AN ANALYSIS

OF DEEP OVERBITE

IN

ORTHODONTICS

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[1957]
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VII. EPILOGUE.
I. PROLOGUE.

1. Definition:

Strang defines overbite as "the overlapping of the maxillary and mandibular central incisor teeth in the vertical plane".

Steadman extends his definition to include all the incisor teeth; "any arrangement of the teeth in which the maxillary central and lateral incisors overlap the mandibular incisors, whether or not an overjet is present."

Bovell takes a broad view and defines the ideal incisor relationship as one "with an angle of 135°-140° between the long axes of the maxillary and mandibular incisor teeth, and an overbite of one-third of the labial surface of the permanent mandibular incisor together with normal antero-posterior apical base relationship and Frankfort Mandibular plane angle."

Ballard in a precise manner defines normal incisal occlusal relationship; "with the maxillary incisor teeth at 107° to the Frankfort plane and the mandibular incisor teeth at 90° to the mandibular plane and a Frankfort mandibular plane angle of 27°," then the incisal tip of the mandibular incisor teeth meets the middle third of the lingual surface of the maxillary incisor teeth.

2. Terminology:

(A) Description.

There is an abundance of terms throughout the literature. Uniformity of expression is desirable for better understanding.

Bovell considers the term closed bite is obsolescent and prefers overclosure or excessive incisor overlap. Some think of true and false closed bites and Americans speak of cases with a large freeway space. Distinction must be drawn between "close bite" and "closed bite"; the former refers to the teeth being close together and the latter, to a loss of vertical dimension. The term "deep overbite" is much preferred
to describe an excessive overlap of the incisor teeth, as it is now known that it is independent of the intermaxillary space.

(B) Range.

There is a wide diversity of opinion in the mode of expressing overbite quantitatively. The usual method - slight, medium or excessive is vague. Porter uses normal and excessive with a range in each group; one quarter to one-third of the upper incisor covered, being the dividing line between the ranges. "Abnormal" and "acceptable" are sometimes described. The terms "normal overbite" and "deep overbite" are much to be preferred.

3. Types:

Marshon described two types of deep overbite:

A. Deep overbite.

B. True closed bite; on a case analysis basis.

A. Deep overbite:

Presents an exaggerated Curve of Spee, small freeway space and the posterior teeth are long and have deep cusps. "It is probably due to an over-eruption of the incisors" state Strang and Marshon.

Hovell debunks the term "closed bite" in these cases. He considers the early loss of deciduous molars or first permanent molar the causative factor, but not by affecting the intermaxillary space. As this type is not due to a loss of vertical dimension, he prefers not to use "closed bite" to describe them, as of old. Hovell considers lack of arch continuity affects the normal forward positioning of the lower incisor crowns. Their apices are carried forward by growth, the crowns are retroclined and when out of occlusion, the lower incisors supraerupt.

B. True closed bite:

The overbite anteriorly is associated with an excessive freeway space. There is an infraclusion of the posterior teeth
permitting overclosure of the mandible. Strang and Dunn say there may be two levels of the occlusal plane in the lower arch or in both arches.

Hemley states the anterior teeth are on a higher occlusal level than the posteriors in the mandible and on a lower level in the maxilla.

Mershon describes the posterior teeth as short and broad thus reducing the distance between the maxilla and mandible. As a result, the distance from nose to chin is in disharmony with the generally accepted concept of an ideal face. Mershon declared these cases could not be treated.

It is universally agreed that this type is due to muscle action alone. Howell postulates that hypertonic musculature retroclines the upper and lower incisors which over-erupt. Some prefer to consider posture at fault.

White, Gardiner and Leighton in their Textbook describe a primary and secondary overbite type depending on the skeletal pattern concerned.

C. Closed bite without deep overbite.

The definition of overbite does not include the type of case, which though many times referred to as deep overbite cases are really only closed bite cases without the presence of deep overbite. In these cases "overlap of the upper and lower incisors in the vertical plane" is not excessive, but lower incisors are biting into the gingivae palatally to the upper incisors.

These cases have a common denominator with cases of excessive overbite in which molars appear to be infracluded, thus permitting overclosure of the mandible. Associated with this, in "closed bite" cases, is usually a severe labial inclination of the upper incisors which carries the incisal edges of these teeth away from the occlusal plane to a position of infraclusion. Thus this infraclusion of upper incisors counteracts to a varying extent the effect of molar infraclusion
i.e. the extent of overbite varies with the relative vertical level of anterior teeth as related to posterior teeth.

NORMAL CASE (BLACK INK): A CASE WITH INFRACLUSION OF MOLARS (RED INK) WITH CONSEQUENTIAL OVERCLOSURE OF MANDIBLE WHEN TEETH ARE BROUGHT INTO OCCLUSION (PENCIL). THE LOWER INCISORS ARE CARRIED UP TOWARDS THE GUMS PALATALLY TO THE UPPER INCISORS. THE POSITION OF THE UPPER INCISORS IN CASES OF EXCESSIVE OVERBITE IS SHOWN IN RED INK WHILE THE UPPER INCISOR IN PENCIL IS THE POSITION OF THIS TOOTH IN 'CLOSED-BITE' CASES WITHOUT EXCESSIVE OVERBITE. NOTE THAT LABIAL INCLINATION OF INCISORS IN SUCH CASES CARRIES THE INCISAL EDGE AWAY FROM PLANE OF OCCLUSION TO A POSITION OF INFRACLUSION.

4. Measurement:

Various methods have been devised:—

i) Strang and Wylie measured overbite in terms of the extent of the palatal surface of the maxillary central incisor covering the mandibular central incisor. Though useful clinically, the method is inaccurate, as labial inclination of the maxillary incisors will affect the overbite measurement without any change in the amount of vertical overlap of the incisors.

Over 7 mm = Severe
3.5 - 6 mm = Medium
2 mm = Slight

Neff reversed this method and measured the overbite in terms of the extent of the mandibular central incisor covered by the maxillary central incisor. The same objection applied
to this method though perhaps of lesser degree, due to the relative infrequency of cases presenting with a severe labial inclination of the mandibular incisors.

Goldstein and Stanton devised a more accurate method of measurement. Models were orientated in the occlusal plane, pointers placed on the incisal edges of the maxillary and mandibular teeth and read off on a vertical scale, the difference being the amount of overbite.

However, criticism can be directed at :-

a. the pointer is parallel to the occlusal plane and any change in plane angulation will cause a change in the pointer angulation.

b. if the overjet is appreciable, a change in the reading on the scale will result, even though the relationship between the incisors remains unchanged.

Frakask and Margolis measured overbite by drawing perpendiculars from the incisal edges to a line joining nasion-pogonion on cephalometric roentgenograms.

McIlair in a cephalometric measurement of 107 clinically excellent occlusions in 1955 gave overbite as 3.76 mms. for boys and 3.2 mms. for girls of the 7-14 age group.

5. Incidence:

A search of the literature failed to reveal any published figures on the incidence of deep overbite in the community. One feels this may result from the border line between so-called normal and deep overbite still remaining to be clearly defined.
In general terms these statements have appeared:

a) Callaway: "one of the most common problems to confront the orthodontist."

b) Salzmann: "prevalence has been emphasized in a survey in modern man, in both dentitions."

c) Lewis: "so many of our patients present themselves with deep overbite that it poses a problem which deserves our close attention."

d) Wylie: "in 90 children of orthodontic treatment age in an evaluation of slight, medium and severe overbite, it was noteworthy that 70% of the total were in the medium and severe group."

