CLASS II DIVISION 1 MALOCCLUSION:

DIFFERENTIAL DIAGNOSIS.

D. M. NADER, B.D.S. (Sydney)

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Department of Preventive Dentistry,

Faculty of Dentistry,

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Introduction.

In 1968 Dr. R. G. Henry[32] wrote:

> In Angle's original classification there was but one Class II Division 1 malocclusion and this was associated with a distal and underdeveloped mandible. It wasn't long, however, before other suggestions were voiced.
>
> Since the advent of cephalometrics many studies have been carried out to locate the area or areas at fault and attempts made to classify this type of malocclusion.
>
> Most recently Salzmann has suggested fourteen cephalo-dento-facial morphologic deviations which, in themselves, or in combination, may characterize Class II Division 1 malocclusions. From these he has evolved eight different types and presents an analysis of these types.

The aim of the present study is to evaluate Salzmann's (1966)[64] differential diagnosis of Class II Division 1 malocclusion. Thirty examples of this malocclusion were analyzed in the manner suggested by Salzmann and an attempt made to distinguish each

example as one or other of his eight types, the objective being to test Salzmann's differential diagnosis by practical application.

The review of the literature relates to the subjects of classification, diagnosis, and differential diagnosis in orthodontics; the Angle classification, and alternative methods of classification with specific reference to Salzmann's differential diagnosis of Class II Division 1 malocclusion.

Discussion of any analysis or classification system which is based on cephalometric data must at some point concern itself with the norms or standards used in the analysis. This subject, referred to as the "norm concept", is included in the review of the literature together with a brief discussion of the subject "computers and diagnosis".

REVIEW OF THE LITERATURE.

1. Classification, Diagnosis, Differential Diagnosis.

Classification:

Moyers (1963)[50] on page 228 defines classification as the grouping of clinical cases of similar appearance. According to Moyers this is done for traditional reasons, for ease of reference, and for purposes of comparison. It is this grouping together and nothing more. It is not a system of diagnosis, nor is it a method for determining prognosis or a way of defining treatment.

Moyers points out that historically certain types have always been grouped together, and thus the literature contains many articles confined, for example, to "The treatment of Angle Class II Division 1 malocclusions". It is necessary, if we are to appreciate such an article, to have a clear concept of just how an Angle Class II Division 1 case appears. He advises that care must be taken not to assume that all

Class II Division 1 malocclusions are exactly alike, as their etiology is not necessarily identical, their prognoses similar, nor do they demand precisely the same treatment. It is traditional to group them together, however, and it probably will continue to be done.

The second reason for classification given by Moyers is that of ease of reference. It is much easier to call a case a Class II Division 1 malocclusion than it is to go into all of the detail necessary to describe the morphology of this type of malocclusion. The listener will have a rough idea of the problem simply from the label Class II Division 1, although again he does not know in this specific instance what is the etiology, the prognosis, or the best treatment procedure.

Moyers' third reason for classification is that the previous grouping of similar cases facilitates comparison of the progress of their treatment, although it is just as important to know when comparing wherein

similar cases differ.

On page 229, Moyers warns against straining to put a case in a given classification: " the fit is seldom perfect. Any classification system should be a clinical aid, not a hindrance. Immediate classification often prejudices all later thinking. Study the malocclusion carefully; describe it in detail; then, if possible, classify it."

According to Graber (1966)[27] on page 423, classification is just one diagnostic facet that creates arbitrary categories based on morphologic, spatial and functional variances for the purpose of organizing the thinking of the dentist. Like Moyers,[50] Graber warns against relying solely on categorizing as a basis for therapeutic decisions.

Strang (1950)[73] on page 81 defines classification as a process of analyzing cases of malocclusion for the purpose of segregating them into a small number of groups, which groups are characterized by certain specific and fundamental variations from normal occlusion of the teeth. These variations, in turn, become

influential and deciding factors in determining the correct plan of treatment.

Strang enumerates the objects of classification as being, first, the segregation of the countless number of cases of tooth malposition into a comparatively low number of groups, each group containing only such cases as are characterized by a common factor or factors of fundamental significance. The second objective is the simplification of the problems of treatment by this grouping of cases that call for the same general plan of tooth movement in order to establish normal occlusion. Third, classification distinctly indicates the proper procedures in treatment; and fourth, it facilitates more accurate conclusions pertaining to the etiology, prognosis, retention and prevention of the malocclusion.

In contrast to Moyers,[50] Strang states that there is no reason or excuse for case classification unless it has an important and specific bearing upon the method of treatment.

Hellgren (1960)[29] on page 77 comments that while examples of malocclusion as a rule deviate from the ideal in several respects, and the possibilities of variation are practically infinite, a classification of malocclusion into groups according to essential characteristics can be of great value especially if the grouping provides a guide to the treatment to be followed.

Sassouni (1969)[66] defines classification as the identification of a number of characteristics which, seen together, present enough similarities to be included in the same group, this process disregarding minor details.

Salzmann (1957)[60] on page 106 describes classification as the description of dentofacial deviations according to a common characteristic. In Salzmann's opinion classification is concerned with determining the nature of a dentofacial deformity in relation to certain dental, facial, and cephalometric norms.

In 1966, Salzmann[64] on page 391 describes

classification as being concerned chiefly with the recognition of deviations from a quantitative and qualitative biologic norm. This concept of norms and standards is mentioned by him again on page 390 when he states that the classification of dentofacial deformity depends primarily on ascertaining the nature of the anatomic deviations from the normal in the individual patient and that in order to arrive at a classification of morphologic deviation it is necessary to have morphologic standards or norms. According to Salzmann, in the recognition of dentofacial anomolies, deviations from accepted norms are classified into various categories of dental malocclusion and maxillodento-facial deviations.

Salzmann discusses classification in terms of morphologic or biologic norms or standards even though in 1957[60] on page 106 he expresses the opinion that since individual variation is the rule in nature, there can be no norm or structural unit representative of the human species as a whole, and in 1966[64] on page 390

that although clinical orthodontics deals with the prevention, interception, and correction of anatomic or morphologic deviations from accepted norms, these norms themselves are not as yet clearly established because of the wide range of variation in human morphology, and, even if there were specific norms they would be limited by the laws which apply to the accuracy of physical measurements.

Moorrees and Gron (1966)[49] write of classification being actually an abstract diagnosis; an ordering process which enhances general understanding, but which also sacrifices the reality and uniqueness of the individual patient. Like Moyers[50] and Graber,[27] they warn that classification lacks the necessary information for rational treatment.

Hovell (1966)[40] describes classification in terms of "pigeon-holing" a case into one compartment of Angle's classification. He points out, however, that having done this we are still as far as ever from a diagnosis in spite of Angle's intention that his

classification be a guide to treatment, and in fact virtually a final diagnosis.

Horowitz and Hixon (1966)[37] on pages 325-326 consider that classification serves a dual purpose in medicine and dentistry: 1. it facilitates communication regarding specific conditions or disease entities, and 2. it serves as the basis for diagnosis. In discussing how well these aims are met by orthodontic classification systems, they point out that while classification in biology and medicine has proceeded along both morphologic and etiologic lines, and there is no question as to the desirability of a classification based on etiology, the morphologic approach has prevailed in orthodontics and will probably continue to do so. The reasons given for this morphologic approach are that dental occlusions are defined by a set of morphologic conditions; there are relatively few persons with malocclusion in whom etiologic factors can be discerned; and malocclusions are rarely pathologic states in contrast to the many disease entities

in which knowledge of the etiology usually provides guidance for treatment.

Horowitz and Hixon are of the opinion that in the absence of a meaningful etiologic basis for classifying malocclusion, morphologic descriptions provide the most practical alternative. They advise that in practice, despite the fact that morphologic classifications in orthodontics have diagnostic value, it is necessary to recognize their limitations in that the wide variations routinely observed in dental occlusions do not lend themselves easily to definitive, meaningful groupings. On page 330 these authors go further in stating that the extent of individual variability observed in the dentofacial complex accounts for the fact that we have no all-encompassing classification system in orthodontics, and, because it would have to be useful clinically, but not so complex as to be unwieldy, it is unlikely that a workable scheme ever will be devised.

On page 341, Horowitz and Hixon divide ortho-

dontic classification into two types. The first is a classification of dentitions into ideal occlusion or one of three classes of malocclusion. This is a categorical, qualitative division based on arbitrary standards. Instead of describing dentitions as they exist in relation to the population, such a classification rests on a paradigm of ideal occlusion that separates dentitions into those that are "as they ought to be" and malocclusions that do not meet these criteria. Horowitz and Hixon consider that this type of dichotomous classification is useful as it implies decisions regarding treatment goals.

The second type of classification, currently employed in cephalometrics, is biometric in nature. Group averages are used to represent the typical or common value of a dimension, which is continuous from the smallest to the largest value. When this variation around the average is described in various categories, percentiles, or standard deviations for a specific population it is called a norm. Norms describe a trait

"as it exists" in a population and not "as it ought to be". As such, Horowitz and Hixon consider that no treatment decisions can be infered from the norm, and no part of it (including the average) serves as a satisfactory treatment goal.

Diagnosis:

Diagnosis is defined in Blakiston's Medical Dictionary (1956)[36] as:

1. The art or the act of determining the nature of a disease.
2. The decision reached.

Some definitions of diagnosis which have appeared in the orthodontic literature will now be quoted.

"Diagnosis may be defined broadly as the procedure by which an occlusal abnormality is recognized and identified" (Horowitz and Hixon[37] in 1966 on page 344).

"Orthodontic diagnosis may be defined as the process of determining by examination the nature and

circumstances of dentofacial imbalance" (Moore[48] in 1969).

"The diagnosis is the determination of the presence or absence of abnormality. In orthodontics it concerns itself with establishing the existence and character of dentofacial deformity" (Moyers[50] in 1963 on page 166).

"Diagnosis is the art of recognizing and classifying disease or abnormality from its symptoms and the decision reached" (Salzmann[64] in 1966 on page 585).

"Diagnosis may be defined as the process of determining the disease or malformation from which an individual is suffering, by deductions from the symptoms presented" (Strang[73] in 1950 on page 268).

"Diagnosis may be defined as the decision arrived at or the judgment rendered regarding the presence or absence of abnormality or the adequacy of various observed phenomena" (Zwemer[82] in 1969).

There does not appear to be any real disparity in the ideas expressed in these definitions. However,

when it comes to a discussion of diagnosis in orthodontics, differences of opinion become evident and the distinctions between the processes of examination, diagnosis, classification, and treatment planning becomes clouded.

According to Hovell (1966)[40] the first step in coming to a diagnosis is the classification of the dental occlusion present in terms of the Angle classification system, this procedure being followed by a cephalometric analysis.

Horowitz and Hixon (1966)[37] on page 325 refer to classification as serving as the basis for diagnosis although they point out that the clinician is faced daily with individual variations in occlusion that defy simple classification, and for this reason, it is necessary to analyze many related aspects of malocclusion in the process of diagnosis.

Graber (1966)[27] also refers to classification as a diagnostic facet, while warning of its limitations, stressing the need for a "battery of diagnostic criteria."

Moorrees and Gron (1966)[49] regard classification as a descriptive aspect of orthodontic diagnosis, describing it as an "abstract diagnosis" which enhances general understanding, but sacrifices the reality and uniqueness of the individual patient.

Hellman (1943)[30] when discussing the limitations of the Angle classification system commented that "Just the same, it should be remembered that the sorting out of groups of things or conditions of similar nature having like peculiarities, or characteristics is a sound scientific way of identifying or diagnosing them."

Salzmann (1957)[60] on page 106 describes classification and diagnosis in similar terms:

> Diagnosis is the determination of the nature of a disease. It is only with the acceptance of a biologic norm of an organism that deviation from the norm may be diagnosed.
>
> Classification in orthodontics is concerned with determining the nature of a dentofacial deformity in relation to certain dental, facial and cephalometric norms.

Later, in 1965, Salzmann[62] wrote that "diagnosis in orthodontics is based primarily on the classification of deviations from the normal."

None of these writers regard classification in itself as constituting a diagnosis, but they do place classification prior to, or within, the process of diagnosis.

Strang (1950)[73] on page 268 has a very uncomplicated approach to orthodontic diagnosis. He writes:

> In medicine and surgery this (diagnosis) is often a careful, painstaking, studious procedure because there are many diseases that have similar symptoms and careful distinction must be made. In orthodontia, however, there is nothing complicated about making a diagnosis, for the moment one has detected a deviation from normal occlusion and so determined that there is malocclusion, the diagnosis is complete. All steps and procedures from then on have nothing to do with the diagnosis but are stages of "case analysis".

Beresford (1965)[8], in the preface to his book "Orthodontic Diagnosis", says, like Strang[73], that in terms of general medicine the diagnosis in the case of any patient referred to an orthodontist would simply be malocclusion. However, he goes on to say that the orthodontist takes the diagnosis further so as to reveal the possibility or otherwise of treatment being

successfully undertaken, and the basic form of that treatment. In his opinion in orthodontics the diagnosis must bring out the basic principles upon which the treatment will be planned.

Ackerman and Proffit (1970)[2] have suggested the term "therapeutic diagnosis" to describe a procedure in which an initial diagnosis is made, in the face of some uncertainty, of the most likely cause or nature of the orthodontic problem. An initial stage of treatment is based on this diagnosis and the response to treatment is used to confirm or modify the original diagnosis and treatment planning.

