that 7 mm of convexity was present. The lower incisor was just on the APo plane. After treatment the chin was more forward, the convexity was only 2 mm and the upper incisor was only 4 mm forward of APo. Although the lower incisor was 2 mm forward at retention, it had been retracted and intruded 3 mm as seen in Fig. 14. The original tracing was at fourteen years, five months and the second at sixteen years, eight months.

suggest the manner in which a given case differed in facial pattern, malocclusion or esthetic relationship. Analysis thus told the clinician "where he was" with a case. "Where to go" with a case is directed by an entirely different aspect of cephalometrics, that of synthesis.

If a hunter is to shoot a duck on the fly, he must lay the shot in the pathway of the duck so that the shot and the bird arrive at the same instant of time. An estimation is made of the rate of speed and direction of the flight. If a hit is scored a correct prediction was made of the physical factors involved.

To a less critical degree the orthodontist moves teeth in a growing child so that he arrives at a desired goal commensurate with anticipated change. Any treatment plan is thus a prediction of change; otherwise there would be no plan and everything would be left strictly to chance. Treatment planning with cephalometrics is based on a knowledge of *growth* and familiarity with the *possibilities* of structural alteration and tooth movement as viewed in the headplate. Cephalometric synthesis rightfully includes an estimation or prediction of changes in the skeletal framework in conjunction with the movement of teeth. However, certain types of treatment seem to affect the behavior of the mandible as far as bite opening is concerned and dramatically affect growth of the maxilla. Thus, estimation must be projected on the basis of the selection of different mechanical procedures.

Rarely a hunter can pick up a gun and hit a clay pigeon without practice. He may hit a few by accident in the beginning but it takes patience and practice in order to be proficient. Likewise, in cephalometric synthesis, it takes patience, study and practice to plan a case and hit the desired mark.

The technique outlined is comparatively new and much work remains to be done on a statistical basis to make it even simpler and more foolproof. As it stands it is merely an aid or a guide to help the clinician envision treatment and one should not be dismayed if things don't work exactly as anticipated. The clinician should be satisfied if he has achieved the general characteristics and appreciated the general biologic factors at work in the individual case and has been able to make a rough estimation of the case in point.

Cephalometric films can be employed for descriptions of morphology, for knowledge of growth, for outlining objectives of treatment and for utilizing advantages of different treatment techniques. Cephalometrics is another tool for aid in diagnosis and treatment planning. When used properly, cephalometrics is the most excellent tool for this purpose available today to the clinical orthodontist.

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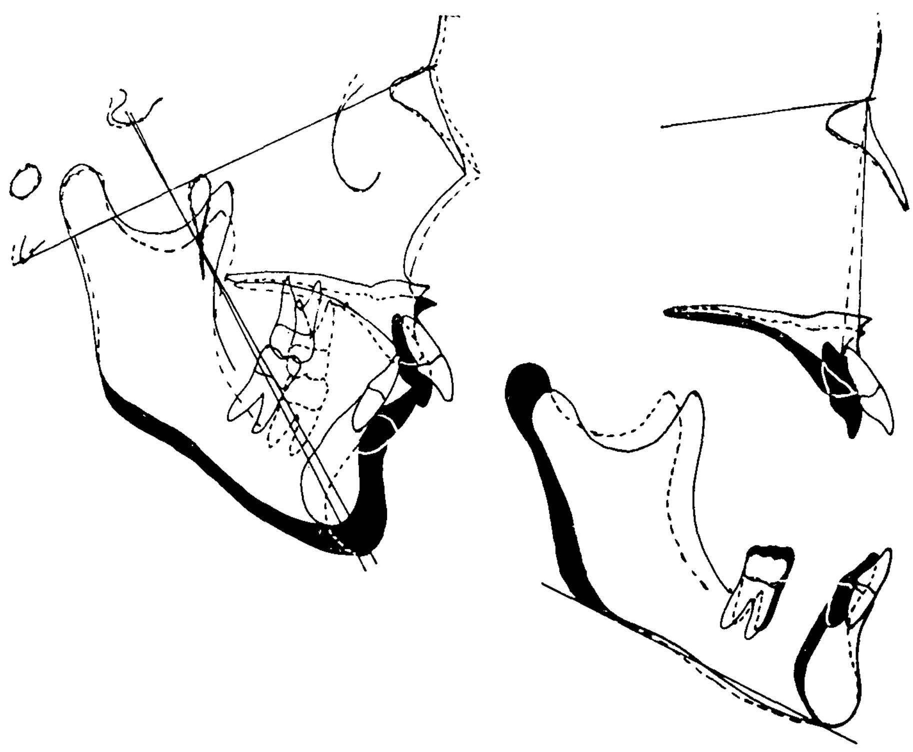

Fig. 14 Growth and treatment analysis of the above case. Note the closing of the Y axis slightly more than 1 degree and about 10 mm of SGn increase. Note the SNA decrease and upper incisor retraction, and finally the stability of the lower first molar and bodily retraction of the lower incisor. Good mandibular growth helped immensely in the conclusion of this case but it was expected, relied upon, and utilized.

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