Studies of Dento-Facial Morphology

1. A Simple Instrument for Appraising Variations.

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Scientific inquiry requires classification, measurement and controlled experimentation. Dental groups interested in dento-facial morphology have accepted the Angle classification of malocclusion not only as an excellent diagnostic aid, but as a very convenient compartmentalized system of designation of the general types of occlusal aberration. While the Angle classification has had wide application, the observer must make certain judgments especially as to the degree of deviation from an accepted normal. Different observers are even known to have different interpretations as to what constitutes Class I, II or III malocclusions.

Those interested in the frequency with which malocclusions occur have been reluctant to place great reliance on past studies because of the qualitative character of the classifications employed. It is becoming increasingly evident that quantitative measurements are necessary to subject the problem to epidemiologic methods of study. Such methods for the quantitative analysis of dentofacial variations are extremely important if controlled experiments are to be conducted.

At present there are several excellent methods for the quantitative assessment of malocclusion. These are based primarily upon roentgenographic cephalometric technics. Typical of these methods are those of Downs[1] and Wylie[2]. Data used in cranio-facial analyses proposed by these workers are based upon measurements and calculations taken from lateral roentgenograms of the head. The omission of frontal head roentgenograms indicates that Downs[1] and Wylie[2] are primarily concerned with the antero-posterior and supero-inferior relationships of the dentition to the cranio-facial complex.

The use of the sagittal plane rather than the transverse plane in assessing cranio-facial variation is an accepted procedure because malocclusion affects the face in the sagittal plane more than it does in the transverse plane.

The concept of considering dental occlusion as a part of the facial pattern is now accepted in orthodontic groups. The rationale of the concept is based upon the hypothesis that the face is the foundation of the denture. [1] [2] [3] [4] [5]

The technics of anthropometry have been utilized for many years to obtain quantitative data for the study of malocclusion. Perhaps the man best known for the adaptation of anthropometric methods to the field of orthodontics is the late Milo Hellman [3] [4] [5]. He made use of the Todd head spanner and anthropometric calipers.

While both these methods, roentgenographic cephalometry and anthropometry, supply data for the quantitative analysis of malocclusion, both systems have serious drawbacks for epidemiologic use.

Population studies should be based upon the following fundamental criteria:

1. The measuring technic should be so designed that all measurements are objective and reproducible by different examiners.

2. The equipment necessary for measurement should be as simple as possible without sacrificing accuracy.

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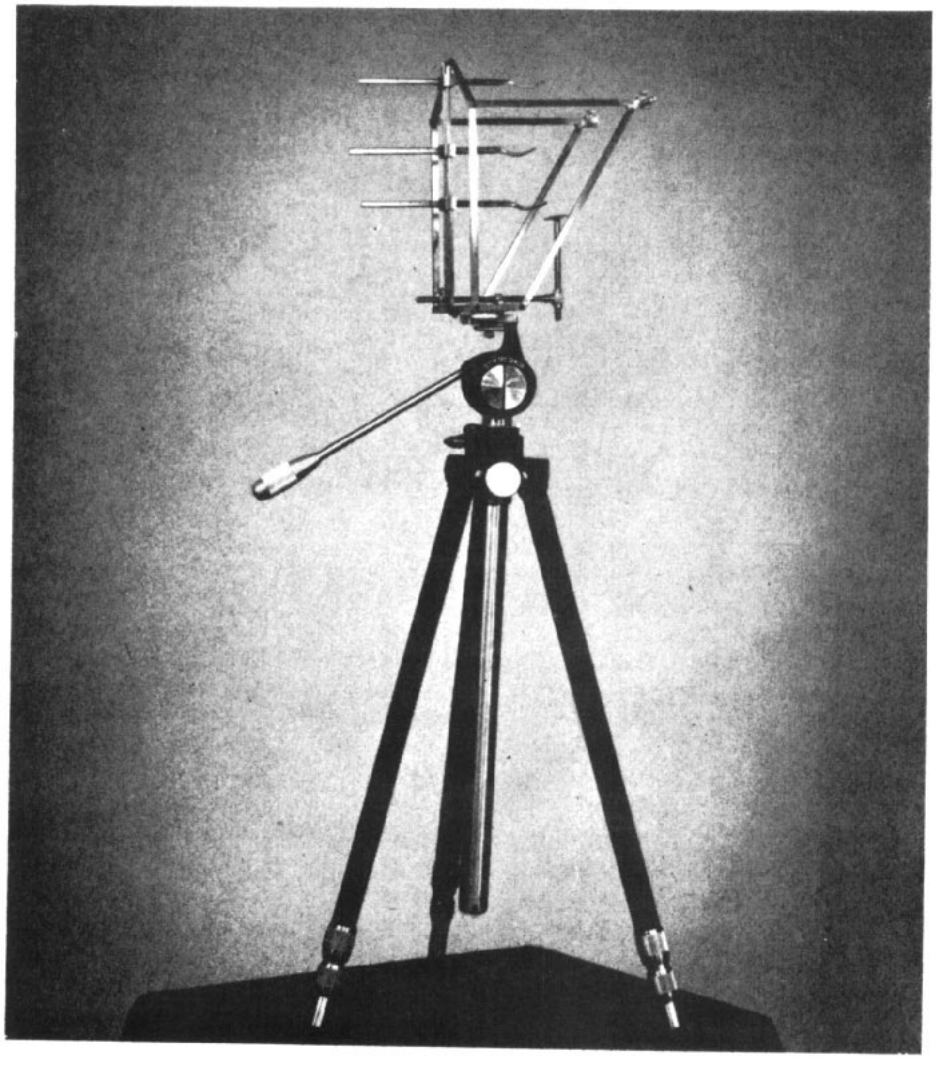