6. Distribution:

A. Race:

Overbite is a trait of civilization.

The presence of overbite is supposedly normal in predominantly Anglo-Saxon races. There is some difference of opinion among anthropologists as to an evolutionary trend.

Lasker found that the amount of overbite among the Chinese and Japanese increased in direct proportion to the increasingly civilized conditions under which they lived.

Among less advanced people there is a tendency towards an edge to edge bite, which progresses to various degrees of overbite.

B. Physique:

Three types of body build are seen normally: asthenic, plethoric and athletic. Bjork has related body build to bite; the slender type with narrow dental arches not infrequently exhibits deep overbite.

C. Physiognomy:

As a clinical observation, faces rather consistently indicate the form of the teeth and the extent of the overbite states Strang. Long narrow faces with long narrow incisors and
deep cusps in the posterior teeth nearly always have a greater overlap of incisors than a short blunt stubby face with short incisors and flat cusped posteriors.

D. Occlusion.

Salzmann states that malocclusion occurs in decreasing frequency in the child population as follows:

i) Intra-maxillary crowding.

Due mainly to lack of alveolar growth and other local interferences with normal tooth eruption and coronal arch development.

ii) Inter-maxillary dental occlusal malrelationships with or without jaw malrelation especially as seen in Angle Class II types chiefly in the form of excessive overjet and vertical overbite.

iii) Disproportions in overall development and growth without or with minor dental irregularities.

iv) Combination of dental irregularities and lack of or disproportion in overall growth, development and relation of the jaws, including the basal arches.

From Prakash and Margolis:

**Distribution of Cases According to Type of Occlusion and Degree of Overbite**

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>SLIGHT</th>
<th>MEDIUM</th>
<th>SEVERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Group</td>
<td>120</td>
<td>18</td>
<td>80</td>
</tr>
<tr>
<td>Normal Occlusion</td>
<td>36</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>Cl. I Malocclusion</td>
<td>44</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>Cl. II Malocclusion</td>
<td>40</td>
<td>2</td>
<td>25</td>
</tr>
</tbody>
</table>

Due to the relatively small number of cases in each malocclusion class, no conclusion can be drawn about the various classes separately.

Dewey Anderson states a deep overbite nearly always accompanies a Class II (Angle) Malocclusion but it is not solely confined to that group for Class I (Angle) or neutroclusion
carries it extensively.

Goldstein and Stanton agree that deep overbite is one of the most common manifestations of malocclusion in neurocclusion cases.

Humphreys and Leighton, in a deciduous dentition survey, concluded that deep overbite was more commonly found in Class II (Angle) cases than Class I. They examined 1,000 children from 2½-5 yrs. age group, 500 normal occlusion, 500 postnormal :-

<table>
<thead>
<tr>
<th>Overbite (greater than 3 mms.)</th>
<th>Postnormal Group (Cl.II)</th>
<th>Normal Occlusion Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>53.6%</td>
<td>33.6%</td>
</tr>
</tbody>
</table>

Ricketts after a cephalometric analysis considered Class II Division II (Angle) cases showed deeper overbite more often than the Class II Division I group.

Class III (Angle) cases are described as :-

i) true and pseudo - Strang, White et al.

ii) true and apparent - Salzmann.

iii) type I, II, III - Dewey Anderson.

The incisor relationship varies :-

a) practically edge to edge. The prognosis is poor and depends on the development of deep overbite in treatment.

b) mandibular incisors are crowded and lingual to the maxillary. There is usually only slight overlapping.

c) Maxillary teeth in linguoversion.

1. In the true cases the mandibular overjet (protrusion) is excessive and mandibular overbite is slight.

2. In the pseudo cases there is little mandibular overjet but the overbite is large and the jaws have the appearance of being overclosed.

It is concluded that Class I (Angle) and Class II (Angle) malocclusions are fertile fields for finding overbites of minor and extreme degree, that the incidence and depth appears to favour the latter and that the overbite is deeper in Division II than in Division I more commonly, acknowledging that Anglés
Classification per se does not embrace malrelationship in the vertical plane.

7. Age:

There is a preponderance of opinion that overbite depth varies with changes in the dentition associated with age, i.e. that occlusion is a dynamic not a static phenomenon.

Goldstein and Stanton have established clinically that in the common deciduous dentition there may be a deep overbite in the incisor region at 3-4 years of age. By 5 yrs. the overbite may be slight or even absent. With the eruption of the permanent incisors, the overbite again becomes deep due to relative increase in the crown length. The depth of overbite is lessened gradually as the deciduous molars are exfoliated and the premolars erupt, and will normally continue to diminish until the age of 15-20 yrs. when vertical growth of the jaws is complete.

Barrow and White's findings disagree. They have measured 528 serial casts of 51 children at yearly intervals from 4 to 17 years of age. They stated that the depth of bite remained very stable after the permanent incisor teeth had erupted sufficiently. Proportionately to incisor tooth size, the degree of depth of bite was very nearly constant throughout, i.e. the incisor relationship existing in the deciduous dentition can be expected in the permanent dentition. The depth of bite necessary to produce palatal impingement was 3-4 mms. in the deciduous and 3.5 - 7.5 mms. in the permanent dentition. True impingement cases have the overbite increasing through the range studied. The lower incisors are completely lingual to the cingulum. False impingement cases contact gingivae over the cingula and are met at 9-10 yrs. due to delayed eruption of maxillary incisors, and the depth of the bite did not increase after 11 years of age.

Dockrell et al examined 139 children of from 2 to 16 years of age in the Aran Islands where there is little population
movement and a restriction of hereditary and other influences. They agreed with all the other investigators in the early years that a decrease of about $1\frac{1}{2}$ mm. occurred probably due to attrition from 4 to 5 years. However, they substantiated Barrow and White's disagreement with the theory of general reduction of overbite by finding a slight tendency to increase, greater in females from 7 to 16 years. Dockrell however, considers his findings have no significance and attributes them to the highly-imbred and highly carious sample material and the great range of values - 10 mms.

Bjork examined cephalometrically 243 Swedish boys in two groups, aged 12 and 20 yrs. He found that, generally, overbite decreases somewhat with advancing age. The changes show a relation to the primary type of bite. Deep bites show a greater tendency to open than normal overbites, whereas open bites show a tendency to close. Bjork has emphasized that these changes must be considered in relation to the rest of the dentofacial complex and has drawn attention to the large individual variation both in degree and direction.

It is concluded that whilst deep (not excessive) overbite may improve up to the age of 20 years, individual differences are pronounced and treatment must be so visualized. Where the overbite is excessive it must be treated, even in the deciduous dentition if the soft tissues are being harmed.

8. The Problem:

In review, the overbite literature is disappointing. Expressed opinions of experienced clinicians far outnumber careful scientific studies. Some say this malocclusion has its drawbacks, some consider it the main 'bugbear' of their practice, and others state it presents no difficulties at all.