Moyers (1963)[50] on page 166 makes a point of distinguishing between the terms examination, diagnosis, and classification. He says that one often sees these terms used interchangeably and that incorrect usage leads to much confused thinking; each term has its own precise meaning and should not be substituted for another. His interpretation of the meaning of these terms in orthodontics is, in my opinion, concise and

logical and worth quoting in full:

> The examination is a technic concerned with gathering data. It is the compilation of sufficient facts about a case to permit a diagnosis. After these facts have been gathered, a decision concerning the nature of the problem in question may be made: this step is the diagnosis. The diagnosis is the determination of the presence or absence of abnormality. In orthodontics it concerns itself with establishing the existence and character of dentofacial deformity. Since the mere gathering of data does not inevitably result in a decision, obviously the examination and the diagnosis are two separate procedures. Once the presence of an abnormality has been determined, similar abnormalities often are grouped together for convenience in discussion: this process is the classification. A necessary sequential dependence will be seen: the examination must be completed before a diagnosis can be made, and classification is impossible until a diagnosis is available. We examine, we diagnose, and then we classify: logic demands this order.

Moyers[50] also distinguishes between diagnosis and treatment planning. On pages 244-245 he writes:

> After the data are gathered, the determination of abnormality completed and the case classified, there remains another important step before the actual therapy is begun; this is the planning of treatment. Diagnosis is the determination of the presence or absence of an abnormality. Planning the treatment is the decision about what to do and when to do it.

Differential Diagnosis:

Blakiston's Medical Dictionary (1956)[36] defines differential diagnosis as the distinguishing between two diseases of similar character by comparing their symptoms.

In orthodontic practice, malocclusions of similar character are grouped together in the Angle classification system. Those malocclusions grouped together in Class II Division 1 share certain common characteristics, but they are by no means all truly alike. A differential diagnosis applied to the Class II Division 1 malocclusion group would have as its objective the distinguishing and further classification of the various types that share sufficient common characteristics to compose this group. In this respect a differential diagnosis of Class II Division 1 malocclusion is in itself a system of classification. It is motivated by the deficiencies in the Angle system.

Salzmann (1966)[63] writes that while the Angle classification is important, differential diagnosis

cannot be based on it alone, and that an example can be cited in diagnosing Class II Division 1 malocclusion. According to Salzmann this type of malocclusion may be due to any one or a combination of at least fourteen different morphologic abnormalities, and that relapse of treated Class II malocclusion is most frequently due to failure to make a differential diagnosis on the type of Class II that is being treated. In 1966 Salzmann[64] presented a differential diagnosis of Class II Division 1 malocclusion which distinguished eight types within this group, and this will be the subject of further discussion.

Moyers (1963)[50] on pages 342-348 presents a differential diagnosis of Class II malocclusion based on the concept of three primary sites in the genesis of malocclusion: bone, neuromuscular system, and teeth. He points out that this is a system of classifying and is thus simply a convenience, not a substitute for careful thinking.

Graber (1966)[27] on page 423 when advising against

relying solely on classification of malocclusion as a basis for therapeutic decisions, writes that individual variability makes a differential diagnosis a paramount consideration for each patient.

In an article on the differential diagnosis and treatment of Class II malocclusions, Sassouni (1970)[67] concludes that "describing Class II treatment in general terms is such an oversimplification as to be dangerous ..... it is critical to make a differential diagnosis of each of our cases."

The question that remains to be answered is to what extent individual patient variability allows the large Class II Division 1 malocclusion group to be successfully differentiated or re-classified so as to provide a useful differential diagnosis.

2. The Angle Classification.

In 1907, on pages 35 and 36 of his book "Malocclusion of the Teeth", Edward H. Angle[5] wrote:

> all cases of malocclusion fall naturally into a very few distinct and easily recognized groups, or three great Classes, with their Divisions and Subdivisions, and when so classified the extent of the variation from the normal in each case is easily comprehended and the requirement of treatment made manifest.
>
> These classes are based on the mesiodistal relations of the teeth, dental arches and jaws, which depend primarily upon the positions mesiodistally assumed by the first permanent molars on their erupting and locking.

The Angle classification is based on the concept of normal occlusion, with the first permanent molars being regarded as virtually constant in taking their normal position in the dental arch, especially the upper first permanent molars which Angle regarded as the "keys to occlusion". The relationship of the dental arches is considered normal when the mesiobuccal cusp of the upper first permanent molar occludes in the buccal groove of the lower first permanent molar.

This treatise is concerned with Angle's Class II

Division 1 malocclusion group, and on pages 44-50 Angle gives his description of this group which I will quote at length:

> Class II.-- When from any cause the lower first molars lock distally to normal with the upper first molars on their eruption to the extent of more than one-half the width of one cusp on each side, it must necessarily follow that every succeeding permanent tooth to erupt must also occlude abnormally, all the lower teeth being forced into positions of distal occlusion, thereby causing more or less retrusion, or lack of development, or both, of the entire lower jaw. This condition of distal occlusion is the determining characteristic of this great Class, of which there are two Divisions, each having a subdivision.
>
> Division 1 is characterised by distal occlusion of the teeth of both lateral halves of the lower dental arches, the lower molars having taken this position on their eruption and locking; a narrowed upper arch, lengthened and protruding upper incisors, short and practically functionless upper lip, lengthened lower incisors, and thickened lower lip which rests cushion-like between the upper and lower incisors, increasing the protrusion of the former and the retrusion of the latter. This form of malocclusion is always accompanied and, at least in its early stages, aggravated, if indeed not caused, by mouth-breathing due to some form of nasal obstruction.
>
> Subdivision, Division 1 has the same characteristics as the main division, except that the distal occlusion is unilateral.

On pages 58-59, Angle states:

> under the author's classification if a case be spoken of as belonging to a certain Class, Division, or Subdivision, there is at once created in the mind a quite perfect understanding of the case -- not only the peculiarities of the occlusion, and the relations of the jaws, but also the art relations, condition of the throat and nose, habits of the patient, etc., and nothing further is needed to complete the picture except minor individual peculiarities.

Biggerstaff and Wells (1972)[9] write that early scholars of occlusion were unable to devise an acceptable method for segregating occlusal types, and that order was brought from chaos when Angle submitted an acceptable classification of occlusion to the dental profession. "In effect, Angle made an attempt to describe a normally distributed biologic entity in terms of discrete classes. Angle's classification was readily accepted by the majority of the dental profession; however, there were those who immediately recognized deficiencies in the Angle Classification."

Ackerman & Proffit (1969)[1] also write of the Angle classification being readily accepted by the dental profession, since it brought order out of what

previously had been confusion regarding dental relationships. In pointing out that "it was recognized almost immediately, however, that there were deficiencies in the Angle system" they list those deficiencies as being:

1. Angle's system disregarded the relationships of the teeth to the profile.

2. Only antero-posterior (sagittal plane) deviations were considered.

3. Classification should include an evaluation of dentoalveolar and skeletal discrepancies and their relative contributions toward the malocclusion.

4. Arch-length problems are not considered.

5. No indication given of the complexity of the problem.

Ackerman and Proffit express their belief in the validity of the criticisms of the Angle system and say that they should be overcome, not by discarding the system, but rather, by enhancing it systematically.

Anderson (1960)[4] recalls that Angle advised care

in observing the "peculiarities and variations" of each malocclusion, and is of the opinion that in relation to Class II Division 1 Angle did not know how many "peculiarities and variations" exist in this large area of practice, and that Angle's definition of the Class II Division 1 relationship is true of some cases, but is not true in a great many cases of similar appearance. He warns against accepting the gross picture of the problem when beneath the diagnostic surface, like an iceberg, lie the most dangerous and treacherous areas.

Begg (1971)[7] discusses "textbook normal" occlusion vs. attritional occlusion and in the light of his concept of attritional occlusion makes some comments on the Angle classification. On page 17 he writes:

> In the Angle classification of malocclusion, diagnosis is claimed to be aided by observing the occlusal relations of the first permanent molars, after making allowances for any mesial drift of these molars that may have occurred. Civilized man's first permanent molars are not far enough mesially, nor are they in their correct positions in the jaws, except in those individuals whose teeth are so small, relative to jaw size, that they remain spaced. Another exception occurs when caries has permitted mesial drift of the first permanent molars. The significance of the Angle classification

requires re-evaluation in the light of these observations on attritional occlusions.

On page 42 he writes:

> Stone Age man developed and maintained excellent occlusion, although his tooth cusps and grooves and also the contact points of proximal teeth wore away very early in life. In civilized man we have a set of artificial and grossly abnormal circumstances. Whenever a good example of so-called "textbook normal" occlusion does develop in civilized man, it does so by marked deviations from the proper pattern of development of human occlusion.

According to Brader (1965)[11] the test of time and accumulated clinical experience leads the orthodontist toward the inevitable conclusion that the Angle classification of dental malocclusion is inadequate for the diagnostic evaluation of complex dentofacial problems, and in point of fact, most systems of classification suffer similar limitations of oversimplification. He says there is developing within the central channel of the stream of orthodontic knowledge an agreement that facial patterns exist as variables independent of malocclusion classes. In Brader's opinion, with increasing acquaintance with orthodontic

patients, it becomes apparent that ranging individual variation and multiple combinations of characteristic traits preclude the division of the dento-facial complex and dental malocclusion into categories as simple as one, two, three. Nor does the orthodontic treatment of a case so classified fall into place with equal simplicity.

Similarly, Coben (1966)[14] says that Class II malocclusion, while accepted as a dentition classification, does not presuppose a specific craniofacial relationship. He points out that in the individual face there can exist infinite combinations of skeletal and denture variation, each resulting in a disharmony in the anteroposterior relation of the dental arches. Faces exhibiting this malocclusion vary from those with good skeletal balance to those with dysplastic patterns, and profiles may vary from retrognathic to prognathic. Faces that exhibit similar profiles also differ in their internal conformation.

A cephalometric appraisal of the skeletal

morphology of Class II Division 1 malocclusions by Blair (1954)[10] revealed a high degree of variability of facial skeletal pattern.

Describing Angle's classification as the most outstanding example of generalization of that period, Fischer (1957)[20] on page 4 goes on to write:

> Fascinated by its simplicity but overlooking its limitations, orthodontists accepted it as a basis for diagnosis and treatment. Thus, a classification useful for assorting certain observations has been extended as a scheme for general clinical practice.
>
> Classification as diagnosis consisted of classifying orthodontic cases according to Angle and formulating objectives of treatment upon this classification with "normal occlusion" as the standard. Conflicting with this method of diagnosis was the fact that in my practice I was confronted by an endless variety of malocclusions which defied classification and that each patient presented a new situation.

On page 24 Fischer states that sooner or later the clinician must come to the conclusion that although a number of examples of malocclusion may present some common attributes that allow their inclusion in a given class, there is a great variation in these attributes even among examples of the same class, and furthermore,

each case presents characteristics that are specifically its own.

In an article on the morphology and physiology of distoclusion, Fisk, Culbert, Grainger, Hemrend, and Moyers (1953)[21] are of the opinion that the cold scrutiny of science does not confirm many of the concepts of Class II Division 1 malocclusions which had become a heritage of traditional teaching. They say that while there is traditional agreement on tooth relationship in Class II Division 1 malocclusions, a similar uniformity of opinion does not exist with respect to the morphologic variations which brought about the abnormal relationship between the maxillary and mandibular dentitions. In their opinion there are at least six possible morphologic variations in the dentofacial complex which may result in Class II division 1 malocclusion, these morphologic variations being:

1. Maxillary bones and teeth anteriorly situated in relation to the cranium.

2. Maxillary teeth anteriorly placed in the

maxillary bones.

3. Mandible underdeveloped.

4. Mandible of normal size but posteriorly placed.

5. Mandibular teeth posteriorly placed on an adequate base.

6. Any combination of the above.

In 1957, Henry[31] wrote that Angle spoke only of one type of Class II Division 1, simply, the mandible was distal and underdeveloped, and although, when considering Class II Division 1 malocclusions as a whole, it would appear that generally the fault lies in a posterior positioned and slightly underdeveloped mandible, when one considers individual cases it soon becomes clear that it is quite ridiculous to treat all Class II Division 1 cases as a whole. He points out that some examples are obviously maxillary dysplasias with an entirely normal mandible. Henry suggests that it is possible to classify the majority of Class II Division 1 malocclusions into four definite groups

which are:

1. Maxillary alveolar protrusion.
2. Maxillary basal protrusion.
3. Micromandible.
4. Mandibular retrusion.

He adds that there is no sharp line of demarcation and, because of superimposition of environmental factors on hereditary influences, some examples may reveal characteristics of two of the types. Also, discrepancy between tooth size and basal bone may be found in some of these malocclusions, but this does not alter the classification.

Graber (1972)[28] on page 252 states that there are a number of limitations to Angle's classification. According to Graber cephalometric studies have shown that the maxillary first permanent molar may vary in its position anteroposteriorly and in the mixed dentition an end-to-end or flush terminal plane relationship of maxillary and mandibular permanent molars is considered normal and the occlusion often

does not "settle in" until the exchange of the deciduous molars for the premolars.

In 1943, Hellman[30] commented that because of Angle's conviction that the upper permanent first molars are constant in position, he (Angle) made the regrettable error of regarding them as the keys to occlusion and the basis for his classification of malocclusion. However, Hellman also wrote that to Angle goes the credit for making the first attempt in laying the foundation for a rational procedure of diagnosing malocclusion, and that Angle's chief interest was to bring some order into the then prevailing mass of confusion about "crooked teeth".

In suggesting a reclassification of Class II malocclusion, Jarabak and Fizzell (1963)[42] on page 425 point out that the Angle classification is based on molar relationships and on the axial inclinations of the anterior teeth without taking into consideration facial morphologic and growth patterns within this molar relationship.

Hovell (1966)[40] and Margolis (1953)[47] make similar comments on the Angle classification to the effect that while it would be erroneous to suggest that one universal plan of treatment is required for a given type of malocclusion as defined by Angle, this classification has stood the test of time and served the profession so well that, rather than discard it, it should be supplemented with data obtained from cephalometric radiographs.