Figure 1a. A photograph of the orthometer in place on a photographic tripod.

3. The number of readings per individual and the time required to make them should be the minimum required for objective classification and for rapid application to population groups.

4. The accumulated data should permit analysis which results in a single index number which expresses the degree of malocclusion for each individual.

Usual cephalometric and anthropometric technics do not meet all of the foregoing requirements. It appears, however, that a modified anthropometric technic offers the best possibility for population studies.

It is the purpose of this report to present a design for a simple instrument which facilitates the application of anthropometric methods to population studies. The instrument developed and described here will be referred to as a Facial Orthometer.

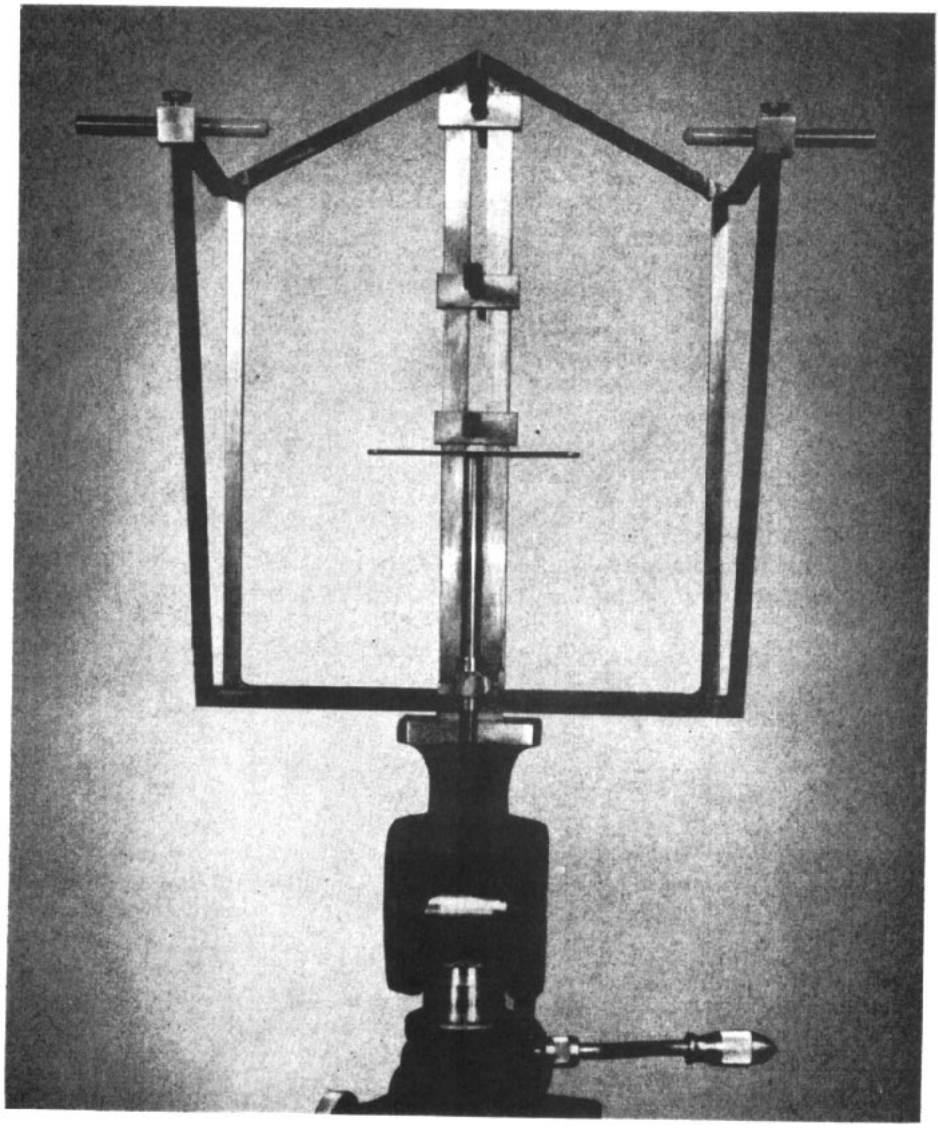

Figure 1b. Detail of the rear section of the orthometer with a view of the ear rod assembly.

Description of the Facial Orthometer

