The Direct Analysis of Cephalometric X-ray Films

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The present widespread adoption of cephalometric methods of diagnosis of clinical orthodontic problems calls for careful re-examination of the philosophies and mechanics of the procedures involved. The classic and continuing research by cephalometric methods is familiar material and it is not necessary to this thesis to review the many studies of this character or their findings. These studies by and large involve two basic biometric procedures:

1. The evaluation of random or selected samples on a longitudinal basis; the following of the same group of individuals through a period of growth or change.

2. Cross section studies, the comparison of groups of individuals at various levels of growth or change to each other.

These lines of research have formed the foundation for a system of tabulation and communication in objective terms of anatomic and facial characteristics and interrelationships. Another logical derivative of biometric growth studies has been the formulation of methods of evaluating clinical problems. Clinical orthodontists were quick to see that from this research material there could be hypothesised standards to which comparisons could be made to determine aberration, for diagnostic evaluation.

Cephalometric evaluation then seems to have provided the clinical orthodontist with the answer to the perplexing problem of delineating normal and calibrating variation from normal in the relationships with which we are concerned. This system, however, must be analyzed carefully if it is to be used intelligently, for this is a system based on an often nebulous concept—normality.

The subject of normality has been fair game for authors and lecturers in orthodontics, this one included, and could be used as a subject for many pages of discussion. There have been semantic, biometric, philosophic and aesthetic treatments all with justification and it is not the author's purpose to enumerate or evaluate them. The fact remains that in order to establish aberration we must first have a sound conception of normal (or if it better suits one's philosophy "ideal" or "aesthetic"), and x-ray cephalometric evaluation can give us biometric normal limits.

However, we must also accept, as clinical orthodontists confronted with a malocclusion, that a concept of normality and the amount of deviation from it present for this particular individual is pertinent only in the light of the amount of change possible in those characteristics which are deviant from normal. Thus, there must be an accompanying evaluation of the limitations of mechanics and an appreciation of growth developmental potentialities as well as a static analysis.

For many of our patients "normalcy" in skeletal, dental and facial proportions is out of the question and, as Goldstein[1] has pointed out, attempts to go beyond the limits of the patient's "morphological pattern" are often ill-advised. The objective must be the optimum result possible for that individual functionally and aesthetically.

This is not compromise in the slovenly

connotation of the term. Nor is this a defeatist attitude or a part of what Wendell Wylie once called the "Blue Period of Orthodontics," the period when it was fashionable to point out the things we were not able to do. Any sound philosophy requires a wholesome respect for its own limitations.

As clinical orthodontists examined groups of measurable characteristics and gleaned from the growth studies the points that they felt most descriptive or diagnostically significant, it became apparent that isolated dimensions were often meaningless. Krogman[2] pointed out that each dimension must be integrated into the complex, and a variation of a single dimension is often important only in its effect upon the entire complex. Wylie[3] showed that the variations can sometimes cancel each other out, that in some cases an increase in size in one contributing part of an anatomical complex can be compensated for by a decrease in size elsewhere in the complex.

The importance of these inter-relationships was demonstrated in early orthodontic and anthropometric literature and was recognized by those early orthodontists whose point of view was not limited to tooth position. Keith and Campion[4] demonstrated coordinated growth patterns by superimposing cross sections of skulls on sella turcica and the cribriform plate of the ethmoid. Hellman[5] in 1929 made direct facial measurements and established a system of interdependent "normal" dimensions. Thus, it soon became apparent that it was necessary to express these interrelated dimensions in groups or systems. Such roentgenographic cephalometric diagnostic systems have been evolved first by Downs,[6] then by Margolis,[7] Riedel,[8] Steiner, Tweed,[10] Higley,[11] and many others. It has become possible to select and combine parts of each to explore a particular problem or suit an individual point of view.