Treatment results of deep overbite have been quoted as:

i) 50% treated were given a satisfactory overbite.

ii) 25% treated were given a reduction of the initial deep overbite.

iii) 25% treated were given no improvement at all.
On the other hand, in spite of the retention difficulties, few failures appear in the orthodontic literature.

However, it is generally conceded that where excessive, overbite creates a knotty problem of considerable incidence and concern, necessitating careful case analysis.

II. THE FUNDAMENTALS:

1. Growth and Development.
2. Eruption of Teeth.
4. Bone and Bones - architecture and anchorage.

The limitation imposed by space prevents complete description of these vital subjects and brief mention will be made of trends of thought and disagreement.

1. Growth and Development:

A. Introduction:

Growth is a permanent increase in size, a pulsating process which shows marked changes in rate from time to time; "stretching" an accelerated spurt when a new outline is formed and "filling" a slower process of strengthening the newly-formed tissue.

The growth cycle of a particular part may be of short or long potential, is independent of, but interrelated spatially to an adjacent part.

The general metabolic growth rate diminishes steadily from gestation to maturity and there is no specific chronological age at which particular stages of growth need take place for normal growth and development. There must be synchronization among the parts e.g. alveolar growth accounts for the bulk of the increase in the vertical dimension of the lower face and ramus growth must co-ordinate to prevent vertical deviations, open or closed bite.

The close relationship of the parts in the growth of the body has been stressed.
Bjork's analysis associated the development of the body as a whole with the developmental bite tendency.

Hellman's studies indicated that the growth of the face is closely related to and easily measured by the differentiation of the dentition. The maximum development of the teeth precedes the maximum development of the other facial features. Developmental stages rather than chronological ages are more satisfactory in differentiation of the dentition.

B. Growth Pattern:

The degree of growth is the sum total of the factors of inheritance, pre-natal conditions and post-natal environment.

a. Inheritance:

Hellman made the first scientific detailed study of growth and development of the face. His account of the course of growth, the stages of development of the dentition and the variations in these events is standard and has never been surpassed.

Current orthodontic literature reiterates the contention that inherited growth pattern determines the form of the jaws and they therefore cannot be modified or influenced, and the effective influence of any treatment is restricted to alveolar bone.

Hellman says: "biology reveals a boundary of limitations within which our practice must be confined."

Jackson and Lundstrom agree: "the size and shape of the basal bone is determined genetically and cannot be altered."

Mershon concurs: "in correcting malocclusion the only change we can make is in the alveolus."

In 1931 Broadbent published his cephalometric technique: "it is convincing that granting the correction of malarticulation of the teeth which is accompanied by some change in the alveolar process, there is little alteration in the body contours.

In 1938 Brodie used the cephalometer to appraise the results of treatment of all classes of malocclusion."
The startling finding was the inability to alter anything beyond the alveolar process. We began to hear of a basic pattern which was unaltered except for those changes one might expect from growth. Therefore, it became apparent that quantitative growth analysis was necessary.

Brodie studied 21 normal children from 3 months to 8 yrs. of age with headplates, quarterly during the first year, semi-annually from 1 to 5 years and annually thereafter. The regularity of growth of the brain case with the lower border of the mandible stable with very little addition was startling.

The downward forward and outward growth pattern is aided by growth sites in the maxilla growing upward and backward against the cranial base.

Weimann and Sicher draw particular attention to the parallel arrangement of sutural sites of the maxilla resulting in downward and forward growth.

There are many references in the literature to orthopaedic thought and Wolff's Law that function determines form. Brodie agrees that architecture and function of bones are interdependent but he states that transplantations of bone anlagae show form is an hereditary transmission and concludes "form and proportion of the human mandible is early established and once established does not change." The position of the mandible in relation to the rest of the face and head, is an integral part of the pattern of the individual and just as unchangeable in form. There are specific genes for the inheritance of teeth, maxilla and mandible.
b. Environment:

Todd states "faces differ and most of us are content to assume that the differences are largely due to hereditary tendencies implicit in the genes. But as the face like the rest of the body is a plastic thing and since the adult contours are the end result of a growth pattern, which in the course of its progress may be expedited, interrupted, retarded, warped or inhibited by misadventures of health and by vagaries in the interplay of those organically organized influences by which the pattern is promoted, it is evident that environment external and more particularly internal must contribute in no small manner to the final result."

Functional factors such as nutrition, vitamins and hormones have been related to jaw growth by the work of Howard, Franke and McCollum who have shown that certain factors, some of them unknown, affecting nutrition and the functioning of the endocrine system, have produced clinically recognizable symptoms, accompanied by alterations in facial bones and contours.

Waugh considers the Eskimos' large jaws and regular teeth are due to their masticatory habits. On the other hand some African tribes have similar well-developed masticatory mechanism on a diet requiring little or no mastication.

Wolff's Law has been interpreted widely that mastication plays a part in evolutionary changes in facial contour.

Jansen has shown by actual demonstration that pressure provides a formative stimulus for bone and that where there is tension alone we find no prominence but a groove. His findings do not coincide with Oppenheim's epochal work.

Breitner has published microscopic proof of bone transformation, induced by altered muscular forces, in areas other than the alveolar process, such as temporo-mandibular joint ramus, angle and lower border of the mandible. He points to the generally accepted biologic laws of Darwin and Russell not supporting the immutable jawbone theory. Breitner claims he
has substantiated Angle's great postulate. Many consider that Breitner's evidence is not clearly seen histologically, is too minute to be of clinical significance and cannot match serial X-ray evidence.

But it is to Schour and Massler that we are indebted for newer knowledge of the effects of temporary inhibitions on the normal growth of the facial and dental structures. Using vital staining methods they have come to important conclusions that have a direct bearing on orthodontic limitations. They have shown that the pattern, number and size of teeth are determined by the fifth year of life.

Both Brodie and Broadbent corroborated this finding though they differ in their opinion concerning the exact time.

Schour and Massler say that the teeth are less affected than eruption or growth by endocrine disturbances.

Brodie with serial X-ray films of the human face and injections of alizarin red in monkeys, studied the behaviour of normal and abnormal growth patterns. He concluded that adverse constitutional factors operating can only affect the sites or processes active at that time. Where all growth centres are active there can only be a generalized arrest which will lead to failure of attaining optimal size as there is no compensation by subsequent acceleration of growth of the affected parts.

In abnormal growth cases, e.g. ankylosis, micromandibular development or craniofacial dystosis, these deformities show the usual growth pattern superimposed on a distorted blueprint or form of the part.

**C. Dental Arches:**

Teeth have been considered an important factor in the development of the arch size and shape.

On the basis of thousands of skulls measured Bonwill and Hawley predicted an ideal arch form, and Gilpatrick a desirable intermaxillary molar width.
Hyde however claims that the teeth of today are larger than the teeth of earlier times and the lack of arch compensation predisposes to malocclusion.

Brash studied the growth of the alveolar bone and its relation to the teeth including eruption from observations on madder-fed pigs. This is a most valuable contribution to growth understanding.

Todd says growth involves three concepts:-
(1) increase in dimension.
(2) increase in proportion.
(3) adjustment of the parts.

Hellman says there is an increase in size in three directions :-
(1) vertical.
(2) transverse.
(3) antero-posterior

and that the same planes at different levels grow at different rates.