The facial orthometer, pictured in Figure 1a, is a steel frame with several graduated measuring rods adjustable both vertically and antero-posteriorly along the vertical plane constituting the anterior aspect of the instrument. In order to facilitate portability of the instrument, it has been so constructed that it can be dismantled into three flat sections which can be carried in a regular brief case.

The upper left lateral section of the instrument is oriented to the Frankfort horizontal plane of the subject as indicated in Figure 2. At the posterior end of each upper lateral section is an adjustable ear rod. The superior surface of the upper left lateral section

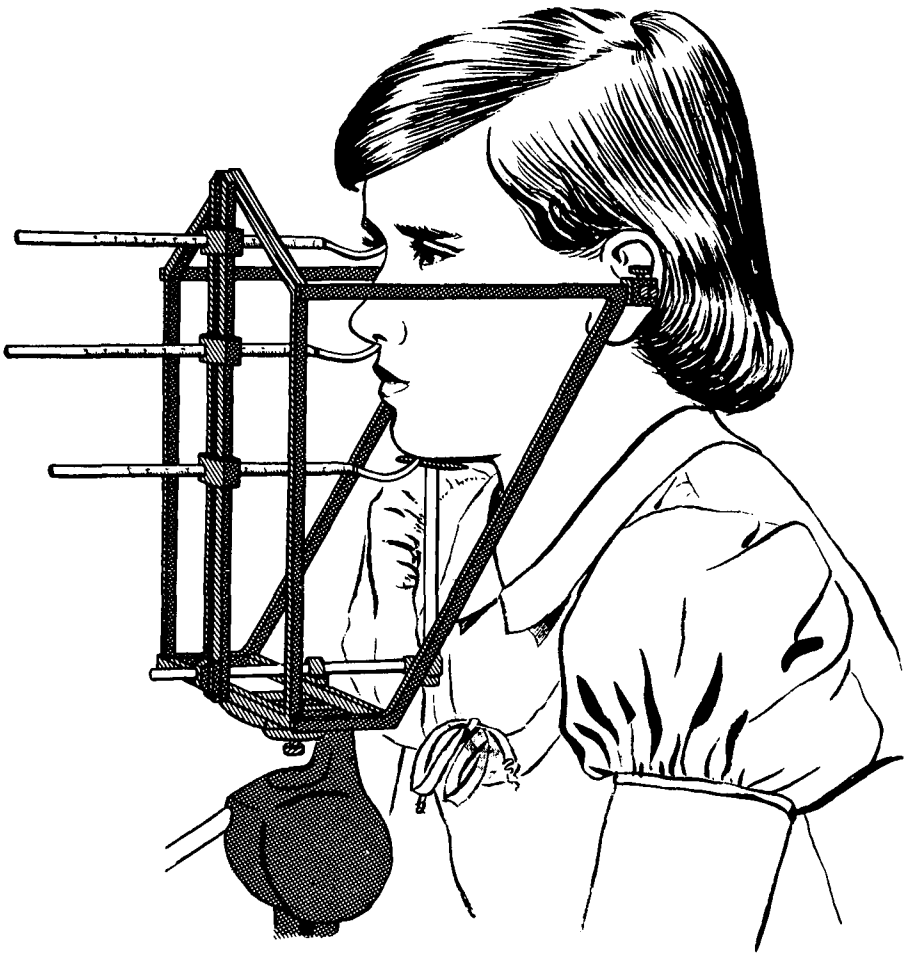

Figure 2. Orientation of orthometer to Frankfort horizontal plane of the subject. Notice that when ear rods are in place, it is relatively easy to adjust orbitale level by means of the chin rest.

contains an inscribed millimeter scale along which a brass pointer slides, and which can be used to indicate the antero-posterior position of gonion with relation to the vertical plane composing the anterior aspect of the instrument.