Moorrees and Gron (1966)[49] comment that a great many classifications of malocclusion have been proposed but in spite of their merits none has replaced the universally accepted Angle system. They say, however, that owing to the great variability of the clinical manifestation from patient to patient within each of the three classes of Angle's system, his classification can never be more than a labelling and overgeneralization of the malocclusion.

Moyers (1963)[50] on page 226 writes that it has been said frequently that the introduction of the Angle

system of classification was the principal step in turning disorganized clinical concepts into the disciplined science of orthodontics, and while this may be true it is also true that no phase of orthodontics is less understood today or more misused. On page 342, Moyers warns that to view and treat all distoclusions as identical entities is foolish and dangerous as although they may appear alike, there are many widely divergent types, with varying prognoses.

Von der Heydt (1951)[77] also notes that the conventional classification of Class II Division 1 has been shown to be a composite consisting of many clinical entities and that being concerned with dental relationships only, the Angle classification tends to overlook those broader craniofacial considerations which are so characteristic of modern diagnostic methods.

Walther (1967)[80] on page 54 states that Angle's classification is used as a basis of the occlusion of the dento-alveolar structures alone and not as a com-

prehensive picture of the whole dentofacial complex plus skeletal pattern. He suggests that the classification serves a useful purpose in differentiating clinical types, especially if used in conjunction with a skeletal classification.

In 1965, Salzmann[62] wrote that those who practice orthodontics find it necessary, for either semantic or diagnostic purposes, to use certain qualifying adjectives and phrases in order to define more exactly the type of malocclusion they seek to describe and this indicates that a large area of subjective value judgement enters into the use of the Angle classification. He adds that it is especially in attempts to classify malocclusion in the deciduous and mixed dentitions that the Angle classification is found to be deficient. Salzmann expresses similar sentiments in an article in 1966[63] and on page 586 of his text (1966)[64].

In contrast to the views of other authors, Strang (1950)[73] is of the opinion that the Angle

classification is all inclusive and makes possible a logically organized and comprehensive treatment plan.

Finally, I think that Horowitz and Hixon (1969)[38] summed up the virtues and limitations of the Angle classification when they wrote that it is the best shorthand method that we have for conveying basic information quickly, and although it does not describe all of the innumerable variations that are observed in malocclusions, it has the virtue of categorizing anteroposterior occlusal relationships in ways that are readily interpreted by orthodontists everywhere. While some important features of malocclusion are not accounted for in the basic categories, the Angle classification immediately triggers mental images of specific conditions.

3. The Norm Concept.

The term "norm concept" appears frequently in the literature, particularly in relation to the subjects of diagnosis, classification, and treatment planning. As Schwartz (1953)[69] wrote, while on cursory examinations the norm concept seems a perfectly well behaved, clearly defined term, further scrutiny indicates that it exhibits a vagueness which merits further investigation.

In general terms, a norm is a standard, a pattern, a usual state, or the average or mean of observed quantities. It serves as a point of reference. Reading the orthodontic literature, it appears that there is disagreement firstly as to whether or not it is reasonable to hope that valid norms can ever be obtained in the light of individual variability, and secondly, if one is prepared to accept the norm concept, in what way should norms be arrived at and how should they be used. Rubin (1969)[59] wrote that the history of orthodontics is replete with attempts to define certain

universal truths in order to simplify the perplexing problems in diagnosing and planning treatment of orthodontic cases, and Zwemer (1969)[82] asks "Are we seeing our patients? Or are we seeing caricatures of them in a web of norms, standards, or stereotypes?"

The object of this section is to review the literature relating to the norm concept in orthodontics.

The Angle classification system is based on a norm concept, namely, normal occlusion or ideal occlusion. Schwartz (1957)[70] has written that the concept of normal occlusion, treated by many as a clinical entity, is in fact an assumption, and Hixon (1972)[35] has described it as a man-made definition, an ideal. Beresford (1965)[8] describes ideal or normal occlusion as an abstraction, and writes that our conception of it follows automatically from our studies of anatomy and dental anatomy. This subject and the textbook-normal vs. attritional occlusion concept was discussed in the previous section.

The "web of norms, standards, or stereotypes"

becomes most apparent when one enters the realm of cephalometrics, for, as Rubin (1969)[59] has commented, the development of cephalometric radiology spawned a whole generation of numerical indicators for treatment planning. Ricketts[54] in 1961 stated his opinion that too many measurements were being employed for routine clinical use, with insignificant details being enlarged out of proportion to their importance without the system yielding a rapid, efficient appraisal of the overall orthodontic problem.

Moyers (1963)[50] on page 215, wrote that elaborate cephalometric diagnostic procedures have been devised, and many of the diagnostic procedures using cephalometrics suffer because of an ill-conceived norm or standard for comparison, while in others the patient's measurements are compared to an idealized configuration devised by an experienced cephalometrist.

There are three different types of "norms" or standards referred to in the orthodontic literature; the ideal norm, the biologic or biometric norm, and the

individual norm.

An "ideal norm" is one derived statistically from measurements taken from samples of "normal" individuals, with "ideal" occlusions and orthognathic faces, this being an empirical concept, involving a degree of subjectivity and assumption in the choice of samples from which the ideal norm is derived. Altemus (1968)[3], Fischer (1957)[20] on page sixteen, Lundstrom (1954)[45], and Salzmann (1969)[65].

A "biologic norm", on the other hand, generally represents the most common finding in the greatest number of persons (Gianelly[23] in 1970). Group averages are used to represent the typical or common value of a dimension, which is continuous from the smallest to the largest value. This variation around the average is described in various categories, percentiles, or standard deviations for a specific population and describes a trait "as it exists" in a population (Horrowitz and Hixon[37] in 1966 on page 341). This enables the determination of the position of the

individual in relation to the whole population (Lundstrom[46] in 1961).

The "individual norm" is an attempt to recognize the uniqueness of the individual, a move away from rigidly defined norms and standards to a consideration of the individual. Brodie is quoted by Schwartz (1953)[68] as having stated "We should stop comparing individuals with some pattern that has been arrived at by either an inner sense of proportion or by a careful compilation and averaging of large series of measurements of different individuals. But if we abandon this criteria, what have we left to guide us? Answer: the individual whom we are treating. He carries the answer to his own treatment."

Altemus (1968)[3] writes that the theory of the individual normal has been recognized for many years and emphasizes the infinite variety of the faces of mankind. In his opinion the rigid use of norms and standards conceived and developed from the basic concept of the health and beauty of the orthognathic face

is confusing to the orthodontist treating patients whose physiognomy and dentition are not naturally orthognathic. He concludes that this value judgment is best made considering individuals as they relate to their racial, ethnic, and family group, and sometimes the artistic sensitivity of the orthodontist.

Reporting on a study performed to determine whether there were any characteristics in an all Class II sample that markedly distinguished that condition, using as a control a "norm" pattern obtained from a random sample, Brodie[12] in 1957 wrote: "The study of numbers of the individual cases revealed no one that had all its variants equal to the values in the average Class II Division 1 table of means. Individual variation was the main feature observed."

Fischer (1957)[20] on page sixteen comments that a statistically created individual is a fiction which has no parallel in nature, and, on page eleven, that all standards of normality used by orthodontists imply their being part of nature's plan for the person to

whom they are applied. Expressing a similar point of view, Carey (1952)[13] wrote that orthodontic diagnosis is not a mathematical formula, nor can it be arrived at by a comparison of measured and related anatomic parts. In his opinion, if orthodontic diagnosis was an exact science and predicated upon such variables, it would be like casting the individual in a common mould.

In 1953, Goldstein[24] wrote of the dominance of the morphological pattern, and stated his view that since the morphogenetic pattern is unique, we should realize that we cannot transpose the pattern of one individual to another by stereotyped methods of treatment. Later, in 1965, Goldstein[25] wrote that too often the operator, in gathering his diagnostic data, tends to relate the data to arbitrary systems of evaluation and that, not content to let the facts themselves show the condition of the denture and lead the way to treatment, the orthodontist too frequently interprets his facts according to preconceived systems of evaluation. Furthermore, each patient has a great variability which

he shares in common with all living things, and a push-button diagnosis based on the study of arbitrary angles would result in treatment that would force the patient into a mould incompatible with his variability.

Hixon (1956)[34] commented that the combination of the norm concept and cephalometrics has at times been visualized as providing an objective, scientific basis for diagnosis and treatment planning. He adds that others, impressed with the wide variation in facial structures, have not considered it helpful to visualize the patient in relation to a normative frame. In Hixon's opinion, there is such a wide variability between individual persons that most cephalometric measures are not diagnostic within themselves and it is abusing normative data to set arbitrary diagnostic limits of abnormality at one or even two standard deviations from the mean. In 1966, Horowitz and Hixon[37], on page 341, state the view that unfortunately when cephalometric averages are used, treatment decisions are based on relatively small differences, and while

such small differences may seem significant when comparing an individual patient against the average, they are of little biologic or individual importance. Further, when a patient is compared with a norm obtained from a population sample that has been selected subjectively because of alleged facial "balance" it must be remembered in making treatment decisions that orthodontic therapy affects only a portion of the facial complex.

In his 1961 report on the first cephalometric workshop, Graber[26] summarizes the answer to the question "should an over-all (cephalometric) analysis concentrate upon an average, a type, a range, a group or a sample derivation, an individual, or the ideal canon of proportion?" He writes that the participants in the first cephalometric workshop felt it unwise to erect a set of standards that in reality, were measures of central tendency, whether obtained from so-called normals or not, and to use these standards as therapeutic goals .... the need for a more individualistic

norm is apparent -- age norms, sex norms, typal norms -- something more than most of the standards now available in clinical cephalometrics give us.

In an article on diagnosis and treatment planning in orthodontics, Reidel (1963)[58] wrote that through the years of cephalometric evaluation, certain planes and angles have come into common usage. In his opinion, however, these various planes and their angular relationships are merely an expression quantitatively of the relationships of various parts of the human head, and, furthermore, that the averages derived from these various measurements should not be used to provide a type of norm into which we can expect to fit each individual that we examine.

Steinvorth (1953)[72] has written that the most frequent cause of misunderstanding and alienation of the clinician's interest from a cephalometric appraisal lies in the presentation of a set of mean values. In his opinion, the mean values taken individually and separately are not the most important findings and

their appearance in a certain pattern does not indicate that this is the most balanced and harmonious skeletal pattern that can exist, but that it is the average harmonious mesiognathic type of face. Thus there also exist an ideal prognathic type, and an ideal retrognathic type, which are as balanced and harmonious as the first, although their readings would not follow the mean.

In 1969, Enlow, Moyers, Hunter and McNamara[19] introduced and described a method of cephalometric evaluation for individuals based on their own particular morphologic and morphogenetic facial patterns. With this method, references to statistical population standards are not required. They state that the purpose of the procedure is to analyze the nature of anatomic fit among the different bones of the craniofacial complex of one subject at any age and through time.

Salzmann on several occasions has written of the dangers of applying rigidly defined norms or standards

in the process of making diagnostic judgements, and has placed emphasis on individual morphologic variation. In 1961, on page seventeen, Salzmann[61] called for an objective appraisal of the parameters established by various workers in the field of cephalometrics, stating that frequently these parameters are based on insufficient sampling, many have not been subjected to statistical testing, and some may be said to be based on wishful thinking. Nevertheless, these findings are being accepted categorically as "standards" by clinical orthodontists who have not considered fully that they cannot apply with a high degree of exactness parameters based on different groups of children to any one child in particular, the exact likeness of whom never existed before and never will exist again.

In 1966, on page 251, Salzmann[64] wrote that consideration of the "normal" in humans is based on a population approach and since populations show greater variation than family studies, the term "normal" becomes almost meaningless. Again, on page 389, he

states that the normal in man is not definable from a morphologic standpoint because of the wide variation in human morphology. On page 390, he goes on to write that although clinical orthodontics deals with the prevention, interception and correction of anatomic or morphologic deviations from accepted norms, these norms are not as yet clearly established because of the wide range of variation in human morphology, and even if there were specific norms they would be limited by the laws which apply to the accuracy of physical measurements. In 1969, Salzmann[65] stated that the use of cephalometric norms drawn from persons with excellent occlusion as a means of defining treatment objectives has no scientific justification; "normal" as applied to structure, form, and function falls well within the subjective responses of the individual orthodontist.

On several other occasions, however, Salzmann appears to contradict the view reported in the preceeding paragraphs. For example, in 1957 on page 106, Salzmann[60] states that in order to diagnose deviations

from normal dentofacial development in the individual patient, it is necessary to have some common norm as a base, and his definitions of diagnosis and classification are based on the acceptance of biologic, dental, facial, and cephalometric norms. Again, in 1966 on page 251, Salzmann[64] defines malocclusion in terms of a morphologic deviation of a biophysical nature from an accepted norm for the human species. On page 390, he states that in order to arrive at a classification of morphologic deviation (i.e. malocclusion), it is necessary to have morphologic standards or norms, and further, that the norm is an important prerequisite in diagnosis.

A reading of the literature relating to the "norm concept" would appear to indicate some confusion and disagreement. While there are those who consider the concept to be misleading and impractical, other opinion exists which varies from a guarded to a seemingly full acceptance of the validity of the norm concept.