Brash showed alveolar growth by surface opposition to be the main and possibly sole factor in the depth of the body of the maxilla and mandible and he maintained that constant additions to the walls of the alveoli gave tooth movement. The alveolar arches could no longer be regarded as stationary and unchanging. There is a state of change and growth in three directions. Differential rates of movement in these directions will bring about the changes to be observed in normal development of the alveolar arches. A disturbance of these movements, however caused, will readily account for anomalies in the shape of the arches and in the position of the teeth.

The method of growth of the dental arch and the period in which it occurs have been much investigated.

a. Period of growth.

Cohen investigated 50 normal children from 2 to 6 years by measurement and found a wide variation in arch development,
and individual children often depart from the pattern described. He also found a sex variation.

Hellman points out the clinical implication of the growth period. He considers it better to have treatment coincidental with growth for easier and better results than a policy of "the nature and extent of the imperfection determine the time treatment should be instituted." He has compiled developmental tables and prefers to delay treatment if possible, if development is retarded according to his tables.

Strang agrees that treatment is influenced by differentiation of the dentition and growth of the face and in some cases advises retention till 18 to 20 when all growth is finished and no more help can be expected. Tweed has mentioned that he doesn't like to extract premolars in some cases till 12 yrs. when no more growth can be expected laterally.

So there are vague general references, and particular periods of growth in the individual case are clouded as Brodie states, after two cephalometric surveys from 3 months to 8 years and 8 to 17 years:—

"Variation is the invariable rule not the exception." Tooth eruption is variable, and though averages show harmony, individuals are frequently out of step to a marked degree. Newborn infants begin at the same level of development but there may be a difference of six years in the eruption of the second molars.

Jaw growth is variable. Some attain most growth by the age of 15 and others not till 21 years. Slow growth must be allied to slow eruption of teeth and early eruption with precocious development if all is to be well and malocclusion averted. Bones and teeth vary in size in different individuals and furthermore teeth are immutable and realize their full size in the mouth whereas bone slowly enlarges and is subject to modifying factors.
b. Method of Growth:

Three theories have been presented for the development of the jaws:

i) due to the development of the teeth.

ii) due to muscle activity and occlusal stresses during mastication.

iii) spatial relationship.

i. Tooth Eruption.

It was generally maintained by early observers that there is a sort of "wedging apart" of the jaws when teeth erupt; the opinion of Brash Hallman and Strang is supported by the evidence of Gottlieb and Orban which appears convincing. They illustrate intermaxillary space developing from the eruption of anteriors. Schour and Massler support the view. In pituitary deficiency, tooth eruption is affected, the jaws are not spread apart and the vertical height of the jaws fails to increase. Broadbent's opinion differs only in the first 2 years of life. In his composite cephalometric tracings from 1 month to maturity a considerable intermaxillary space exists i.e. a centric contact relationship is attained after 2 years of age, as the rest of the tracings show. Broadbent interprets this, as indicating there is sufficient intermaxillary space in the first 2 years for vertical growth and clinical eruption but from then on, wedging of the jaws occurs by the force of eruption.

Baker claimed support for Keith's theory by removing the dental pulp from teeth in animals resulting in severe growth changes in the planes normally traversed by the erupting tooth.

ii. Muscle Activity.

Scott has found in dog experiments that most growth is in the region of the attachment of powerful muscles and he supports Thoma who points to anodontia and ankylosis evidence. The jaws fail to develop in early acquired ankylosis with muscle function reduced to a minimum.

Many cases of partial anodontia are reported but complete
congenital absence of the temporary or permanent teeth is rare. Ivy Warr and Battersby reported cases where no significant impairment of jaw development was present. Cautley and Nager showed jaws underdeveloped.

iii. Spatial Relationship.

Cohen has presented additional evidence that the teeth and jaws develop independently of each other. He studied six cases, two normal occlusion and partial anodontia cases, two complete anodontia (ectodermal dysplasia) cases and two pituitary dwarfs. Cohen concluded that, during the early years of life, the downward growth of the temporal bone and ramus creates the intermaxillary space. Brodie has found that the lowering of the entire mandible in the first five years is contributed to by temporal bone down-growth. Thereafter intermaxillary space is provided for the eruption of the permanent teeth by growth in ramus length alone. Apposition of bone gives vertical jaw growth and ramus growth must continue till all the teeth are erupted with the maxilla and body of the mandible reaching full development.

Diamond has advanced the theory of the ramus being the pacemaker and that lack of ramus height was responsible for deep overbite. He studied twelve cases of submerged first permanent molar teeth which he claimed was due to a lack of intermaxillary space from lack of ramus height.

Wylie roundly condemns Diamond's theory. He found no difference in ramus height in slight and deep overbite cases. Wylie illustrates also cases of micromandibular development and condylar resection to prove his point. He quotes Brodie's work on constant growth pattern and Brodie and Thompson's constant rest position to refute Diamond's theory of misadventure of one part. It is concluded that an inherited spatial jaw relationship is maintained and it would appear that alveolar growth is responsible for most of the vertical increase in the jaws and that co-ordination between the various sites of facial growth is responsible for maintaining the proportions.
D. **Vertical Height and Profile Changes:**

Hellman after measurement of 1,200 people from 5 to 25 years concluded that in transformation, the greatest changes are found in depth and vertical height.

There are two points of view concerning facial growth:

1. the face grows downward and forward and there is a constancy of pattern.

2. with growth the mandible becomes more prognathic than the maxilla and the concept of proportionate relationship between height and depth of the face is in error.

1). Brodie says the late stages of growth are accompanied by a downward and forward movement of the anterior nasal spine and pogonion while the dental arch tends to move more slowly and drop behind. The position of the incisors is not necessarily more upright. The chin point showed forward movement and the so-called straightening of the profile is an allusion.

2). Tweed has claimed a straightening of the profile on achieving a certain face plane angulation. Wylie, Stoner et al disagree with his premise but agree that growth does occur and emphasize his clinical ability. Bjork and Lande have stated the profile tends to straighten up with age. Bushra found sex variations. Felton and Elsasser consider Bjork's measurement on soft tissue could be faulty. They could not ascribe to either view after an extensive survey finding the profiles became more convex. Felton and Elsasser therefore consider treatment must be instituted and there is little hope of profile improvement with growth.

Wylie, Thompson et al have shown that facial height is independent of dental height. Wylie with Johnson have produced transparencies to assess vertical dysplasia and claim this is more accurate than standard means.

E. **Conclusion:**

1). Growth and development show an unfolding hereditary pattern which may be temporarily inhibited by ill-health or permanently restricted by deviation from normal endocrine
control. Those factors influencing the pattern may themselves be inherited.

ii). There is a lack of area, sufficiently stable in growth, to serve as a basis for judging denture normality. It is problematical whether such will ever be found.

iii). There is much yet to be learned about the potential of growth.

iv). Impressive is the marked consistency of individual pattern in spite of great variability between individuals. There is no statistical yardstick for case analysis.

v). Harmonious growth and development of all the parts; teeth supporting bone and musculature, is the basis of normal occlusion.

vi). The theory of "wedging apart" of the jaws by the eruption of the teeth, thereby increasing the vertical height must be discarded and an alternative explanation sought. Probably the degree of growth of ramus length, more than any other dimension, most markedly influences the vertical relationship of the teeth.