Apart from the complexity of relating our patients to concepts of normality, there is yet another part of the problem which must be examined. In any measurable procedure there is inherent a degree of error; no method can be read to a greater accuracy than the sum of the greatest possible errors in each of its parts. Steiner pointed out a very vulnerable area in cephalometric systems when he demonstrated the inconstancy of the registration of porion which he found to vary in an order of magnitude sufficient to cause a variance of several degrees in angular measurements related to it. Variances of nearly as great a magnitude can easily occur in the interpretation and selection of anatomic landmarks used as bases for cephalometric measurements. The introduction of the tracing procedure commonly interposed between the head plate itself and the mechanics of measurement must be viewed as a source of error. The more steps we place between an actual cross section of the skull if it could be achieved, and our measuring devices, the greater the probability of error becomes.

Nonetheless, however, we must recognize that our x-ray cephalometric systems of evaluation, comparison and communication, when intelligently applied, are without question the firmest foundation our specialty has ever enjoyed.

Thus, the conclusion to which we are inevitably drawn is that diagnostic evaluation of cephalometric head plates must approach an intelligent abstract and aesthetic assessment of our whole sphere of influence as applied to a particular patient, rather than a concept of comparison to infallibly absolute standards—which can be expected to yield cookbook-like conclusions. Wylie once reported that one of his students had labeled this preoccupation with super-accurate, super-significant measurements—"The numbers racket!"

Intelligent appraisal of the reliability of methods of cephalometric measurement and the implications of the biometric and philosophic procedures by which "normal" standards are derived lead to the exploration of methods of analysis by matching general patterns rather than measurements; a convenient way of doing this sort of operation is by the use of transparencies.

Higley[13] in 1951 proposed a series of single transparencies—one for each age group, with which the entire skeletal and denture pattern might be evaluated in our operation. However, differences in absolute size and in vertical relationships as well as the more subtle shadings of sex differences and facial maturation changes make this system unwieldy.

Wylie[14] in 1952 devised a set of transparencies for the assessment of vertical dysplasia by comparison with standard angular relationships without tracings or actual measurements.

In 1952 the author presented a method of making evaluations directly from head x-ray films according to the analysis proposed by Downs.[15] This method utilized a series of four transparent templates with the mean and normal limits of each characteristic laid out on them in such a manner as to permit their use directly on an x-ray film. Thus, relationships of skeletal and dental structures to be measured could be compared to the angular relationships as Downs found them in the general population without tracings or actual measurements.