4. Computers and Diagnosis.

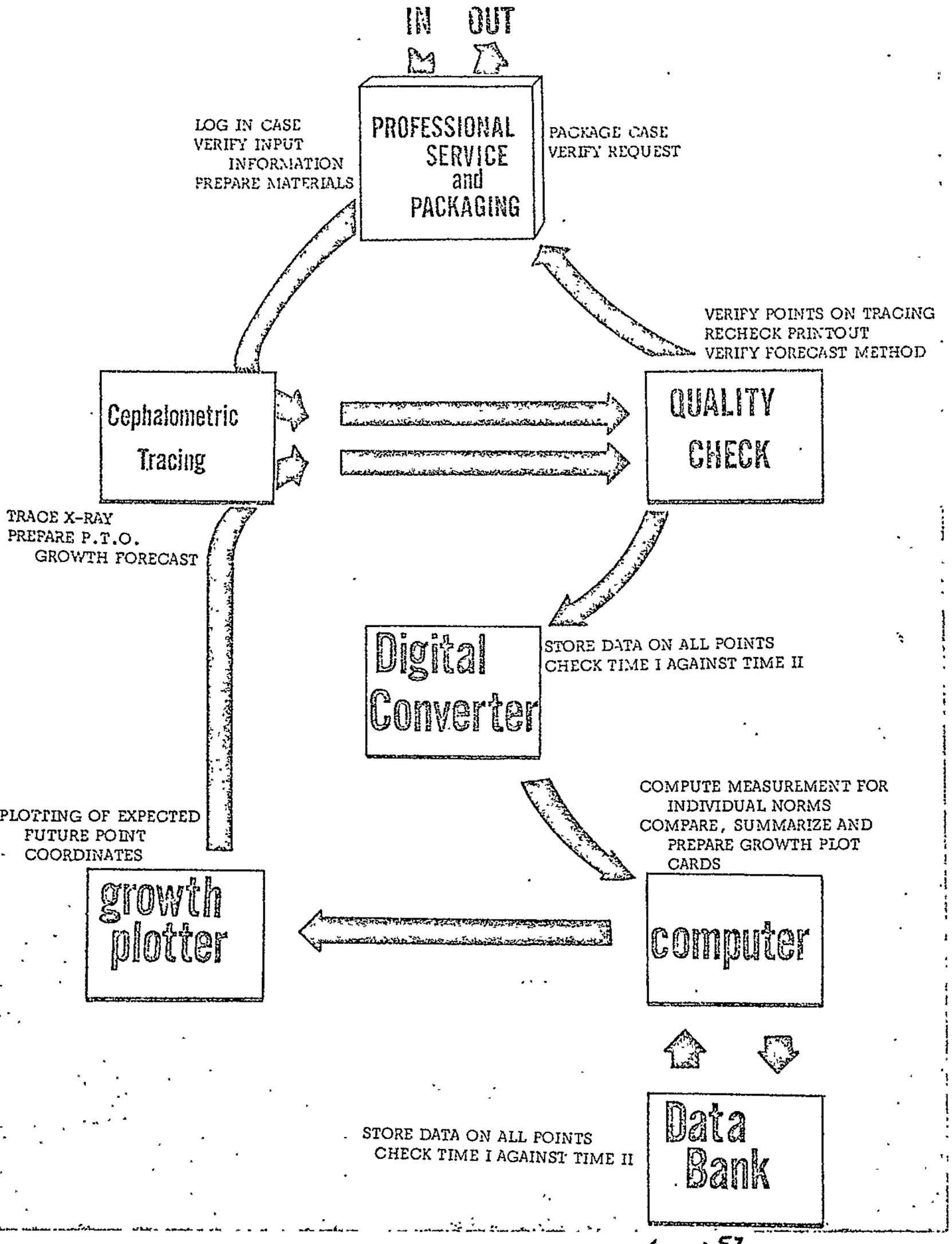
The application of computers to orthodontic diagnosis has been described as heralding in a new era in orthodontics. A brief review of the literature on this subject indicates that this is not a unanimously held point of view. Some of the controversy surrounding the norm concept flows on to the use of computers in orthodontic diagnosis; the fear of dehumanization, the lack of agreement of objectives, and the fear of rigid standardization.

In 1969, writing of the evolution of diagnosis to computerized cephalometrics, Ricketts[55] stated that "The head film lent itself to optical scanning and graphic display for accurate and reliable measurement. Thus, the head film (both the lateral and the frontal views) offered a practical use for the computer. The computer had been employed to describe, digest, and store prodigious amounts of information in the form of data. This information concerning all aspects of diagnosis from all sources, in addition to measurements

from the head film, was subjected to advanced equations, and answers were supplied with lightning speed. Once this kind of procedure was perfected, older methods became quickly outmoded and crude by comparison."

In 1972, Ricketts, Bench, Hilgers, and Schulhof[57] described a computer service program which provides, from lateral and, if available, frontal cephalometric radiographs, (1) tracings of the films, (2) a growth forecast and a growth and treatment projection, (3) computer printout sheets, (4) a summary analysis sheet, and (5) an analysis of the forecast showing the needed soft-tissue change, and change in the mandible, the maxilla, and the upper and lower incisors. The internal procedures of the computer service are shown by means of a flow chart (Figure 1.)

When discussing this computer service program, Ricketts et al. make some statements which would seem to be controversial in the light of other opinion. They state that the ability to forecast natural growth lies at the very heart of contemporary clinical ortho-



FROM RICKETTS, BENCH, HILGERS, AND SCHULOF (1972)[57]

FIGURE 1

dontics and that without this ability on a reasonable basis, the orthodontist will have difficulty in the evaluation of his treatment techniques.

Johnston (1968)[43] has commented:

> Perhaps the most concerted attempt to apply methods of growth prediction to clinical orthodontics has been that of Ricketts. In his method most aspects of clinical estimation are considered in quite some detail. It is, however, unfortunate that his procedures are generally thought to constitute a system of "growth prediction" - unfortunate in that relative to the prediction of individual, as opposed to mean growth changes several objections may be raised:
>
> 1. There is little evidence as to the exact significance of each of the many variables employed.
>
> 2. There is little reason to believe that these numerous variables are not, to a greater or lesser extent, redundant (ten are obtained from the mandible alone).
>
> 3. There are no objective rules available for the use of these variables.
>
> 4. Estimates of confidence intervals or of prediction efficiency for a consecutive, non orthodontic series are not available.

Johnston (1968)[43] also comments that any method, complex or simple, which has a dubious theoretical basis

and which is unsupported by acceptable proof could easily be less accurate than no prediction at all. In Johnston's opinion, if the prediction of change is to be improved dramatically, new sources of information may have to be found, but the ultimate accuracy of cephalometric prediction may be limited, not so much by the availability of significant information, as by the error intrinsic to the method itself. He states that there is one important aspect to prediction for which the computer can supply no formulae: the estimation of orthodontically-induced changes in the craniofacial complex. This is uniquely the province of the individual orthodontist.

Ricketts, Bench, Hilgers, and Schulhof (1972)[57] refer to these criticisms by Johnston and comment that many scientists have objected to the whole program on the basis of its incapability of absolute certainty in prediction. In reply they state:

> No claim for positive dependability has ever been made. However, an attempt has been made to weigh factors upon which the orthodontist

usually bases his intuition. It is understood that treatment techniques vary and that results vary with the treatment chosen. In view of the wide variation, a compromise was made for the program, which included the most typical effects of the most common treatment procedures.

Walker (1972)[79], writing on the subject of computers in orthodontic analysis and diagnosis, stated that although it is now technically possible to simulate almost any normal, or abnormal, growth pattern for an individual patient, it is extremely difficult to predict his or her true growth pattern, as human variability is still very much a fact of life. However, according to Walker, the "normal" or "most probable" growth pattern can be mathematically and graphically projected, and this in itself provides the clinician with "the ballpark in which the game should normally be played".

Hixon[35] in 1972 stated his view of growth prediction and the application of computers to this subject:

> To date, the best estimate of any individual adult facial or dental arch dimension is to

use the dimension presented by the child and to add to that the remaining average growth for the group. The individual variation in growth from that age to adulthood is the error of the prediction. As impressive as the numbers may be, computerization of the presently known information contributes no more to the patient's health than a reading of tea leaves.

When discussing norm values associated with their computer service program, Ricketts, Bench, Hilgers and Schulhof (1972)[57] state:

> A highly reliable but flexible set of norm values is needed. The establishment of these norms required extensive independent study and an intensive research of the literature in order to program the consensus of the published scientific data available. When it is realized that the mean and a range of variation need also to be corrected for ethnic type in addition to age, sex and size, then the value of this information from a computer program can be appreciated.

In 1969, Ricketts[55] wrote that sophisticated and complete as the computer is, the individual clinician must still be the judge and exercise his common sense; there is no substitute for practical experience to arrive at concepts of "normalcy" in orthodontic patients, but the computer can extend the clinician's experience and serve as an organized guide.

Walker (1972)[79] writes that one of the problems that had to be dealt with in his research into the use of computers in the analysis of craniofacial morphology and growth was the processing of large files to extract and compute group averages and so develop morphologic standards. "A host of complex programs written from 1965 onward allows grouping of our data banks by age, sex, race, family relationships, etc. and provides both statistical and graphic analyses of the date."

Walker comments that "the sheer volume of information that we can extract from the data banks carries with it inherent problems. One is reliability of the data. However, a more subtle problem is the relevance of the particular measurements to the patient or syndrome being investigated."

Discussing the role of computers in the development of predictive methods based on complex statistical procedures, Savara (1972)[68] states that growth studies provide data for norms and growth standards and, to some extent, make predictions possible. According to

Savara, since the measurements are used to construct norms, they must be derived from valid and reliable landmarks in addition to being accurate. He points out that facial bones grow in three dimensions and therefore must be studied in three dimensions simultaneously (using lateral and frontal cephalograms).

Savara states that a three dimensional method which satisfies all these requirements has been developed at the Child Study Clinic, University of Oregon Dental School, with assistance from computers. He concludes by stating that it may be possible in the future to construct more accurate and reliable norms, develop predictive methods which are clinically useful, and process patients' records automatically, all with the assistance of computers and better scanning devices.

This seems to indicate that Savara is not entirely satisfied with the accuracy and reliability of the norm values used in the computer program. As Parker (1965)[52] has written, "group conclusions are only valid when the proper material is offered for appraisal.

The computer works perfectly, but only on the data which is programmed for its use." To this could be added Krogman's (1972)[44] statement:

> One thing must be said, firmly and clearly: A digitized craniofacial printout, no matter what its analysis, is only a guide. It is not an answer. Two factors still reign supreme: The orthodontic patient and the orthodontic clinician -- the one with occlusal problems, the other with professional skills and insight.

5. Other Methods of Classification:

There have been numerous attempts to overcome the deficiencies of the Angle classification system, either by modifying and extending it or by replacing it with a new system. One approach that has been adopted by several writers (Ballard[6] in 1957, Graber[27] in 1966 on page 444, Jarabak and Fizzell[42] in 1963 on pages 425-426, Moyers[50] in 1963 on pages 342-348, Reading[53] in 1960, Steinvorth[72] in 1953 and Walther[80] in 1967 on pages 62-63) in relation to Class II malocclusions is that of a division of this Class into skeletal, dental, and neuromuscular types.

Skeletal types primarily involve inherent growth patterns within the facial skeleton. There is a malrelationship of the maxillary and mandibular bases, with the teeth reflecting this malrelation but perhaps in fairly good position when compared with their basal bone alone.

Dental types primarily involve mesial drifting of the teeth in the maxilla. The malocclusion is only

present in tooth areas. Jarabak and Fizzell (1963)[42] refer to this as a dentoalveolar or nonskeletal type.

Neuromuscular types primarily involve learned neuromuscular reflexes. Jarabak and Fizzell (1963)[42] refer to this as a functional type, and according to them, and Moyers (1963)[50], this type corrects almost spontaneously when functional interferences in the occlusion of the teeth are removed.

Moyers points out that each case is likely to be a composite of the three types, and each may also be complicated by other factors, such as large teeth. On page 356 he also states that the more dominant the skeletal aspects of distoclusion, the poorer is the prognosis.

The determination of skeletal and dental factors is made with the aid of a cephalometric analysis. The usual basis for skeletal assessment is the ANB angle. Walther (1967)[80] gives the following averages for this angle:

Skeletal I - a difference of from $+2^{o}$ to $+4^{o}$.

Skeletal II - above $+4^{o}$.

Skeletal III - below $+2^{o}$.

Reading (1960)[53] describes a Skeletal I pattern as occuring when the anterior limits of the maxillary and mandibular basal bones coincide in a vertical plane; a Skeletal II pattern describes the situation where the maxillary basal bone is in advance of the mandibular basal bone; and a Skeletal III pattern occurs when the mandibular basal bone is in advance of the maxillary basal bone. He adds that it is commonly thought that the skeletal pattern is innate and cannot be changed by orthodontic treatment.

Jarabak and Fizzell (1963)[42] describe four types of skeletal distoclusions:

1. Maxilla and Mandible related posteriorly to cranial anatomy and mandibular base also posterior to maxillary denture base - the severest type.

2. Maxillary denture base related normally to cranial anatomy, mandibular denture base posterior to it.

3. Maxillary denture base forward, mandible normal.

4. Maxillary denture base forward, mandibular denture base somewhat posterior.

They also list five types of dental Class II malocclusions.

1. Mandibular teeth in satisfactory alignment and upright over their denture base. Maxillary teeth protrusive and in many instances spaced.

2. Generalized spacing and procumbency.

3. Minor crowding in one or both arches.

4. Major crowding and excessive labioaxial inclination of maxillary teeth alone.

5. Major crowding and excessive labioaxial inclination of teeth in both arches -- the bialveolar Class II malocclusion.

Ballard (1957)[6] has suggested a classification of Class II Division 1 malocclusion based on the labial segment relationship rather than the molar relationship. It is summarized as follows:

1. With a Class I dental base relationship --

   a. Incompetent lip morphology.

   b. Atypical swallowing behaviour.

   c. a and b together.

   d. Other variations of orofacial morphology or behaviour (may be associated with a and b).