It is possible for ramus growth to be normal and subsequent alveolar growth to fail resulting in deficiency in vertical dimension i.e. closed bite.

2. Eruption of Teeth.

A. Introduction:

The concept of occlusion today is dynamic. The eruption of teeth is a co-ordinated part of growth and development and close relationships have been determined.

Hellman has classified stages of eruption by the appearance of certain teeth and related these stages by tables to various facial dimensions at these developmental stages.

Bjork has found that skeletal sturdiness is accompanied by earlier eruption of the permanent teeth.

Massler and Schour have related muscle action to the
alveolar process. In mouth-breathers with notoriously weak action of cheek and lip musculature, there is a relatively increased or supra-eruption of the clinical crowns of the teeth. Those with strong musculature and powerful bite show much less eruption of the clinical crowns of the teeth.

Weinmann has noted a similar pattern of eruption in the deciduous and permanent dentitions.

Important advances in knowledge of tooth development were:

i). Brash's experimental studies of alveolar bone growth and its relation to eruption.

ii). Gottlieb and Orban's recognition of continuous eruption.

iii). Schour and Poncher's quantitative analysis of the growth pattern of the enamel and dentine.

iv). Stein and Weinmann's histologic evidence for mesial drift.

B. Relation of the Gum Pads at Birth:

Clinch claimed that a wide variation in the relation of the gum pads existed in the newborn. No satisfactory correlation with the ensuing occlusion could be had, though Clinch felt that a space anteriorly between the gum pads in contact was normal and an absence indicated developing deep overbite. Sillman disagreed with Clinch's analysis as no consideration had been taken of rest position. He classified the space anteriorly between the gum pads and whilst he felt some types might develop deep overbite, he had to admit quite often normal occlusion resulted. Gottlieb also disagreed with Clinch and regarded complete contact relationship of the gum pads as normal and that vertical height is achieved by the eruptive force of the teeth.
From Balint and Orban:

Fig. I. The contact relationship between the endentulous gum pads at $5\frac{1}{2}$ months.

Fig. II. The intermaxillary space between the posterior endentulous gum pads with evidence of clinical eruption of maxillary first deciduous molar. Age 16 months.

Fig. III. Increased intermaxillary space between the opposing jaws. The first deciduous molars have erupted in occlusal relationship and there is evidence of increased clinical eruption of the anterior teeth. Age 21 months.

C. Process of Eruption:

Orban divides the eruptive process into three stages:

i). pre-eruptive.

ii). pre-functional.

iii). functional.

Atkinson has described how the permanent mandibular tooth buds begin their development on the upper border and are left behind as the deciduous tooth and buccal and lingual plates develop occlusally.

Stallard has pointed out how the maxillary molars swing into position on arcs of great curvature.

Broadbent has cephalometrically studied the third molar eruption. He has found the crypts of the developing
successive molar teeth occupy the same position and have a similar path of eruption. The first second and third mandibular molars migrate out of the ramus by a downward and forward movement. The root ends shift forward indicating an approach to its adult axial position (generally at 16 to 18 years with third molars) and they erupt from the body of the mandible upward forward and inward to wiggle their way into the posterior end of the arch.

D. Rate of Eruption:

Broadbent has pointed out:–

i) the growing tooth may remain stationary whilst its forming root grows from the incisal or occlusal surface into the bone.

ii) the tooth may migrate through the bone with little addition to its root length.

iii) the root length addition and migration of the tooth may occur simultaneously.

In 1944 Carlson studied the rate and amount of eruption of certain human teeth. He used the lower border of the mandible as a base line and measured serial X-rays at 6 monthly intervals over a 10 year period on 5 children with normal occlusion. He concluded:–

i) During the period of crown formation there was little movement of the tooth in the occlusal direction.

ii) Early stages of root formation, however, which follow immediately on completion of the crown show a downward growth of the root into the bone of from 2 to 4 mms. This is not accompanied by acceleration of the occlusal movement of the germ.

iii) After this small amount of root formation the entire tooth begins its most rapid phase of eruption. The whole root moves occlusally while the root end grows simultaneously. This rapid phase of eruption continues in most teeth until occlusion is reached.

iv) From now on the root is completed by forcing its way
down into the bone of the jaw.

v) Upon completion of root formation the entire tooth continues to rise in the occlusal plane. This substantiates Gottlieb's contention of perpetual eruption.

vi) The rate of eruption differed in different teeth. Similar mouths showed variations in different individuals.

Hoffman and Schour used vital staining giving a red line at the alveolar crest from which they measured to the cemento-enamel junction. They found :-

i) The eruption rate was greatest prior to functional occlusion.

ii) The eruption rate decreased with age.

iii) The eruption rate was not retarded by the appearance of the tooth in the mouth.

iv) The eruption rate was abruptly retarded when the tooth came into occlusion.

From Massler and Schour :-

Factors which may influence the rate of eruption.

<table>
<thead>
<tr>
<th>Local Factors</th>
<th>Constitutional Factors</th>
<th>Endocrine Factors</th>
<th>Nutritional Factors</th>
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<tbody>
<tr>
<td>Premature extraction of deciduous predecessor and loss of antagonist (+•)</td>
<td>Diseases causing an increased blood pressure and B.M.R. (+•)</td>
<td>Hyperpituitarism (+•••)</td>
<td>Tumor of adrenal cortex (+•)</td>
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<tr>
<td>Local hyperaemia (+•)</td>
<td>Prolonged fevers</td>
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<td>Periodontitis</td>
<td>Healthy (+)</td>
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<td>Coarse foods.</td>
<td>Robust</td>
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<tr>
<th>Acceleration (+••)</th>
<th>Normal (+•—)</th>
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<tr>
<td>Mechanical obstructions(—•)</td>
<td>Female</td>
<td>Hyperthyroidism(—•)</td>
<td>Fluorosis(—)</td>
</tr>
<tr>
<td>Impactions</td>
<td>Male</td>
<td></td>
<td>Vitamin A</td>
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<tr>
<td>Ankylosis</td>
<td></td>
<td></td>
<td>deficiency(—)</td>
</tr>
<tr>
<td>Bone or fibrous scar over crown</td>
<td></td>
<td></td>
<td>Severe</td>
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<tr>
<td>Retardation (—•)</td>
<td></td>
<td></td>
<td>Multiple</td>
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<tr>
<td>Badly twisted</td>
<td></td>
<td></td>
<td>avitaminosis (—)</td>
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<tr>
<td>root</td>
<td></td>
<td></td>
<td>Magnesium deficiency(—)</td>
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</table>
E. Theories of Eruption:

Numerous theories have been presented as causes of eruption and clinical observation, vital staining histologic and roentgenologic methods have been used. The theories naturally revolve about various changing histologic structures and processes that characterize tooth development.

The following theories have been advanced and from the evidence considered inadequate or not valid:

1) Growth of the root.
2) Growth of dentine and pulpal constriction.
3) Growth of and pull by periodontal tissues.
4) Growth of alveolar bone.
5) Pressure from muscular action on alveolar process.
6) Resorption of alveolar bone exposes the tooth.
7) Pressure from cellular proliferation.
8) Pressure from the dental pulp due to cellular proliferation, vascularity or both.