In an attempt to devise a series of

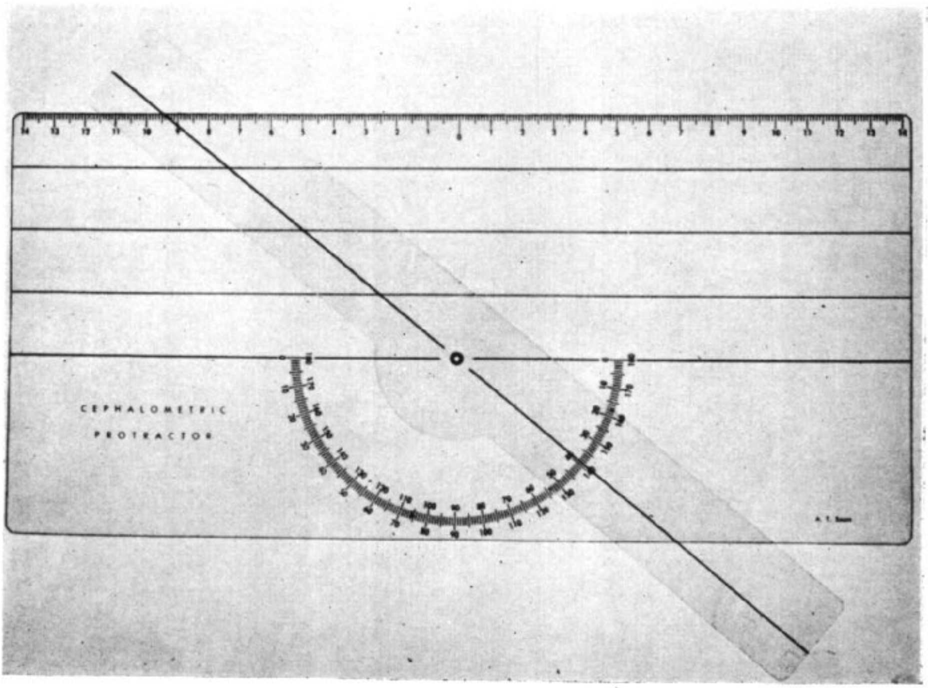

Fig. 1 The cephalometric protractor assembled.

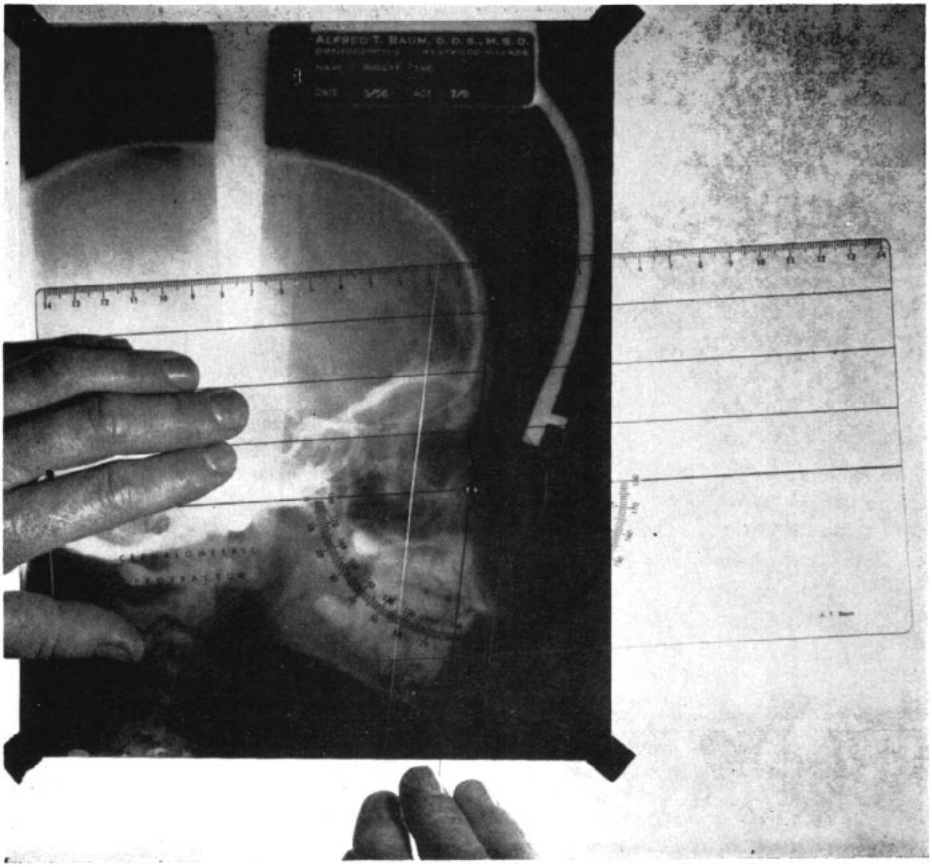

Fig. 2 The protractor in use on a lateral x-ray mounted on a light box.

templates more generally useful and applicable to other angular measurements than those used in Down's analysis it was observed that the problem of making this sort of angular measurement involved the measurement of two types of angles: (1) Those whose legs form vertices within the area of the x-ray film; (2) Those whose legs are far apart on the head plate and have low numerical values so that the vertices of these angles lie in the area beyond the edges of the head plate. The first of these classes of angles is easily measured by any sort of protractor which has a fixed 0-180° point and a measuring arm pivoted at the vertex and able to travel through 180°. To measure the second class of angles it is necessary to provide several lines at varying distances from and parallel to the 0-180° line. One of these lines can then be used for one leg of the enclosed angle while the pivoted measuring arm delineates the other leg. The device should be made broad enough so that it might be conveniently used for head plates facing in either direction. It should have a metric scale along one edge with its zero point coordinated with the measuring arm in such a way that the measuring arm crosses the zero millimeter mark at a