2. With a Class II dental base relationship --

   a. Competent lip morphology.

   b. Incompetent lip morphology.

   c. Atypical swallowing behaviour.

   d. b and c together.

   e. Other variations of orofacial morphology and behaviour.

Subdivision: Mandibular labial segment proclined in soft tissue balance to completely or partially compensate for the post normality of dental base relationship.

In both arches the buccal segment can be --

1. In contact with the labial segment.

2. Forward of the labial segment, producing overlap of canines over laterals and incisor crowding -- anteroposterior crowding.

3. Spaced from the labial segment.

Tweed (1966)[76] has suggested the use of the ANB angle in a classification of facial growth trends. Tracings from pre-treatment cephalometric radiographs taken twelve to eighteen months apart are superimposed on S-N with S the reference point. Tweed states that "The faces of all children grow downward and forward in one of three ways. Therefore, facial growth trends may be classified as Type A, Type B, and Type C, each type having a subdivision."

A Type A growth trend is one in which the middle and lower face are growing forward in unison, with no change in the ANB angle. If the ANB angle exceeds 4.5^{o} and the molar relationship is Class II, it is a Type A Subdivision growth trend. According to Tweed, approximately twenty five percent of patients present this type of growth trend.

A Type B growth trend is one in which the ANB angle is increasing and growth is therefore undesirable. If the ANB angle ranges above 7^{o} it is a Type B Subdivision growth trend. According to Tweed, approximately fifteen percent of patients present this type of growth trend.

A Type C growth trend is one in which the ANB angle is decreasing, and "whether treated or not, the patient's facial aesthetics will improve". If the FMA is 20^{o} or less, indicating predominantly horizontal growth, it is a Type C Subdivision growth trend. Tweed estimated that approximately sixty percent of all patients have Type C growth trends.

Tweed has suggested the use of this growth trend classification as a guide to the timing of commencement of treatment and also an indication of the likely duration of treatment and retention.

Ackerman and Proffit (1969)[1] have devised what Graber (1972)[28] on page 250 has described as "an all-inclusive method of diagramming and categorizing

malocclusion". They write that "We are suggesting not that the Angle system be discarded but, rather, that it be enhanced systematically ..... ours is a synthesis of two schemes, the Angle classification and the Venn diagram ....." and further state that "This method of classification based on five descriptive characteristics and defining nine groups of malocclusions overcomes the major weaknesses of the Angle system. Specifically, arch-length problems, with or without an influence on the profile, are recognized; the influence of the dentition on the profile is taken into account; all three planes of space, not just the sagittal plane, are taken into consideration; the differentiation between dental and skeletal problems is made at the appropriate level, and diagnosis is inherent in the classification. An additional advantage is that the logical approach used in constructing the classification is similar to that employed for preparing computer programs."

Graber (1972)[28] on page 250 states that Venn proposed his symbolic logic diagram as a visual

demonstration of the interaction or overlap among parts of a complex structure; in other words, it deals with groups or collections of entities or characteristics (called sets). Ackerman and Proffit (1969)[1] have represented malocclusions with a modified Venn diagram, and in their scheme, a set is defined on the basis of morphologic deviations from the ideal.

Henry (1957)[31] has described a method of classification of Class II Division 1 malocclusion and suggests four readily discernible types:

Type 1. Maxillary alveolar protrusion.

Type 2. Maxillary basal protrusion.

Type 3. Micro-mandible.

Type 4. Mandibular retrusion.

He points out that there is no sharp line of demarcation, and because of superimposition of environmental factors on hereditary influences, some cases may reveal characteristics of two of the types. Also, discrepancy between tooth size and basal bone may be found in some cases but does not alter the classification.

Of one hundred and three cases studied by Henry, fifty seven fell distinctly into one of the four types. He writes that these tended to be the extreme cases and were easily categorized, but adds that with the aid of the measurements suggested by him it is possible to classify the other cases into one or a combination of the four types.

Sassouni (1970)[67] has suggested that Class II problems can be subdivided into one hundred and twenty eight dentofacial situations which, in his opinion, logically call for one hundred and twenty eight different treatment plans. On the other hand, Swain (1952)[74] states the view that the analysis and treatment problem in Class II Division 1 malocclusion is concerned with a malocclusion exhibiting two characteristics --

1. Upper anteriors in labial axial inclination,

and

2. Occlusion of some or all of the teeth of the buccal segments in Class II relation.

Swain comments that this may be an oversimplification in the midst of the current ramifications in classification of this syndrome, but claims it has the practical advantage of focusing attention on two common characteristics of Class II Division 1 malocclusions, and treatment on the bony areas most responsive to desired tooth movement.

This brief survey of methods of classification, or in effect, methods of differential diagnosis, perhaps gives some indication of the variety of alternatives to, or modifications of, the Angle system and leads to a discussion of the Salzmann (1966)[64] differential diagnosis of Class II Division 1 malocclusion.

6. The Salzmann Differential Diagnosis.

In chapter twenty four of his book, "Practice of Orthodontics", on pages 633-660, Salzmann (1966)[64] presents an analysis of eight types of Class II Division 1 malocclusion. He states that "Relapse of treated Class II malocclusion is most frequently caused by failure to obtain a differential diagnosis on the type of Class II under treatment. A cephalometric analysis is required for differentiating among these various types of Class II malocclusion."

A summary of the cephalo-dento-facial morphologic deviations which characterize the eight types is shown in Table 1, and the five principal interrelations of the eight types are shown in Table 2.

The cephalometric analysis is based on that of Downs (1948)[16], (1952)[17], with the omission of the incisor relationships mandibular central incisor to occlusal plane and maxillary central incisor to AP plane, but with the addition of the SNA, SNB angles and the gonion angle. An example of the cephalometric

FROM SALZMANN (1966)[64] P. 634

TABLE 52. Class II, Division 1 (Angle) Malocclusion

TYPE		A	B	C	D	E	F	G	H
Skeletal Classif.		1	1	1	2	2	2	2(?)	2
Facial Angle	Mean	n	b	b				b	
	Range		n	n	b	b	b	n	b
S-N-A	Mean	n	n	a	n	n	b	a	b
S-N-B	Mean	b	b	b	b	b	b	b	b
Angle of Convexity	Mean				a		a		
	Range	a	a	a	n	a+	n	a+	a+
A-B Difference	Mean		b		b				
	Range	b	n	b	n	b	b	b	b
Y-Axis	Mean	b	a	a	a		a	n	
	Range	n	n	n	n	a	n		a
Ramus Length	Adequate		ad.	ad.	ad.		ad.		
	Inadequate	inad.				inad.		inad.	inad.
Gonion Angle	Mean	a	n	b	a	a	n		
	Range	n		n	n	n		a	a
$\bar{1}$ to Mand. Plane	Mean	b	a				n	a	a
	Range	n	n	a	a	a		n	n
Max. Incisor Prognath. to N-Pg	Normal Progn.	p	p	p	p	p	p	p	p
Mand. Inc. Progn. to N-Pg	Normal	n		n			n		n
	Progn.		p		p	p		p	
$\frac{1}{\underline{1}}$	Mean	a					a		
	Range	n	b	b	b	b	n	b	b
S-N Relation to F.H.	Cranially Divergent	div.	div.	div.			div.	div.	div.
	Parallel				para.	para.			
Occ. Plane to F.H.	Mean	a	n	b		a	a	b	
	Range	n		n	a	n	n	n	a
Mand. Plane to F.H.	Mean	a		n	a		a		
	Range	n	a		n	a	n	a	a

LEGEND

n = normal, mean, or normal range
a = above the mean or above normal range
a+ = extremely above the normal range
b = below the mean or below normal range
ad. = adequate
inad. = inadequate
p = prognathic
div. = divergent
para. = parallel

TABLE 1

FROM SALZMANN (1966)[64] p. 660

TABLE 53

	A	B	C	D	E	F	G	H
MAXILLA	Normal	Normal	Protracted	Normal	Normal	Retracted	Protracted	Retracted
MANDIBLE	Normal	Normal	Normal	Retracted	Retracted	Retracted	Normal	Retracted
GONION	Normal	Normal	Acute	Obtuse	Obtuse	Normal	Obtuse	Obtuse
PROFILE	Short	Normal	Long	Short	Long	Long	Short	Short
RAMUS	Short	Long	Long	Long	Short	Long	Short	Short

TABLE 2.

analysis for a Type D Class II Division 1 patient is shown in Table 3 and an example of the tracing for the same patient is shown in Figure 2.

The profile measurement is made on the patient from a point in the middle of the forehead between the eyes (nasion) to the tip of the lower jaw (gnathion). This measurement is then referred to a table of basic body measurements of school age children (Table 4).

Looking first at the cephalometric analysis used by Salzmann, there are certain points that merit further discussion. The use of the Frankfort horizontal as a reference plane has been questioned by several writers. Wylie and Johnson (1952)[81] have stated their opinion that the Frankfort plane in headfilms is something of a hybrid: "it depends upon orbitale, an anatomic point, at its anterior end, and upon the ear-rod, a portion of the machine, at the posterior end. Orbitale is usually not difficult to locate accurately in a film because it is an anatomical point. On the other hand, porion, which we would use in a skull,

FROM SALZMANN (1966)[64] p. 646

Patient C. G. Age 8 years (Fig. 379)

Dimension	Downs Range	Mean	Age 8 Years
Facial Angle (F.H. to N-Pg)	82° to 95°	87.8°	79°
Angle of Convexity (N-A-Pg)	−8.5 to +10°	0°	+8°
A-B line to N-Pg	−9° to 0°	−4.8°	−8°
Mand. Plane to F.H.	28° to 17°	21.9°	28°
Y-Axis	66° to 53°	59.4°	63°
Occlusal Plane to F.H.	1.5° to 14°	9.3°	16°
$\underline{1}$ to $\bar{1}$ angle	130° to 150.5°	135.4°	119°
$\bar{1}$ to Mandibular Plane	81.5° to 97°	91.4°	99°
S-N-A		82°	82°
S-N-B		80°	78°
Gonion Angle	Tweed 116° - 135°	126°	132°

TABLE 3

FROM SALZMANN (1966)[64] P. 645

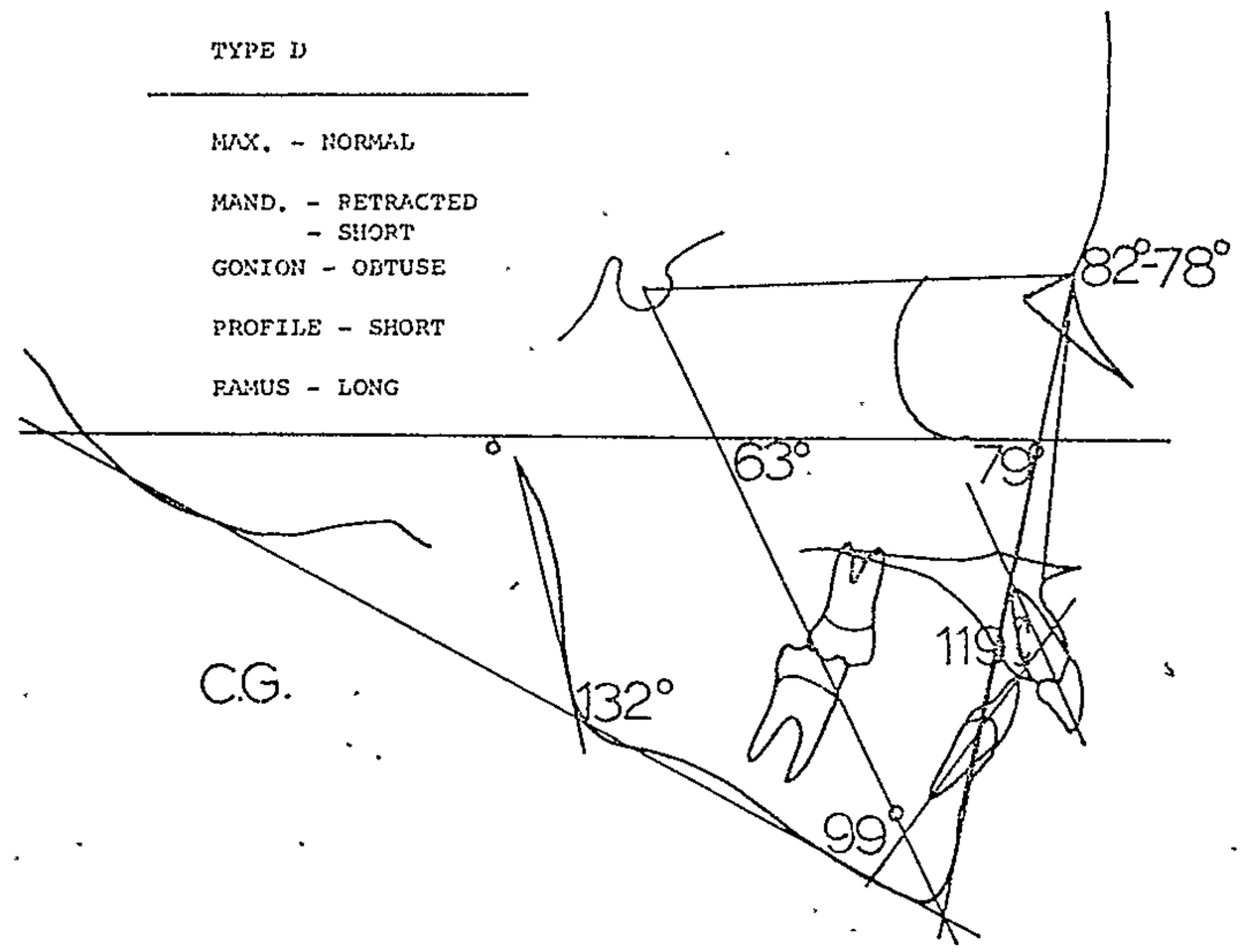
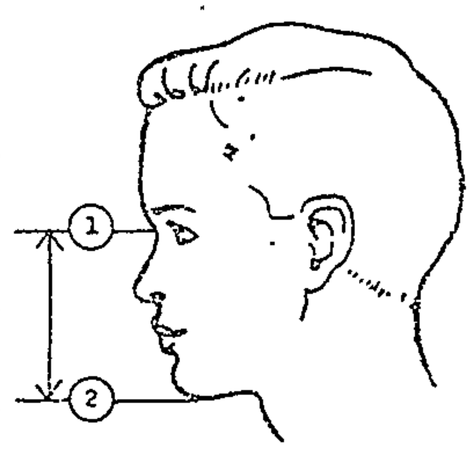