Figure 3[a] indicates the detail of the anterior aspect of the instrument. It can be seen that the central axis of this anterior portion consists of a slit bounded by two vertical brass members, one of which contains an inscribed millimeter scale, and three sliding members which are free to travel in a vertical direction. A hole is provided in each sliding member through which a horizontal measuring rod is passed. On the left side of each measuring rod is an inscribed millimeter scale as indicated in Figure 3[a]. At the base of the vertical scale, in the midline of the anterior aspect of the instrument is located a rod and set screw for the support of the chin rest. The chin rest can be adjusted in both horizontal and vertical directions.

The instrument is mounted on a photographic tripod and the person to

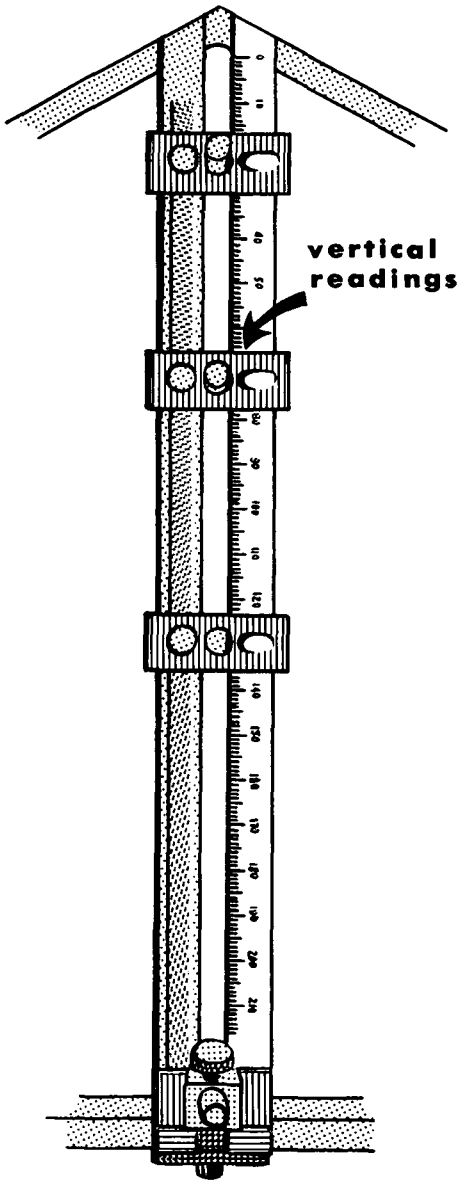

Figure 3a. Indication of the points at which reading will be taken on the vertical measurements.

be measured leans slightly forward until his ear orifices are opposite the ear rods of the instrument. With gentle pressure, the ear rods are placed in the orifices of the ears and the ear rods are locked.

The individual is instructed to close in centric occlusion and to maintain his jaws in this relationship until the examination is complete. The left superior section is adjusted by moving the chin rest, so that the superior section is parallel to the Frankfort horizontal plane of the patient. This is a relatively simple matter because the posterior end of the Frankfort plane is determined by the fact that the ear rods of the instrument are placed in the ear orifices. The superior aspect of the orifice determines the posterior end of the Frankfort horizontal plane and the left orbitale determines the anterior end of the plane.

Figure 3[b] illustrates the three measuring rods which have millimeter scales inscribed on their left sides. The uppermost rod is used to measure the distance from the anterior vertical plane of the instrument to the nasion of the subject. This measurement is made, as indicated in Figure 3[b], at the outer

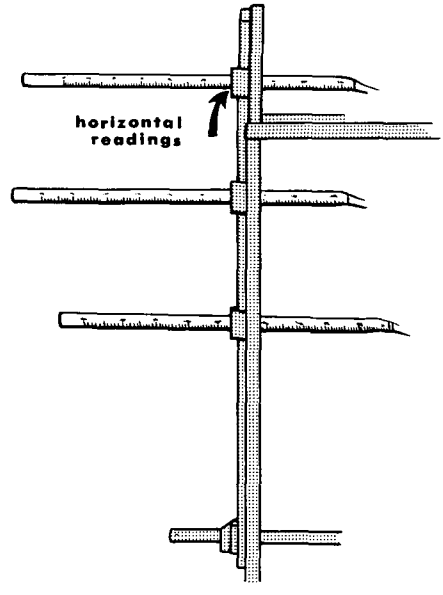

Figure 3b. The point at which readings will be taken on the horizontal measurements.

facing of the vertical sliding member. When the plane-to-nasion reading is made, the set screw on the vertical sliding member is tightened and the superior edge of the vertical sliding member is used to note the reading on the vertical scale.

