A Concept Of Cephalometric Interpretation

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The purpose of a clinical cephalometric analysis is to express quantitatively the nature and extent of an aberration in the growth and development of the skull. Simply referring to a bone as "large" or "small" is qualitative and unscientific. The late Lord Kelvin once said: "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it in numbers, your knowledge is meagre and unsatisfactory; it may be the beginnings of knowledge, but you have scarcely in your own thoughts advanced to the stage of Science — whatever the matter may be."

The study of the linear relationship of the component bones of the skull was first undertaken by the anthropologists but these measurements have a limited clinical application thus necessitating another approach. The development of the cephalostat and the subsequent use of x-rays to investigate skull growth culminated in the Downs cephalometric analysis (Downs, 1948). This excellent appraisal is probably the most widely used method of skeletal analysis, but some difficulty may occur in the interpretation of these measurements. In spite of the fact that there are no stable or fixed points, the skeletal pattern of the Downs analysis does yield valuable information not only for the research worker but for the practicing orthodontist.

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I. *FACIAL ANGLE*

Downs states that the facial angle is "an expression of the degree of recession or protrusion of the chin." The chin position, represented by pogonion, does indeed affect the facial angle. This angle, however, is also influenced by the position of three other points, namely, nasion, orbitale, and porion.

Nasion: At birth the outer and inner plates of the frontal bone are parallel, the supraorbital ridge does not exist, and the frontal sinus is absent (Weinmann and Sicher 1955). After seven years of age the rate of growth of the brain diminishes to such an extent that the rate of growth of the facial skeleton overshadows it. Anteroposterior and vertical growth of the face accounts for the apparent recession of the frontal bone. The superior border of the orbit or outer plate of the frontal bone, which serves to protect the eye, becomes elaborated to maintain its relationship with the anterior and inferior positioning of the eye (Dreyer, 1961). The degree of elaboration of the outer plate of the frontal bone will affect the position of nasion.

In addition, unequal growth of the two bones bounding the frontonasal suture may cause the latter to undergo migration thus affecting the position of nasion (Scott, 1956).

Orbitale: Moyers (1959) states that as the nasomaxillary complex grows in height, apposition of bone occurs on the superior or orbital surface of the maxilla. The orbit thus "grows only slightly in height from birth to adulthood, since most of its final size has been achieved by birth."

Porion: Björk (1955) shows that during the formative development of the cranial base and the brain case, a lowering of the two medial and posterior cranial fossae occurs in relation to the anterior one. As a result the glenoid fossa is displaced posteriorly. This displacement of the temporal bone affects the position of porion and will incidentally affect the position of pogonion as well.

II. *THE ANGLE OF CONVEXITY*

The angle of convexity is a measure of the protrusion of the maxillary part of the face relative to the total profile (Downs, 1948).

Variations in this angle, however, may be produced by variations in nasion (previously discussed), point A, or pogonion.

Point A: This point represents the anterior limit of the maxillary basal bone. It is often obscured by the base of the anterior nasal spine which must be excluded and regarded as a superstructure of the maxilla which has developed to support the nose. Variation in the position of point A may result from an aberration in the normal sutural growth by which the maxillary complex is thrust downwards and forwards during growth. This in turn may be related to defective growth of the cartilaginous nasal septum since the latter is thought to be the primary factor responsible for separation of the circummaxillary sutures (Scott, 1954).

Pogonion: The position of this point is determined by growth of the mandible, movement of the glenoid fossae and position of the condyles in relation to the temporal articular surface. The latter may be influenced by muscular and dental factors; thus the condyles and pogonion may be positioned anteriorly in certain habits and Angle Class I type III cases, or posteriorly placed in distal thrust cases.

III. *THE A-B PLANE ANGLE*

The A-B plane angle, according to Downs, is a measure of the relation of the anterior limit of the denture bases to each other and to the profile.

The four points that can influence the size of this angle are nasion, point A, point B and pogonion. Apart from inherent local bone growth and other functional influences point B is affected by the same factors as pogonion. The other three points have been previously discussed.

IV. *THE MANDIBULAR PLANE ANGLE*

The mandibular plane angle is influenced by the position of the four points: orbitale, porion, menton, and gonion.

Variations in orbitale and porion have already been discussed. Gonion varies with the ramus height and position of temporomandibular joint.

Moss (1960) states that ramus height is affected largely by growth in the condylar cartilages. He also points out that minor alterations occur in the gonial region at the attachments of the masseter or internal pterygoid muscles. Gonion may also be influenced by the migration of the temporomandibular joint to its inferior position on the temporal bone.

Menton is influenced by the size of the gonial angle and by all the factors affecting gonion. Initially condylar growth may directly produce an antero-inferior movement of the chin but, with the development of the gonial angle, condylar growth is mainly responsible for increasing the vertical height of the ramus. A mechanism exists, however, for the conversion of this growth into a horizontal component. Failure of this mechanism may be one of the factors responsible for the large Frankfort — mandibular angles seen in many Angle Class II, Division I and Class III malocclusions.

V. *THE Y AXIS*

The Y axis is an expression of the direction of growth of the face from the cranial base (Downs 1948).

Four points may influence the size of the Y axis, orbitale, porion, sella and gnathion. Reference has already been made to orbitale and porion. Gnathion is affected by the same factors that influence pogonion and menton.

Sella: The rate of increase of the distance between sella and nasion is approximately equal to that between sella and Bolton point after the age of six months (Brodie 1941). Dreyer (1961), in discussing the growth in height of the body of the sphenoid bone, states that, although there may be some deposition on the external or nasal surface, it is likely that most of the growth occurs at the inner aspect of this bone. All of the above factors may contribute to a change in position of sella.

Discussion

To interpret the significance of the various measurements obtained in the Downs analysis, cognizance must be taken of the fact that variation in an angle may be produced by movement of one or more of the three or *four* points used. Variation in a linear measurement may be produced by movement of one or both of *two* points.

When confronted with an abnormal reading, the investigator should try to determine which point is most responsible for this. A thorough knowledge of the growth mechanism of the skull is required, particularly of those factors that may cause a variation in position of the points used as landmarks in the Downs analysis.

No attempt should be made to reach a conclusion from one reading alone. The futility of such a procedure is evident when one considers that the mandibular plane angle is characteristically high in many Class II as well as Class III malocclusions. Each reading must therefore be evaluated in relation to all the other readings.

Furthermore, in some cases a final diagnosis of the craniofacial disturbance can only be made when the cephalometric findings are considered in conjunction with the clinical examination of the patient. An example of this is the Class III malocclusion where the clinical examination may help to determine whether the condition is the result of a maxillary deficiency, a mandibular overgrowth, or a combination of both. Although the above discussion has utilized the Downs analysis as an example, the principles elaborated apply equally well to any other cephalometric analysis.

Summary and Conclusions

1. A difficulty in cephalometric investigations is the interpretation of the readings obtained.

2. Variation in an angle may be produced by movement of one or more of *three* or *four* points used.

3. Variation in a linear dimension may be produced by movement of one or both of *two* points.

4. In order to determine which point is mainly responsible for variation in a particular reading, a thorough knowledge of the growth mechanism of the skull is necessary.

5. Individual readings must not be considered alone.

6. The cephalometric analysis is in itself usually not sufficient for making a diagnosis.

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