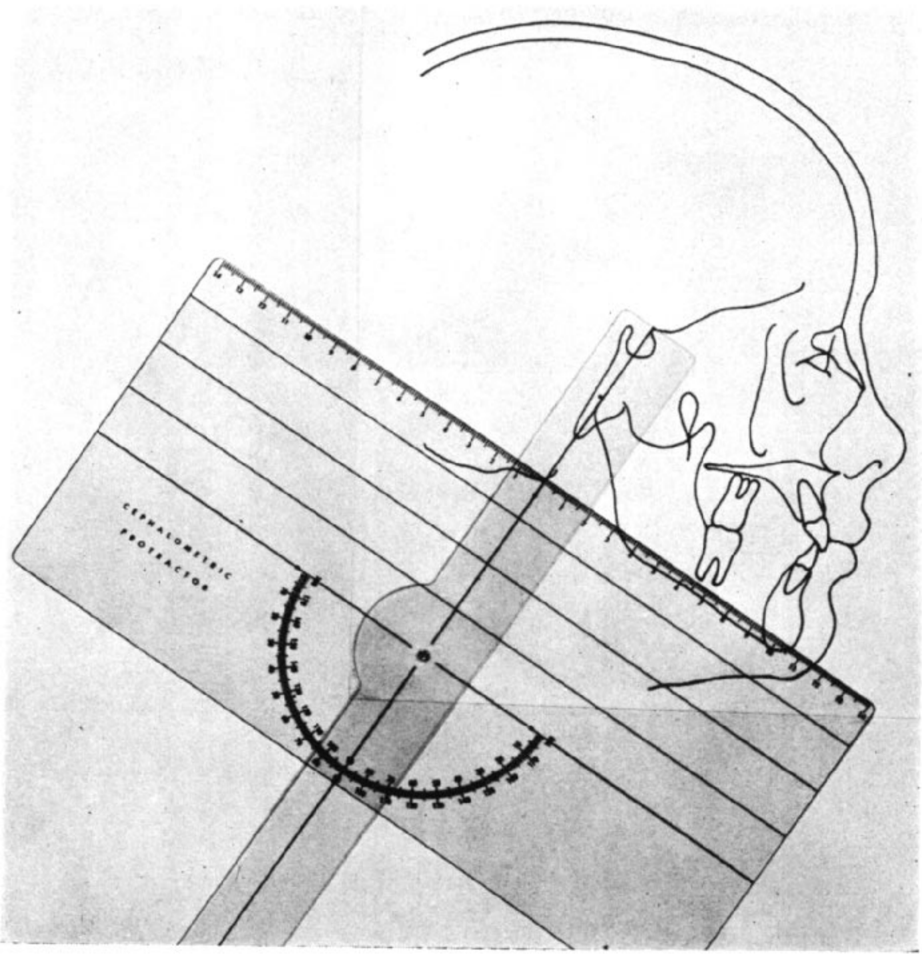

Fig. 3 Measurement of the effective length of the mandible, as in Wylie's assessment of antero-posterior dysplasia.

right angle. This would allow the linear evaluation of anatomic points by extending them to a base plane by lines at right angles to the base plane (as in Wylie's method of antero-posterior dysplasia assessment).

An instrument of this sort is easily capable of making any angular measurement required for cephalometric comparison to any of the accepted systems of analysis directly on the head film.

Figure 1 shows a photograph of the protractor devised by the author to fit these requirements. A duplicate may be easily made by photographing this figure with a copying camera and projecting it with an enlarger on a large sheet of heavy film at a focal distance which yields an accurate enlargement of the millimeter scale.