The middle rod is used to measure the following distances: plane-to-subnasion, plane-to-upper incisor, plane-to-lower incisor and plane-to-pogonion. The method of measuring to the incisors is indicated in Figure 4. When the distance, plane-to-subnasion is measured, the reading on the vertical scale at the upper edge of the vertical sliding member should also be noted. The difference between the nasion level on the vertical scale and the subnasion level on the vertical scale will be the vertical dimension of the upper face.

The lower rod is placed on the lowest midline point on the chin. The difference on the vertical scale between the level of the lower sliding member and the vertical scale reading of the upper sliding member opposite nasion will give the total facial height.

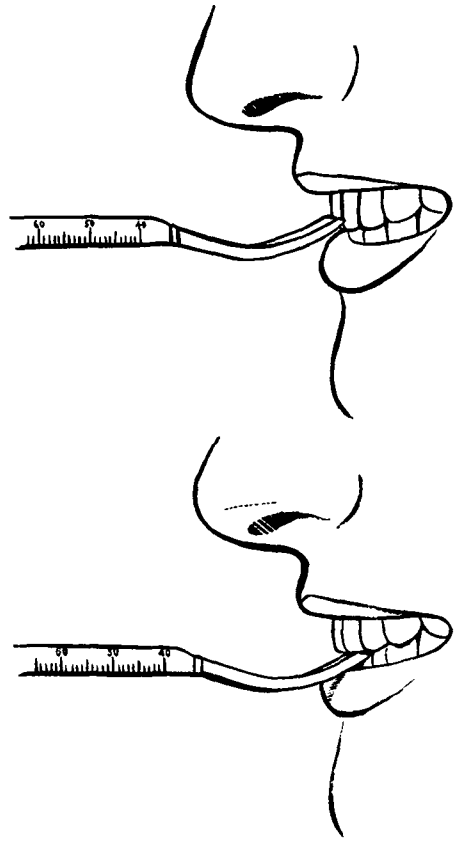

Figure 4. Method of measuring the distance from the vertical plane of the instrument to the upper and lower central incisor teeth. For the upper arch, the horizontal measuring rod is placed against the labial incisal edges of the upper central incisors at the midline (or the most protruded portion of the incisal edges). For the lower arch, the horizontal measuring rod is placed against the labial surfaces of the central incisors at the most superior point possible while the teeth are in centric occlusion.

Discussion

The work of Downs[1] and Wylie[2] indicated that occlusion could best be studied by establishing a *normal* relationship of the antero-posterior and super-inferior positions of selected points in the midline of the face and cranium. Individual malocclusions were then determined by the deviations from a *standard.*

To establish a *normal* in the description of the face is impossible, because it is undesirable to compartmentalize faces on the basis of the variation of dimensions of their several components. There is, however, a *standard* by means of which we can judge all faces.[1] This standard cannot be fixed or enforced. It is based merely upon the personal preference of the standard maker.

The Downs analysis presents malocclusion as a departure from certain *norms* which he has established. The *norms* are expressed both as evaluations of angles and as linear distances from certain reference points. The *normal face* according to Downs' standards approaches orthognathy or straight profile. In short, if one were to view the *perfect face,* according to Downs, he would note that the profile was relatively straight.

In the cranio-facial assessment according to Wylie[2], the various components which contribute to the antero-posterior relationships of the face are analyzed. One group of measurements is balanced against the other, and the *perfect face* is the one in which the anterior contributing components balance the posterior contributing components to produce an orthognathic profile.

While *standards* of various authorities differ, the orthognathic concept prevails and is widely accepted by practicing orthodontists since many of them strive for orthognathy in their completed cases.[7]

The orthometer, therefore, was designed to measure the departure of various points in the facial midline from orthognathy.