FIGURE 2

TABLE 45. Basic Body Measurement of School Age Children—Face Height, Measurement*

Age in Years	Sex	Variability: Mean in Inches	Variability: Standard Deviation in Inches	Variability: Number of Cases[1]	Range in Inches: Reported in Studies	Range in Inches: Computed at ± 1 Sigma from Mean[2]	Sample: Number of Cases	Sample: Source of Data
1	2	3	4	5	6	7	8	9
4	Boys	3.5	0.2	187	2.8 - 3.7	3.3 - 3.7	187	1, 5
	Girls	3.5	.2	163	3.2 - 3.9	3.3 - 3.7	163	5
5	Boys	3.7	.2	235	3.4 - 3.8	3.5 - 3.9	235	1, 5
	Girls	3.6	.3	215	2.8 - 3.9	3.3 - 3.9	215	
6	Boys	3.9	.2	289	3.5 - 4.3	3.7 - 4.1	289	1, 5
	Girls	3.7	.2	244	3.4 - 3.9	3.5 - 3.9	244	
7	Boys	3.9	.2	306	3.4 - 4.2	3.7 - 4.1	306	1, 5
	Girls	3.8	.2	252	3.4 - 4.0	3.6 - 4.0	252	
8	Boys	4.0	.2	313	3.6 - 4.3	3.8 - 4.2	313	1, 5
	Girls	3.9	.2	273	3.4 - 4.2	3.7 - 4.1	273	
9	Boys	4.1	.2	324	3.7 - 4.3	3.9 - 4.3	324	1, 5
	Girls	4.0	.2	280	3.5 - 4.1	3.8 - 4.2	280	
10	Boys	4.2	.2	391	3.8 - 4.6	4.0 - 4.4	391	1, 5
	Girls	4.1	.2	342	3.5 - 4.3	3.9 - 4.3	342	
11	Boys	4.2	.2	394	3.8 - 4.6	4.0 - 4.4	394	1, 5
	Girls	4.1	.2	333	3.9 - 4.6	3.9 - 4.3	333	
12	Boys	4.2	.2	507	3.9 - 4.7	4.0 - 4.4	507	1, 5
	Girls	4.2	.2	384	3.9 - 4.3	4.0 - 4.4	384	
13	Boys	4.3	.2	557	3.9 - 4.7	4.1 - 4.5	557	1, 5
	Girls	4.3	.2	389	3.9 - 4.6	4.1 - 4.5	389	
14	Boys	4.5	.2	479	4.1 - 4.7	4.3 - 4.7	479	1, 5
	Girls	4.3	.2	291	4.1 - 4.5	4.1 - 4.5	291	
15	Boys	4.6	.3	481	4.1 - 4.7	4.3 - 4.9	481	1, 5
	Girls	4.4	.2	247	3.9 - 4.7	4.2 - 4.6	247	
16	Boys	4.8	.3	292	(4.0 - 5.5)[3]	4.5 - 5.1	292	1
	Girls	4.5	.2	86	(3.8 - 5.1)	4.3 - 4.7	86	
17	Boys	4.8	.2	229	(4.2 - 5.5)	4.6 - 5.0	229	1
	Girls	4.5	.2	86	(3.9 - 5.0)	4.3 - 4.7	86	



Description of Measurement: Made from a point in the middle of the forchead between the eyes [nasion (1)] to the tip of the lower jaw [gnathion (2)].

*(Martin, W. E., and Story, R. C.: U.S. Dept. Health, Education, and Welfare)

[1] Number of cases for which the standard deviation was reported in the studies used as sources.

[2] Obtained by adding and subtracting the standard deviation (Col. 4) to the mean (Col. 3). The computed range includes approximately the middle 68 per cent of the cases in the composite sample.

[3] Ranges in parentheses were not given in studies; they were computed at ± 3 sigmas from the mean.

TABLE 47

FROM SALZMANN (1966) [64] p. 483

is simply not seen at all. The practical solution to the dilemma is to assume that the upper surface of the ear-rod is the closest possible approximation to the unseen porion, and the suggestion is valid provided the technician so orders his affairs that the patient never rises from the ear-rods. In the event that he does, all the anatomical points go up with him, including the true porion, to say nothing of the angle of the jaw, orbitale and other landmarks which enter into commonly used systems of appraisal. Since the ear-rod stays down, however, the one who uses the film produced under these circumstances gets an incorrect judgement of Frankfort."

Steiner (1953)[71] wrote that working with cephalometrics discloses the difficulty of accurately locating the porion point. "This difficulty can be explained on the basis of the fact that porion is a point upon the external exit of the bony auditory canal. This point is covered by soft tissue intervening between the ear posts and the porion point. Tracings

are not made from the porion itself, but from the top of the ear posts which approximate it in position." Steiner then shows that patients can and do move in relation to the ear posts. Frantz (1968)[22] has also commented that the location of porion is "fraught with considerable error."

Dickson (1959)[15], writing of the use of porion as a landmark, on page 41 comments that the ear post of the machine, used as representing porion, may vary by as much as five millimetres depending on whether the patient is suspended by the ear posts or is pressing up against them. He further comments that as the orbital margin is difficult to locate and the porion is impossible to fix, in his opinion there is no advantage in persisting in the use of Frankfort horizontal in cephalometric analysis.

Taylor and Hitchcock (1966)[75] state the opinion that orbitale, which is located on different sized orbits in different persons, and porion, which is mechanically determined from a machine, are not very

satisfactory as landmarks for determining a base line. "Admittedly, every base line is variable. Nevertheless, we have reluctantly concluded that the Frankfort plane is not reliable enough to use."

Nanda and Sassouni (1965)[51] wrote that in the clinical evaluation of antero-posterior variations in the facial profile by means of roentgenographic cephalometry, different reference planes have been used. The object of Nanda and Sassouni's investigation was to test if the diagnoses derived from different planes of reference are interchangeable. Five methods of measuring the antero-posterior position of the chin were used:

1. Downs' facial angle Na-Pog/FH.
2. Bjork's facial angle S-Na Pog.
3. Modified Koski's analysis.
4. De Coster's method.
5. Sassouni's archial method.

The thirty normal patients studied (mean age 11.9 years) showed individually a different degree of

chin retrusion and protrusion depending on the planes used. The ten Class II patients showed a concordance of results of the five analyses in only two cases.

Downs (1961)[18] wrote that he had found cases in which the patient had a very good posture and a good profile, but the facial angle was 81°, and, according to previous studies, this would indicate a retrusive face, which the individual did not have. The Frankfort horizontal deviated 9° from true horizontal. Downs points out that if you make the correction of 9° you come up with a corrected facial angle of 90°, which places the case in an average Class I profile. Downs suggests that cephalometric radiographs be taken with the head in "natural head position", that is, when the visual axis is horizontal, with the eyes focussed on the horizon. Deviations of the Frankfort horizontal plane from the true horizontal can then be detected and compensation can be made.

Taylor and Hitchcock (1966)[75] have stated a preference for the use of the facial plane to SN angle

instead of the facial plane to Frankfort horizontal angle. They point out that this angle SNP has an extremely high coefficient of correlation (0.95) with the angle SNB. They also found that the angle of convexity, the second measurement in Salzmann's cephalometric analysis, has an exceptionally high coefficient of correlation (0.92) with the SNA-SNB difference. They explain that the numerical evaluation of the coefficient of correlation extends from +1 to -1. A +1 coefficient of correlation between any two measurements would mean that for every unit increase in one of those measurements there would be a proportionate increase in the other measurement. A -1 coefficient of correlation between any two measurements means that as one measurement increased, the other would decrease by a proportionate amount. While a high coefficient of correlation is not interpreted to mean a cause-and-effect relationship between two variables, it can mean that one measurement may be substituted for the other in the evaluation of a particular criterion. Taylor

and Hitchcock found a standard deviation or spread of the angle of convexity of $\pm$5.1, whereas the standard deviation of the SNA-SNB difference was $\pm$2.0. They give this reason for omitting the angle of convexity from their "Alabama Analysis".

Salzmann utilizes Downs' norms or standards in his analysis, and these are expressed as means and a range of normality around these means. The subject of norms and standards has been discussed in general terms in section three of this treatise. In relation to Downs' analysis, certain more specific comments could be made.

First, with regard to the selection of patients for the establishment of Downs' standards, Schwartz (1953)[69], (1957)[70], has commented that Downs set out to determine the range of facial and dental pattern within which one might expect to find the normal. To do this, Downs selected twenty individuals possessing what he judged to be normally occluding teeth, and then performed a cephalometric analysis on these individuals.

Schwartz points out that Downs did not seek to define the normal; this was assumed in his selection of cases, and conceivably another investigator could have selected a different group of so-called normals and developed a different range of values.

Hirsch, Hall, and Bachand (1969)[33] reported on a cephalometric evaluation of thirty eight-year-old ($\pm$six months) caucasians, eighteen males and twelve females, all of whom had all eight incisors erupted and in occlusion, with the first permanent molars in Class I or cusp to cusp relationship, and with no evidence of malocclusion. Their findings, compared to Downs' figures, are set out in Table 5.

Salzmann uses the angles SNA and SNB in his analysis and has chosen 82^{o} as his mean for SNA and 80^{o} for SNB. Hirsch, Hall, and Bachand (1969)[33], in the study reported above, found mean figures of 80.5^{o} for SNA (M and F) and 76.4^{o} (M) and 77^{o} (F) for SNB.

Hovell (1966)[39] states that an SNA angle of 81^{o} indicates a mesognathic relationship of the upper

DIMENSION		MEAN	RANGE
FACIAL ANGLE F.H. TO N-Pg	D	87.8°	82° TO 95°
	E	M 83.63°	75.16° TO 88.66°
		F 84.85°	77.83° TO 92.33°
ANGLE OF CONVEXITY N-A-Pg	D	0°	-8.5° TO +10°
	E	M 8.36°	2.33° TO 12.83°
		F 7.31°	1.66° TO 12.16°
A-B LINE TO N-Pg	D	-4.8°	-9° TO 0°
	E	M -6.74°	-4.00° TO -10.60°
		F -6.10°	-1.66° TO -10.50°
MAND. PLANE TO F.H.	D	21.9°	17° TO 28°
	E	M 29.11°	18.66° TO 39.50°
		F 28.52°	22.66° TO 39.16°
Y-AXIS	D	59.4°	53° TO 66°
	E	M 60.18°	52.83° TO 69.50°
		F 61.94°	51.50° TO 70.33°
T TO MAND. PLANE	D	91.4°	81.5° TO 97°
	E	M 92.28°	83.33° TO 100.00°
		F 97.69°	87.00° TO 106.33°

D = DOWNS' GROUP. E = EASTMAN GROUP

HIRSCH, HALL, AND BACHAND (1969)[33]

M = MALE. F = FEMALE

TABLE 5

dental base to the skull, and with this relationship an SNB angle of 78° allows the incisors to come into normal relationship, and therefore indicates a normal antero posterior dental base relationship. He also states that an increase in SNA to 90° indicates a very prognathic facial skeleton, and with this degree of prognathism an SNB angle of 82° gives a normal dental base relationship, while an SNA of 72° is at the other end of the scale and is obtained with a very retrognathic facial skeleton, and with this angle the SNB angle must also be 72° to give a normal dental base and incisor relationship. Hovell concludes that the SNB angle does not bear a constant relationship to the SNA angle when the maxillary and mandibular bases are correctly related to each other, but varies directly according to the degree of facial prognathism or retrognathism. According to Hovell, the amount of variation is ⅓° per degree change from the normal of the SNA angle.

Walther (1967)[80] on pages 62-63 discusses the

SNA and SNB angles. He states that American figures give mean values as SNA 82°, SNB 80°, but gives English figures as being SNA 80.3° and SNB 75.6°, with the SNA-SNB difference being 4.7°.

Walker and Kowalski (1971)[78] give the results of a survey of 1100 "normal" individuals selected by Krogman as being "reasonably representative of the (white) children of the city of Philadelphia". They found the typical value of the ANB angle to be quite different from 2° (SNA 82°, SNB 80° as used by Salzmann), the overall mean being more in the region of 4.5°. Walker and Kowalski conclude that this is not to say that the angle of 2° is not in some sense "better", but indicates that "normal" individuals do not, on the average, attain this ideal, and one may continue to insist that 2° is the ideal value for the ANB angle, but should realize that the great majority of "normal" individuals simply do not look this way.

Some of the cephalo-dento-facial characteristics listed in Tables 1 and 2 require further explanation.

The ramus length is described as being either adequate or inadequate in Table 1, and long or short in Table 2. Salzmann considers the ramus as being adequate or long when a line tangent to the mandibular base (lower border) is tangential to, or below, the occiput. The ramus is considered as being inadequate or short when a line tangent to the mandibular base extends within the occiput.

The maxilla is described as being normal, protracted, or retracted in Table 2. This is based on whether the SNA angle is about the mean of 82^{o}, above the mean, or below the mean. The mandible is described as being normal or retracted, and this is based on whether the facial angle is within the range of 82^{o} to 95^{o}, or below this range.