Vascularity of the periapical tissues is the most favoured theory of tooth eruption but not to the exclusion of other factors or theories as supplementary agents or sources of the eruptive force.

Brash considered that tooth eruption was subservient to alveolar bone growth. Hoffman and Schour's quantitative rat molar studies showed alveolar bone not growing as fast as the tooth erupted. Thoma takes the middle view and considers that teeth contribute to, but are not the primary factor in jaw growth.

Brodie has described interesting shedding and rebuilding of alveolar bone when the permanent dentition erupts.

F. Sequence of Eruption:

Delabarre describes eruption as a gradual unfolding time-sequence event and has arbitrarily divided it into five phases on a chronological basis.
Hellman is aware of the significance of eruption rate and eruption sequence in the production of deep overbite. He has described total erupting periods and rest periods.

The longest erupting period and a delayed rest period occurred in Class II Division II (Angle). Sex variations are described. Hellman says the rest periods are shorter in girls. Schour corroborated Hellman's explanation experimentally and found that girls teeth erupt at an earlier chronological age and a more rapid rate than boys. Hellman considers there is a pattern of eruption but individual variation is so marked as to invalidate comparison with mean tables. He also found wide racial variation. There was much variation from the general rule of lower teeth erupting first particularly with premolars and second permanent molars. There was also much delayed eruption particularly second premolar and lateral incisors.

Lo and Meyers studied the effect sequence of eruption had on malocclusion. They claimed:

i) In the maxilla the most unfavourable sequence is where the second permanent molar erupts before the cuspid and premolar.

ii) This was unfavourable in the mandible. Here also the cuspid erupting later than the premolars was undesirable.

iii) In Class II (Angle) cases there was a strong tendency for the maxillary molars to erupt before the mandibular.

G. Interference with Eruption:
The stages of tooth development are:

i) Growth.

ii) Calcification.

iii) Eruption.

A tooth successfully passing through stages i) and ii) is useless if stage iii) is interfered with.

Johnson Appleton and Fittershofer in 1926 described deformation of root apex in orthodontic animal experimentation. Gottlieb Urban and Kronfeld in developing dog molar showed the apex blunted when exposed to excessive force. Breitner has
placed caps on the incisors of monkeys. Schour and Massler reported the effects of high crowns on the permanently growing teeth of rodents as distinct from the teeth of limited growth such as monkeys and dogs. They reported that traumatic occlusion results in marked retardation and cessation of eruption. No histologic examination was carried out.

Kalmus examined by X-ray and microscope the capped incisors of guinea pigs. The disproportion caused between the eruption, attrition and growth of dental tissue resulted in the elongation of the crown and the displacement of the tooth. There was a subsequent increased functional demand upon the paradontal tissue and the transmission of masticatory force into the formative part of the tooth. There is a deposition of new bone on the inner and outer surfaces of the alveolar process. The delay in eruption with simultaneously continued normal growth of dentine in width and length results firstly in hypertrophy, and secondly in the folding of the dentine wall.

H. Continued Eruption of Teeth:

Gottlieb and Urban's recognition of continued eruption by deposition of secondary dentine was a most valuable contribution to understanding. Carlson Hoffman and Schour have substantiated this work. It is claimed that attrition compensates for the continued force of eruption which would otherwise elongate the face. Most authorities feel however that this cause-effect relationship could well be reversed. The incisor teeth of the rodent experimentally has been shown to grow at a rate unrelated to normal wear and natural grinding maintains the occlusal level.

I. Conclusion:

It is concluded:-

(a) that the eruptive force is not sufficient to increase the height of the jaws.

(b) that tooth eruption and bone growth are distinct though synchronized entities.
(c) that whatever the cause of eruption it seems to be situated at the apical area. The most likely cause is vascularity of the surrounding tissues. It will be necessary to conduct specially designed experiments to increase or decrease the tissue vascularity in animals, e.g. by reducing the blood supply to one side of the jaw or raising the blood pressure over a long period systemically, or locally, or both. Eruption may be the resultant of many factors.

(d) that individual variability has not helped to find a relationship between the period and rate of eruption in deep overbite cases. No evidence of shortened total period or altered rest period could be found to indicate that the anteriors erupted quicker or longer and the molars were retarded in deep overbites examined.

(e) that the expected changes in bite opening are based on the continuous eruption of teeth as long as they are in the mouth.

(f) that the eruptive rates of all the teeth, involved in bite opening, tend to return to normal as soon as occlusion again becomes effective, is to be expected.

It is interesting to speculate why this eruption does not occur without orthodontic interference in those cases with an excessive freeway space. Recent experimentation by plant biologists has revealed tremendous sap pressure generated in tomato rootlets.

III. AETIOLOGY.

1. Introduction:

Teeth are passive; they are the victims of the bones that hold them, the muscles surrounding them and the forces playing upon them, that make up the unique pattern for the individual.

During development the dento-alveolar structures grow vertically from dental bases which have a pre-determined relation.
The resultant of the forces between tongue and lips and cheeks direct the structures into a normal or abnormal occlusion. Soft tissue can modify dental base discrepancies to produce acceptable occlusion or can produce abnormal occlusion on normal bases.

A) The Factors Producing Abnormalities of Arch relationship are (1) Skeletal Morphology

(2) Soft tissue morphology and behaviour.

Johnson has shown a definite correlation between typical occlusal abnormalities (Angle) and fairly definite cranio-facial form in interpreting the Frankfort-Mandibular Plane Angle. Brodie suggests variation in the cranial base rather than the mandible in the etiology of some Class II (Angle) Malocclusions. He has further given a significant difference in the relationship of the condyle to the Frankfort plane in typical Class II (Angle) cases in both Divisions.

Elsasser and Wylie have related cranio-facial forms to Class II Division I (Angle) abnormalities.

In America the emphasis is on skeletal etiology. No attempt is made to relate labial segment abnormalities with lip and tongue posture and behaviour patterns. There is no reduction of abnormal muscle patterns. Margolis is investigating lip pressure. Thompson, Brodie and Noyers are working on muscle action.

B) Physiology of Production of Normal Occlusion:

The factors are almost entirely genetic in character: -

(a) Size of tooth relative to size of dental arch - most important.

(b) Relation of jaws to each other antero-posteriorly and laterally by pre-determined jaw morphology.

(c) Path of closure - from rest to occlusion - elevators relax.

(d) Position of developing teeth in the jaws.

(c) Musculature - tonus, posture and function.
Tooth size is unchangeable whereas jaw growth, but not pattern, can be diminished by illness, lack of function (improbably). Jaws cannot be made to grow larger than their genetically determined size excepting gross pathology and endocrinopathies. Stockard in his work on inheritance of skeletal pattern has distinguished a flat and a wedge-shaped face with distinct jaw patterns. The undershot lower or overshot upper jaw is "a disharmony that can be registered among those ills resulting from type and racial hybridization" according to Stockard.

2. Skeletal Morphology:
   A. Cranio-facial.
   B. Dental.
   A. Cranio-Facial:
      (a) Size, Shape and Position of the Jaws:

      Since Angle postulated his great concept of normal occlusion and classified malocclusion many have sought by measurement of models and skulls and cephalometric X-rays to prove or disprove that discrepancies in the relationship of the parts would give rise to the malocclusion.