Methods of Measurement

In order to measure the variation from orthognathy, several points on the profile had to be selected for reference. These points are as follows:

1. Nasion
2. Subnasion
3. Tip of upper incisor
4. Tip of lower incisor
5. Pogonion

In addition to measuring the distances of the above points in a horizontal direction from the vertical plane of the facial orthometer, the vertical dimensions of various parts of the face can also be measured with this instrument. Expression of upper face height in terms of percentage of total face height will yield information on the degree of close bite which exists in the individual. Brodie[8] and Thompson[8] [9] have indicated, on the basis of cephalometric data, that there is a close correlation between the degree of close bite and the relationship between the lower face height and the total face height.

Obviously, measurements from the anterior vertical plane on the instrument to the profile points are meaningless. This is because the posterior end of the instrument is fixed in the ear orifices of the subject, and the distance from a point on the profile to the vertical plane of the instrument would be much greater in an individual with a skull of small antero-posterior dimension than it would be in an individual possessing a skull of large antero-posterior dimension.

To preclude this difficulty, a plane parallel to the vertical plane of the instrument was selected. It was located 20 millimeters anterior to the nasion of the individual. The distance from nasion to the vertical plane now became a constant of 20 millimeters for each person. In effect, the orthometer measures the distances from various points in the mid-line of the profile to a plane perpendicular to the Frankfort horizontal plane, 20 millimeters anterior to nasion. This gives a standard of departure which can be applied to all individuals regardless of the gross size of the head.

Recording the Data

Recording of the collected data is a relatively simple matter. A card can be designed with the abbreviations P-N, N, P-Sn, Sn, P-UI, P-LI, P-Pg and L.C.P. These designations are abbreviations for the following:

P-N: plane to nasion
N: nasion level, vertical scale reading
P-Sn: plane to subnasion
Sn: subnasion level, vertical scale reading
P-UI: plane to upper incisor
P-LI: plane to lower incisor
P-Pg: plane to pogonion
L.C.P.: lowest chin point level, vertical

It is at once apparent that these readings are recorded without regard to the plane located 20 millimeters anterior to nasion. It is an easy matter,

however, to translate the recorded distances into distance from the plane of reference to the various profile points.

The procedure is as follows:

1. Subtract 20 millimeters from the reading P-N.

2. Subtract the resulting difference from the readings P-N, P-Sn, P-UI, P-LI and P-Pg.

3. The differences for each of the above points give the actual distances from the plane of reference to these points.

The following is an illustration from an actual case:

A Actual measurements	B P-N minus 20 M.M.	C Actual distance from refernce plane to facial points
P-N :85	65	RP-N :20
P-Sn :97	65	RP-Sn :32
P-UI :112	65	RP-UI :47
P-LI :114	65	RP-LI :49
P-Pg :117	65	RP-Pg :52

Data concerning the vertical dimensions of the face are handled as follows:

Reading on vertical scale	reading Upper face ht.	Lwr. face ht.	Total face ht.	Lwr. face ht. in terms of total face
N_v Sn_v $L.C.P._v$	$Sn_v - N_v$	$L.C.P._v - Sn_v$	$L.C.P._v - N_v$	$\frac{Lwr.\ face\ ht.}{\text{Total face ht.}} \times 100$

Illustration from an actual case:

Vertical scale reading	Lwr. face ht.	Upper face ht.	Total face ht.	Lwr. face ht. in terms of total face
$N_v = 38$ $Sn_v = 84$ $L.C.P._v = 132$	$132 - 84 = 46$	$84 - 38 = 46$	$132 - 38 = 94$	$\frac{48}{94} \times 100 = 51\%$

Summary

The facial orthometer is an instrument which measures dento-facial morphology. Measurements obtained by the use of this instrument may be used as a quantitative classification of human dento-facial morphology.

The construction and use of the facial orthometer follows accepted anthropometric principles. It is inexpensive, simple in design, portable, requires a minimum of time to obtain readings and no special training is necessary to operate the device.

The facial orthometer, therefore, eliminates judgment variations in assessing dento-facial morphology and in so doing permits a quantitative use of Angle classification. A precise measuring technique such as that made possible by the use of this instrument also permits the formulation of an index of dento-facial morphology for epidemiologic as well as diagnostic purposes.

With an accurate measuring device available then, it is possible for the dental profession to conduct experiments on the prevention and treatment of malocclusion, and in so doing, permit orthodontics to continue to meet all the requirements of scientific inquiry: Classification, measurement and controlled experimentation.

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