The skeletal classification is based on the facial angle (F.H. to N-Pg). It would appear that if the facial angle is near the mean of 87.8^{o} the patient is classed as skeletal 1, if below the mean as skeletal 2. The relationship between the facial angle, skeletal

classification, and description of the mandible, together with the SNA angle and description of the maxilla for the examples of each type given by Salzmann is summarized in Table 6. I have included the SNB angle and SNA-SNB difference (or ANB angle) in this table. The ANB angle is considered by some writers to be an indication of the skeletal pattern and it is interesting to observe the ANB angle in relation to the skeletal classification based on the facial angle in each of Salzmann's examples.

It is interesting to note that Salzmann's example of a Type B Class II Division 1 malocclusion has a facial angle of 85^{o} and is classified as skeletal 1, whereas his example of Type G, also with a facial angle of 85^{o}, is classified as skeletal 2. Of the Type B, Salzmann writes that the facial skeletal pattern is Class 1; the facial angle is below the mean (87.8^{o}) of normal range and is indicative of a slightly retrognathic mandible, but well within normal range (82^{o} to 95^{o}) in relation to the upper face, Frankfort

TYPE A	FACIAL ANGLE 88°	SKELETAL I	MANDIBLE NORMAL
	SNA 82°		MAXILLA NORMAL
	SNB 75°	ANB 7°	
TYPE B	FACIAL ANGLE 85°	SKELETAL I	MANDIBLE NORMAL
	SNA 82°		MAXILLA NORMAL
	SNB 76°	ANB 6°	
TYPE C	FACIAL ANGLE 86°	SKELETAL I	MANDIBLE NORMAL
	SNA 84°		MAXILLA PROTRACTED
	SNB 77°	ANB 7°	
TYPE D	FACIAL ANGLE 79°	SKELETAL 2	MANDIBLE RETRACTED
	SNA 82°		MAXILLA NORMAL
	SNB 78°	ANB 4°	
TYPE E	FACIAL ANGLE 77°	SKELETAL 2	MANDIBLE RETRACTED
	SNA 83°		MAXILLA NORMAL
	SNB 76°	ANB 7°	
TYPE F	FACIAL ANGLE 81°	SKELETAL 2	MANDIBLE RETRACTED
	SNA 79°		MAXILLA RETRACTED
	SNB 74°	ANB 5°	
TYPE G	FACIAL ANGLE 85°	SKELETAL 2	MANDIBLE NORMAL
	SNA 85°		MAXILLA PROTRACTED
	SNB 76°	ANB 9°	
TYPE H	FACIAL ANGLE 77°	SKELETAL 2	MANDIBLE RETRACTED
	SNA 80°		MAXILLA RETRACTED
	SNB 71°	ANB 9°	

TABLE 6

horizontal, related to the facial line (N-Pg). When describing the Type G, however, Salzmann writes that the skeletal pattern is Class 2; the facial angle is below the mean (87.8°) but in normal range (82° to 95°); the mandible is in retrognathic relation to the upper face, Frankfort horizontal, in relation to the facial line (N-Pg). In both types the SNB is 76° and the B point is on the facial line, and in both types Salzmann describes the mandible as "normal".

The cephalometric analysis chosen by Salzmann for his differentiation of eight types of Class II Division 1 malocclusion could perhaps be said to arouse sufficient doubts as to make its rigid application to diagnosis questionable. Further doubts must arise when one considers that Salzmann's division of this large malocclusion group into eight types carries with it specific treatment implications for each type.

Jackson (1956)[41] put one point of view when he wrote that the cephalometric method at present employed in orthodontics is so incomplete and inaccurate that

dependence on its use may not only distort all sense of proportion, but may lead to some extremely dangerous diagnostic decisions. Ricketts (1970)[56] wrote that Steiner has insisted that no responsible clinician fulfills the possibilities he can offer patients without the insight and information gained by cephalometric procedures. In Ricketts' opinion, the problem of interpretation has become the melting pot for arguments, and the selection of standards for comparison or objectivity has become dogmatic and clouded.

Ricketts (1961)[54] has also given his opinion that too many measurements are being employed for routine clinical use. "Insignificant details are enlarged out of proportion to their importance without the system's yielding a rapid, efficient appraisal of the overall orthodontic problem." Perhaps it is possible that this statement by Ricketts could be applied to Salzmann's analysis which does give the impression of being rather unwieldy.

The determination of whether or not this

criticism is justified is the object of the original investigation which now follows.

ORIGINAL INVESTIGATION.

Aim.

The aim of this investigation is to test Salzmann's (1966)[64] differential diagnosis of Class II Division 1 (Angle) malocclusion.

Materials and Method.

Thirty examples of Class II Division 1 (Angle) malocclusion were obtained from patients presenting for treatment in the Orthodontic Department of the United Dental Hospital of Sydney. The patients in this sample consisted of sixteen males and fourteen females ranging in age from nine years and ten months to sixteen years and one month. None of these patients had received orthodontic treatment prior to examination.

A cephalometric radiograph was obtained for each patient, using the cephalometer in the Department of Orthodontics, University of Sydney, and observing the cephalometric conventions. A tracing was made of each radiograph, using Kodatrace and a 2H pencil. Each tracing was analyzed in the manner suggested by Salzmann (Section 6 of the Review of the Literature).

The profile measurement was obtained directly from the patient, using a vernier gauge. This profile measurement is made from a point in the middle of the

forehead between the eyes, to the tip of the lower jaw. The reference table used by Salzmann (Table 4) was used in this investigation.

An example of a tracing obtained from a cephalometric radiograph of one of the patients, number ten in this series of thirty, is shown in Figure 3. The cephalometric analysis for this patient is shown in Table 7. At the end of the cephalometric analysis, the profile measurement is recorded, although this measurement is obtained from the patient, not the tracing.

Salzmann's table of the five principal interrelations of the eight types of Class II Division 1 malocclusion was next referred to, and for each patient the relevant characteristics were noted, as in Table 8 which represents the findings for patient number ten.

Salzmann's summary of the cephalo-dento-facial morphologic deviations which in his opinion characterize the eight different types of Class II Division 1 malocclusion was then referred to, and the characteristics of each patient were noted, as in Table 9 which again

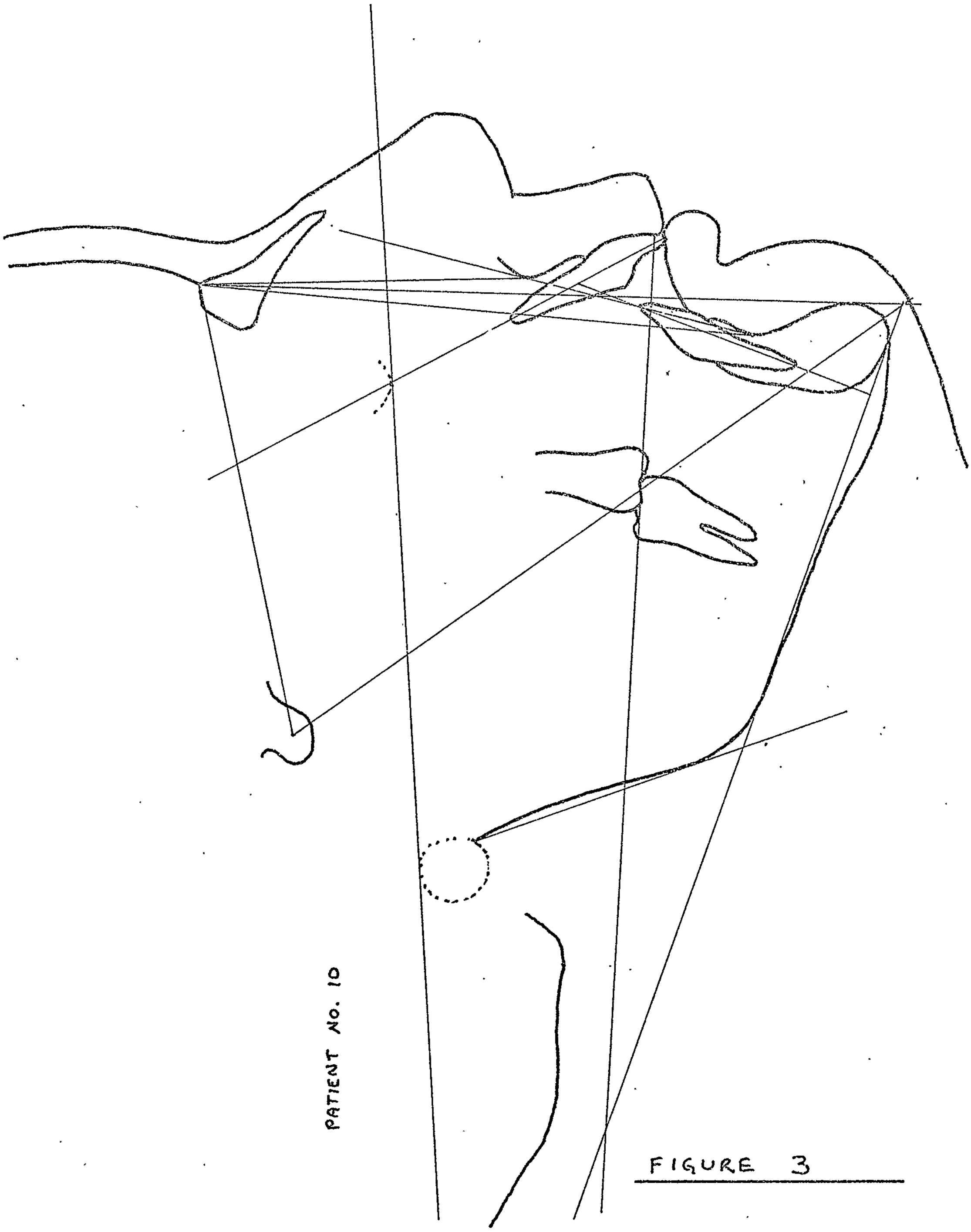


FIGURE 3

DIMENSION PATIENT NO. 10 (M)	DOWNS RANGE	MEAN	AGE 13 yrs
Facial Angle (F.H. to N-Pg)	82° to 95°	87.8°	85°
Angle of Convexity (N-A-Pg)	−8.5° to +10°	0°	+6°
A-B line to N-Pg	−9° to 0°	−4.8°	−13°
Mand. Plane to F.H.	28° to 17°	21.9°	24°
Y-Axis	66° to 53°	59.4°	58·5°
Occlusal Plane to F.H.	1.5° to 14°	9.3°	7°
$\underline{1}$ to $\bar{1}$ angle	130° to 150.5°	135.4°	130·5°
$\bar{1}$ to Mandibular Plane	81.5° to 97°	91.4°	91°
S-N-A		82°	80°
S-N-B		80°	74°
Gonion Angle	Tweed 116° - 135°	126°	130°
PROFILE			4"

TABLE 7

PATIENT NO. 10

	A	B	C	D	E	F	G	H
MAXILLA	Normal	Normal	Protracted	Normal	Normal	Retracted	Protracted	Retracted
MANDIBLE	Normal	Normal	Normal	Retracted	Retracted	Retracted	Normal	Retracted
GONION	Normal	Normal	Acute	Obtuse	Obtuse	Normal	Obtuse	Obtuse
PROFILE	Short	Normal	Long	Short	Long	Long	Short	Short
RAMUS	Short	Long	Long	Long	Short	Long	Short	Short

TABLE 8

PATIENT NO. 10

Type		A	B	C	D	E	F	G	H
Skeletal Classif.		(1)	(1)	(1)	2	2	2	(2(?))	2
Facial Angle	Mean	n	(b)	(b)				(b)	
	Range		(n)	(n)	b	b	b	(n)	b
S-N-A	Mean	n	n	a	n	n	(b)	a	(b)
S-N-B	Mean	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Angle of Convexity	Mean				(a)		(a)		
	Range	a	a	a	(n)	a+	(n)	a+	a+
A-B Difference	Mean		b		b				
	Range	(b)	n	(b)	n	(b)	(b)	(b)	(b)
Y-Axis	Mean	b	a	a	a		a	(n)	
	Range	n	n	n	n	a	n		a
Ramus Length	Adequate		(ad.)	(ad.)	(ad.)		(ad.)		
	Inadequate	inad.				inad.		inad.	inad.
Gonion Angle	Mean	(a)	n	b	(a)	(a)	n		
	Range	(n)		n	(n)	(n)		a	a
$\bar{1}$ to Mand. Plane	Mean	b	a				(n)	a	a
	Range	n	n	a	a	a		n	n
Max. Incisor Prognath. to N-Pg	Normal Progn.	(p)	(p)	(p)	(p)	(p)	(p)	(p)	(p)
Mand. Inc. Progn. to N-Pg	Normal	(n)		(n)			(n)		(n)
	Progn.		p		p	p		p	
$\frac{\bar{1}}{\underline{1}}$	Mean	a					a			b
	Range	n	b	b	b	b	n	b	b	n
S-N Relation to F.H.	Cranially Divergent	(div.)	(div.)	(div.)			(div.)	(div.)	(div.)	
	Parallel				para.	para.				
Occ. Plane to F.H.	Mean	a	n	(b)		a	a	(b)	
	Range	n		(n)	a	n	n	(n)	a
Mand. Plane to F.H.	Mean	(a)		n	(a)		(a)		
	Range	(n)	a		(n)	a	(n)	a	a

LEGEND

n = normal, mean, or normal range	b = below the mean or below normal range	p = prognathic
a = above the mean or above normal range	ad. = adequate	div. = divergent
a+ = extremely above the normal range	inad. = inadequate	para. = parallel

TABLE 9

represents the findings for patient number ten.