      Brodie's work on immutable growth pattern has lead to the discarding of the theory that disruption of growth would cause a local dis-relation. Wylie agrees that an over-all disturbance would occur but stresses the importance of inheritance, the infinite variety of nature which has little regard for the going together of the parts giving:-

      (a) Malrelationship of the teeth in the arch, one to another.
      (b) Malrelationship between the teeth of one arch to those of the other arch.
      (c) Malrelationship between the bony bases of the jaws.
      (d) Malrelationship between the dental arches and their respective bases.

      Downs' analysis gives ten standards to appraise the
facial pattern and relate the teeth and alveolar process to the facial skeleton thereby determining areas of disharmony.

The skeletal pattern of the front of face, relating maxilla to mandible and both to the cranial base, have been given by Graber - ANB, SNA and SNB.

Dockrell has listed the site of the primary abnormality as the cranial base, maxilla, temporal bone (glenoid fossa) and mandible. The part can be affected as a whole or the alveolar process or the teeth by increase or decrease in growth forward, downward or laterally affecting the position shape or size.

A review of the fairly extensive research literature provides the reader with little that is generally accepted. Conflicting reports are given on almost all of the variables studied.

I. Mandible.

1. Length.

Blair Adams Renfroe Braun Schmidt and Young found no significant difference between Class I (Angle) and Class II Division I (Angle) Mandibular length. Blair stresses the high degree of variability of the facial skeletal pattern in each class of malocclusion studied.

Craig Dunn Gilmore Hellman Nelson Elsasser Mitchell claim the Class II Division I (Angle) mandible is shorter than the Class I (Angle). Wylie demonstrated a sex variation and Higley an age variation. Altemus considers the Class II (Angle) mandible longer.

In 1931 Hellman by measurement said the Class II Division II (Angle) mandible was normal and Benson has queried whether the division really exists. Adams has found no difference in the divisions though Blair considers the Division II mandible shorter than the Division I.

2. Height.

Hellman states by measurement the Class II (Angle) mandible has less height. Young, using calipers agreed for
girls but found boys normal. In Class III (Angle) Shoemwetter
records height less at the molar region and greater anteriorly.

(3) Size and Form.

Wylie stresses the variation of the individual. Normal
size and form can be combined unfortunately. "Good" faces show
some balance of combination. Cohen agrees, the variation shown
in the cranio-facial complex clearly indicates no rigid
combination of small or large mandibles or other factors that
could be associated with any particular malocclusion. Higley
gives the mandible as normal in size and form but posteriorly
placed by a combination of :-

i) condyle being up and back in the fossa.
ii) fossa up and back in the skull.
iii) body or ramus or both too short.
iv) mandibular teeth distally placed or maxillary
posteriors mesially placed.
v) gonial angle too acute.

(4) Position.

The mandible is posteriorly situated in relation to the
brain is the opinion of Baldridge, Renfroe, Riedel, Myers.
Craig claims the anterior segment is at fault and Drellich the
body is in error in Class II (Angle) cases. Gilmore's and
Blair's view is that the position is normal.

From a comparison of NS-6 year molar and NS6n Brodie
concluded that the Division I mandible was posteriorly placed
and that the readings and frequent appearance of a bony shelf
at the chin point in Division II cases, indicate that the
mandible is normal and the arch and teeth are posterior in
accordance with Hellman's findings. Blair states the Division
II mandible is forward, and Renfroe thinks the maxilla anterior
in Division II.

Brodie has found the distance between the maxillary
tuberosity and the glenoid fossa unusually long in the Division
I cases and points to a possible etiological significance.
Breitner claims extra-alveolar bone changes positioning the mandible forward are possible. Lundstrom, Broadbent, Brodie strongly disagree with Breitner.

Fischer considers the position and inclination of the mandible depends on ramus height, glenoid fossa position and length, shape and origin of musculature. Mitchell has found the ramus shorter in Division I and Renfroe and Blair think the lower border of the mandible is more horizontal in Division II. Swann is of the opinion that Division II is a problem of development of maxilla and the eruption of maxillary teeth rather than a skeletal dysplasia as in Division I. Baker and Baume agree that eruption sequence (of canines and premolars) affect the formation of the overbite. Baume emphasizes that lack of forward growth of the mandible in the transition period of change from deciduous to permanent dentition is a potent factor in determining the degree of overbite, and that the degree of deciduous overbite seems important in the determination of permanent overbite.

II. Maxilla.

(1) Length:
Elsasser and Wylie has described the maxilla as longer in Class II Division I (Angle) males than Class I (Angle) males.

(2) Height:
Hellman in 1939 presented a sufficiently-sized study of normal and malocclusion cases. He found that Class II (Angle) cases exceeded the normal in the vertical but were less in width and depth, though admitting of great variability. The maxilla was more often greater in height in Class II (Angle) cases.

Young substantiated the findings for boys and girls using measuring calipers.

(3) Position:
Bjork gives three main causes of maxillary overjet and overbite:--

1) A relative difference in basal prognathism
(a) the relative size of the jaw bases
(b) the relative position of the jaw bases
   (i) long cranial base
   (ii) relatively straight cranial base
   (iii) ramus inclined backward
(c) mobility of temporo-mandibular joint.

2) A relative difference in alveolar prognathism.
3) Incisor inclination.

Facial prognathism as distinct from alveolar prognathism may occur:

1) due to a shortening of the cranial base.
2) due to an angular deflection of the cranial base.
3) due to changes in the shape of the facial skeleton which cause the angle formed between ramus and cranial base to diminish.
4) due to increased jaw length.

Todd and Bjork have described a tendency for diminution of facial prognathism as an evolutionary trend, the maxilla being more affected resulting in a less convex profile.

Lande after a cephalometric analysis said that alveolar bone growth did not keep pace with the growth of the bases in a horizontal direction. Graber has pointed out that facial type whilst related to the degree of maxillary protraction can vary independently with race type etc. Strang states that alveolar and basal prognathism tend to be concomitant. Bjork considers the relative differences between the length of the jaws of far greater significance in the production of overbite than changes within the occlusion itself.

Fischer considers that three-quarters of Class I (Angle) malocclusions are due to a forward growth of the maxilla.

Baldridge and Oppenheim completely reject this view. Wylie has described a more forward anterior outline of both jaws in Class II Division II (Angle) Hellman states there is an
anterior drift of the alveolar process thus causing the maxillary teeth to be in mesial relationship in Division II.

Blair on the other hand says there is a slight forward positioning of the maxilla in Division I and that the dentition is responsible for the discrepancy.

Renfroe showed the maxilla was posteriorly positioned in Class II (Angle) cases. Riedel found no variation from normal.

(4) Conclusion:

It is difficult to reconcile many of these findings. Some of the differences might be explained by an analysis of the sampling. Choice of the control group may be an important factor, one cannot compare findings using "excellent occlusion" control with Class I (Angle) malocclusion control.

Of the literature cited, Drellich Gilmore and Elman used the former control.

Age and sex differences have been ignored by Adams, Renfroe, and Baldridge. There was a 5 to 6 year difference in the control and study group of Elman and Drellich.