Figure 2 shows the protractor in use on a cephalometric x-ray mounted on a light box.

Figures 3 and 4 are photographs of

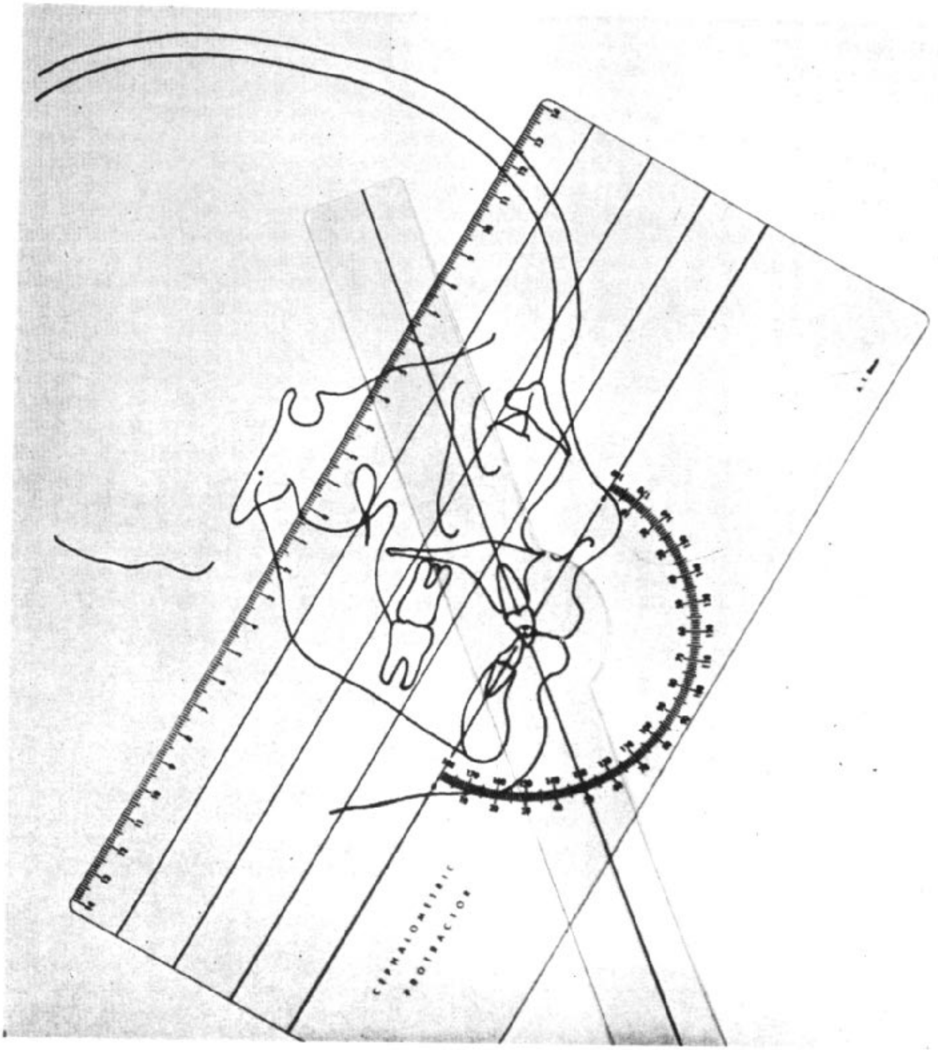

Fig. 4 Measurement of the angle of the upper incisor to the lower incisor as in the Downs' analysis.

the protractor positioned on a headplate tracing to demonstrate but two of the various types of measurements possible. Figure 3 is the measurement of the effective length of the mandible—as in Wylie's assessment of anteroposterior dysplasia. In Figure 4 is demonstrated the measurement of the angle of the upper incisor to the lower incisor as in Downs' analysis.

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