The total material used in this investigation amounted to the cephalometric radiographs and tracings of thirty examples of Angle Class II Division 1 malocclusion, cephalometric analyses (in the manner suggested by Salzmann) for each of these thirty patients, and tables prepared for each patient showing the principal interrelations and the cephalo-dento-facial morphologic deviations which in Salzmann's opinion, characterize the eight different types of Class II Division 1 malocclusion.

These tables were then studied to determine if there was

1. A pattern of characteristics in each table which would indicate that the patient could be classified as one or other of Salzmann's eight types.

2. A concordance of results from the tables of principal interrelations and cephalo-dento-facial morphologic deviations. That is, if a patient could be classified as a particular type from one of the tables,

was the patient able to be similarly classified by the pattern which emerged from the other table.

The number of characteristics of each of the eight types which each individual possessed was totalled for each table.

Findings.

The cephalometric analyses, with the profile measurement, for the thirty patients are shown in Table 10. The findings from the tables of principal interrelations and cephalo-dento-facial morphologic deviations are shown in Table 11.

Recorded in Table 11 is the number of characteristics of each type which each patient was found to present. For each type, from the table of cephalo-dento-facial morphologic deviations there are sixteen possible characteristics, and from the table of principal interrelations there are five possible characteristics.

From Table 11 it can be seen that patient number one presented twelve of the possible sixteen characteristics of Type B from the table of cephalo-dento-facial morphologic deviations, and all five of the principal interrelations of the same type, Type B. This patient could be classified as a Salzmann Type B Class II

TABLE 10

DIMENSION	DOWNS' RANGE	MEAN	1	2	3	4	5	6	7	8	9	10
FACIAL ANGLE (F.H. TO N-Pg)	82° TO 95°	87·8°	82°	91°	81·5°	82·5°	75°	89°	90°	85°	78·5°	85°
ANGLE OF CONVEXITY (N-A-Pg)	-8·5° TO +10°	0°	+8·5°	+9°	+15·5°	+13°	+20°	+6°	+8°	+13°	+6°	+6°
A-B LINE TO N-Pg	-9° TO 0°	-4·8°	-10·5°	-8·5°	-11°	-12°	-13·5°	-6·5°	-7°	-9°	-6·5°	-13°
MAND. PLANE TO F.H.	28° TO 17°	21·9°	30°	15°	26·5°	29·5°	39°	21°	28·5°	46°	43°	24°
Y-AXIS	66° TO 53°	59·4°	65·5°	56°	65°	61°	73°	57°	58°	65°	69°	58·5°
OCCL. PLANE TO F.H.	1·5° TO 14°	9·3°	10°	2·5°	11°	10°	21°	9°	9°	10°	17°	7°
1 TO T ANGLE	130° TO 150·5°	135·4°	120°	126°	112°	109°	114·5°	101°	122°	115·5°	132°	130·5°
T TO MAND. PLANE	81·5° TO 97°	91·4°	90·5°	105°	107°	98°	102°	115°	88°	74°	80°	91°
S-N-A		82°	81°	87·5°	84°	80°	82·5°	87°	83°	75·5°	76°	80°
S-N-B		80°	75°	82°	76°	73·5°	73°	83·5°	79°	68°	72·5°	74°
GONION ANGLE	TWEED 116° TO 135°	126°	125°	116°	122°	132°	129°	125°	124°	151°	140°	130°
PROFILE			4·5" 14 YRS F	4·3" 16 YRS F	4·5" 12 YRS M	3·8" 10 YRS F	4·5" 9 YRS M	4·3" 14 YRS M	3·9" 12 YRS F	4·4" 12 YRS M	4·1" 12 YRS F	4·0" 13 YRS M

TABLE 10 CONTINUED

DIMENSION	DOWNS' RANGE	MEAN	11	12	13	14	15	16	17	18	19	20
FACIAL ANGLE (F.H. TO N-P_g)	82° TO 95°	87·8°	84·5°	88°	93°	87°	85°	87·5°	87·5°	87·5°	87·5°	87°
ANGLE OF CONVEXITY (N-A-P_g)	-8·5° TO +10°	0°	+12·5°	+10·5°	+14°	+20·5°	+10°	+6°	+17·5°	+14·5°	+6°	+10·5°
A-B LINE TO N-P_g	-9° TO 0°	-4·8°	-10°	-8°	-10·5°	-15·5°	-11°	-12°	-11°	-15°	-8·5°	-10°
MAND. PLANE TO F.H.	28° TO 17°	21·9°	40°	18·5°	19·5°	27°	31°	22°	26°	29°	29°	30°
Y - AXIS	66° TO 53°	59·4°	67°	55°	53·5°	60°	63°	54°	59°	60·5°	59·5°	59°
⊥ TO T ANGLE	130° TO 150·5°	135·4°	112°	115·5°	119°	108°	125°	119°	122°	119·5°	124°	131°
T TO MAND. PLANE	81·5° TO 97°	91·4°	82°	106°	98·5°	105°	92·5°	92·5°	102°	97·5°	86·5°	88°
S-N-A		82°	82·5°	86·5°	86°	85°	83·5°	78°	86°	82°	82°	79·5°
S-N-B		80°	75·5°	82°	79°	74°	77·5°	72°	78°	74°	78°	73·5°
GONION ANGLE	TWEED 116° TO 135°	126°	145°	124°	118°	130°	131·5°	136°	130°	132°	129°	127°
PROFILE			4·5" 12 YRS M	3·8" 14 YRS F	4·1" 12 YRS M	4·4" 16 YRS M	4·3" 14 YRS F	3·5" 11 YRS F	4·0" 13 YRS M	4·5" 12 YRS M	4·0" 12 YRS F	4·4" 13 YRS M

TABLE 10 CONTINUED

DIMENSION	DOWNS' RANGE	MEAN	21	22	23	24	25	26	27	28	29	30
FACIAL ANGLE (F.H. TO N-Pg)	82° TO 95°	87·8°	79°	81·5°	82·5°	81·5°	87·5°	88°	83°	85·5°	80°	81°
ANGLE OF CONVEXITY (N-A-Pg)	-8·5° TO +10°	0°	+10°	-3°	+6·5°	+17·5°	+10°	+11·5°	+5°	+12°	-2°	+14·5°
A-B LINE TO N-Pg	-9° TO 0°	-4·8°	-8°	-4°	-10°	-11·5°	-11·5°	-14·5°	-5°	-19°	-4·5°	-11°
MAND. PLANE TO F.H.	28° TO 17°	21·9°	34°	25°	32°	33°	17·5°	25°	26°	26°	37°	38°
Y-AXIS	66° TO 53°	59·4°	66°	64°	66°	64°	54°	55°	64°	60°	66°	68°
OCCL. PLANE TO F.H.	1·5° TO 14°	9·3°	15°	11·5°	17·5°	11°	3°	6·5°	7°	10°	12°	17·5°
$\underline{1}$ TO $\overline{1}$ ANGLE	130° TO 150·5°	135·4°	116°	125°	123°	127°	108°	120°	128°	123°	115°	117°
$\overline{1}$ TO MAND. PLANE	81·5° TO 97°	91·4°	96°	93·5°	91°	91·5°	111·5°	97·5°	96°	92·5°	87°	91°
S-N-A		82°	80°	77°	77°	85·5°	80·5°	84°	79·5°	77·5°	78°	87°
S-N-B		80°	74·5°	76°	72°	77°	74·5°	76°	77°	69·5°	76·5°	79·5°
GONION ANGLE	TWEED 116° TO 135°	126°	117°	120°	134°	129°	123°	129°	118·5°	132°	134°	126°
PROFILE			4·3" 14 YRS M	4·3" 15 YRS F	4·3" 14 YRS F	4·1" 12 YRS F	3·6" 11 YRS M	4·3" 13 YRS M	4·3" 15 YRS F	4·6" 15 YRS M	4·6" 16 YRS M	4·1" 12 YRS F

CASE NO.	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E	TYPE F	TYPE G	TYPE H
1	7	12	10	7	6	10	8	7
	3	5	2	2	1	2	1	0
2	6	6	11	6	3	5	5	4
	2	2	4	2	0	1	3	1
3	7	6	11	9	9.	11	7	9
	1	2	3	2	2	4	1	1
4	8	10	11	6	7	7	8	8
	3	1	1	2	2	1	4	4
5	6	6	5	11	15	5	8	11
	3	2	1	2	4	3	1	2
6	6	8	9	6	3	6	4	4
	3	3	3	2	0	2	3	1
7	9	10	6	6	6	6	7	7
	5	3	1	2	2	1	3	2
8	6	12	8	6	6	5	10	8
	2	2	1	1	2	1	3	3
9	5	5	4	7	7	8	6	12
	1	1	0	2	3	2	2	4
10	8	6	9	6	4	10	8	6
	2	2	2	3	1	2	3	3

TABLE 11

CASE NO.	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E	TYPE F	TYPE G	TYPE H
21	4	7	6	10	8	8	6	11
	2	0	1	2	2	2	2	4
22	6	8	8	9	6	11	5	9
	0	2	2	2	1	3	0	2
23	8	8	9	7	6	9	9	10
	2	2	1	1	2	1	3	3
24	7	7	7	8	12	9	10	10
	2	2	1	1	2	2	2	2
25	8	8	9	5	4	9	7	8
	3	3	2	2	0	3	2	2
26	12	6	11	6	7	6	8	7
	3	3	2	0	1	1	3	1
27	6	9	11	7	3	9	8	7
	1	3	3	1	0	2	1	1
28	9	9	10	6	5	9	8	7
	1	3	2	2	1	2	2	2
29	7	5	5	8	10	8	5	9
	1	1	0	2	3	2	2	4
30	5	5	6	7	11	8	8	12
	2	2	1	1	2	2	2	2

TABLE II CONTINUED

CASE NO.	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E	TYPE F	TYPE G	TYPE H
11	9	10	9	5	9	4	12	9
	3	2	2	2	4	1	3	1
12	7	8	10	5	3	5	5	4
	3	3	3	2	0	2	3	1
13	7	8	13	6	6.	5	8	5
	1	3	4	1	0	1	2	0
14	8	7	10	8	8	6	10	6
	2	2	3	3	1	1	4	2
15	8	9	10	6	7	8	10	8
	2	2	2	1	2	0	4	1
16	8	6	10	5	4	9	7	8
	2	2	2	3	1	2	3	3
17	9	6	9	7	9	5	11	7
	3	1	2	2	1	0	5	2
18	11	9	9	6	9	5	8	8
	3	2	2	2	4	1	3	2
19	10	8	7	7	7	5	8	7
	4	4	1	1	2	1	2	1
20	11	7	7	2	6	8	7	8
	3	3	1	0	1	2	2	2

TABLE II CONTINUED

Division 1 malocclusion.

An analysis of the findings shown in Table 11 reveals that in eight cases (1, 2, 5, 9, 13, 17, 21 and 22) there is a corresponding majority of cephalo-dento-facial morphologic deviations and principal interrelations for a particular type. These eight patients could be classified as follows:

Patient 1	Type B
Patient 2	Type C
Patient 5	Type E
Patient 9	Type H
Patient 13	Type C
Patient 17	Type G
Patient 21	Type H
Patient 22	Type F

In the remaining twenty two cases, no clear pattern emerges which would enable each case to be distinguished as a particular type in Salzmann's differential diagnosis.

Discussion.

When performing this investigation, the first impression gained of Salzmann's analysis of eight types of Class II Division 1 malocclusion was that it was rather complicated and time consuming in its execution. While the actual performance of the cephalometric analysis is straightforward, although the analysis itself is open to criticism as discussed in Section 6 of the Review of the Literature, the application of the data obtained from this analysis to the tables of cephalo-dento-facial morphologic deviations and principal interrelations and the interpretation of these tables is a process which does not seem to yield a rapid, efficient appraisal of the overall orthodontic problem.

If Salzmann's analysis succeeded in differentiating eight types of Class II Division 1 malocclusion, then the unwieldy nature of the analysis, while remaining a problem, could perhaps be overlooked. When,

however, this investigation reveals that only eight out of thirty examples can reasonably be classified as one or other of the eight types, it could be said that not only is the Salzmann analysis unwieldy, but also that the time spent in its execution adds little if anything to the understanding of the problems presented by the patient.

Again, if Salzmann's analysis succeeded in differentiating eight types of Class II Division 1 malocclusion, one could ask what advantages would have been gained. Because of the complex nature of the analysis, it would in my opinion do little, as a classification system, to facilitate communication and reference. The treatment implications of the analysis, and Salzmann gives brief notes on the treatment of each type, would be that having successfully classified a patient as a particular type, the treatment for that patient would be similar to the treatment for all other patients of that type. In general terms I think that this concept is open to question. It implies that

individual variability is limited to the point that there are only eight types of Class II Division 1 malocclusion and that the individuals who make up each type are similar enough to warrant similar treatment plans.

Salzmann's objective in presenting his eight types of Class II Division 1 malocclusions was to overcome the inadequacies of the Angle classification system. He has attempted to do this by extending the Angle classification with the aid of a cephalometric analysis and tables of morphologic deviations and interrelations. The results of this test of Salzmann's differential diagnosis indicate that he has not achieved his objective.

Summary and Conclusions.

1. The Salzmann (1966)[64] differential diagnosis of Class II Division 1 malocclusion was tested on thirty examples of this malocclusion.

2. The findings of this investigation show that of the thirty examples only eight could reasonably be classified as belonging to one or other of Salzmann's eight types.

3. The Salzmann analysis appears to be unwieldy and not capable of producing an efficient appraisal of the overall orthodontic problem.

4. Salzmann's stated objective of overcoming the inadequacies of the Angle classification system does not appear to have been achieved.

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