Recent studies by Bjork on growth indicates that changes in the antero-posterior relationship due to growth can occur in the ages of the samples. Compensation made for sampling and method differences do not explain age differences in the findings.

Craig Elsasser and Wylie groups were well controlled as to age, sex and other variables. Yet with a similar method each gave widely different results. This might be due to the considerable variability in each single class of malocclusion being great enough to mask any real skeletal differences. Further a classification of malocclusion might not divide the sample into well defined patterns.

Minor or diverse differences in Class II Division I (Angle) and Class I (Angle) have been reported suggesting that the lateral as well as the antero-posterior dimension might need consideration or the antero-posterior discrepancy is restricted largely to the dentures.
(b) **Vertical Height.**

Hellman says the rate of growth is highest in the antero-posterior direction, next in the vertical plane and least in width. Hemley blamed sub-clinical metabolic disturbances causing muscle hypertonicity or weak bone cells or both.

Dunn considers improper mastication main factor in lack of vertical height.

Hellman, Schour and Massler attributed the vertical jaw growth to a wedging apart action of the erupting teeth. Under these conditions the treatment objective for deep overbite is the elevation of posterior teeth to force the jaws apart, and in keeping with Angle's concept every tooth had a definite place and role in jaw development, and only then with full function could full development be expected. However the influence of hereditary and environmental musculature has modified this simple approach. Brodie in 1941 proved the constancy of the nasal spine to the lower border of the mandible on 21 normal males from 4 months to 7 years and said that the teeth were of minor importance in vertical development of the face as the relation of the mandible to the rest of the face is established before eruption. In 1944 Wylie after a cephalometric survey of 29 individuals with malocclusion found the vertical height of orthodontic patients less than the general population in occlusion and at rest. Therefore the position of the teeth is not the only operative factor, otherwise differences would be obtained between the groups only when the jaws are closed.

Individual for individual there is a high correlation between vertical height in occlusion and at rest i.e. in the majority the freeway space is established early in life by a morphogenetic muscle pattern that is individual and the buccal teeth erupt to a position compatible with that jaw relationship so as to permit a normal freeway space. In six cases of the
twenty nine, about 20%, for reasons not clearly understood the posterior teeth had not erupted to the extent permitted by the musculature. Bjork on the other hand has found no difference in face length in those with normal or crowded arches. Sarnot has substantiated the case for musculature controlling vertical height of the jaws by illustrating a constant relationship of mandible to cranium in complete anodontia. McKair advocates intervention where face height is lacking and points to treatment possibilities by stating the greatest amount of vertical facial growth occurs in boys from 12 to 13 years and in girls one year earlier. Sleichter emphasizes Thompson's rest position is the natural one and that increases in jaw height gained by a bite-plate at the expense of freeway space would not therefore affect face height.

**Face Height:**

Johnson studied the relationship of the Frankfort Mandibular Plane Angle to total face height and condylar angle. He reported that when the FMA is large the condylar angle is large, as is also the total face height. The total face height is affected in faces with poor balance by excessive vertical development of the alveolar processes in the anterior segment of the denture. However, investigators have given varying FMA:-

- **Tweed** 25°
- **Downs** 21.9°
- **Riedel** 27°

Wylie has found total and lower face height significantly reduced in cases with medium and severe overbite. Dockrell related the deep overbite of the Aran Island children to their short face length. Bjork claims a negative facial height - degree of overbite relationship.

(c) **Ramus Height.**

Strang has given ramus height as an etiological factor, many overbite cases being due to a failure in condyle growth centres giving a too short ramus. Clinically it is considered
there is a direct relationship between mandibular length and ramus height, and the ramus has received little scientific attention. Diamond has focussed interest here with a controversial article stating the ramus is the pacemaker in growth and development of the facial height; metabolic disturbances cause delay in ramus height and therefore a lack of face height. Wylie and others have condemned his viewpoint. Drellich claims the Class II (Angle) ramus is shorter but Craig found no difference between the normal and malocclusion, except for overall size variations. McNair in a cross-sectional study of excellent occlusions found ramus height increased 6.3 mms. in boys from 8 to 13 years and 10.9 mms. in girls from 7 to 13 yrs. Wylie found cases with deficient length of ramus but more than average freeway space and concluded that whilst ramus height is important for facial lines there is no direct relationship with freeway space development. One realises more research is necessary to determine the normal range of growth spurt and when it occurs in each part so that any undue delay would be known.

(d) Rest Position.

I. Definition: 1. "The rest position of the mandible is the result of muscular co-ordination existing between post-cervical muscles and the groups lying anteriorly. The position of rest with the teeth slightly separated is maintained by the tone of the muscles" - Softly.

2. "That position of the mandible in which it is suspended involuntarily by the muscles of mastication constituting a co-ordinative balance of elevator and depressor muscles in tonus" - Ballard.

II. Measurement:

Thompson say 2-4 mms. is normal range of freeway space but may vary up to 10 mms. for the individual. Bright calculated arithmetical means for freeway space as 4.24 mms. in mixed
dentition and 3.31 mms. in a young adult group. Lundstrom has measured up to 12 mms. freeway space and goes to the heart of the problem by asking; "how can we judge the normal in such a wide range?"

### III. Head Posture.

Rest position of the mandible is now seen to be a position determined by muscular equilibrium which is a function related to maintenance of head posture.

![Diagram of Head Posture](image)

The rest position is modified by certain conditions:

(a) Hypotonicity - fatigue disease sleep.
(b) Hypertonicity - exaggerated function leading to spasm.
(c) Unconsciousness or deep anaesthesia - freeway space nil.
(d) Posture. It is necessary then to have the patient's head on same position for serial X-ray comparisons.
(e) Review of Literature.

Hellman and Weinberger deny the claims of those who believe that changes in mandibular angle and condyle neck occur through muscle pull when teeth are lost. Neiswonger and Gillis claim rest position constant. Tench and Mershon point out that muscle would limit any bite opening. Thompson and Strang emphasize importance of depression of anterior teeth in any deep overbite with lack of freeway space. Brodie and Thompson have pointed out that the proportions of the face as far as vertical height is concerned are constant throughout life. Pringle thinks that the rest position depends on the swallowing action. Those using the tooth apart swallow having the more open rest position.
Thompson and Brodie's work has focussed interest on the path of closure. Ricketts has shown the path need not be in an upward and forward direction thought of as normal. It can be deflected by the teeth in malocclusion or by the form and inclination of the articular eminence that Brodie says this makes questionable the common habit of viewing models in occlusion. A deep overbite with a large freeway space is a "filling in" procedure posteriorly rather than a bite opening. Wylie has shown there is a significant difference between total molar height in slight and extreme incisal overbites, the severe overbites being associated with decreased molar height. This suggests a hereditary factor which possibly limits permanent changes to incisor depression, which, however, Cole and Litowitz question. If freeway space were exceeded, eruption of teeth would be slowed as they came into full occlusion. This retardation would be effective unless muscular and skeletal growth progressed sufficiently to accommodate the treated occlusion.

Moyers has found some resist change in muscle pattern but others with orthodontic interference adopted a new neuromuscular pattern with a new rest position. Moyers has advanced electromyographic analyses as diagnostic aids showing the closure pattern may be altered by occlusal factors and that some Class II Division I (Angle) cases arose this way. Some Class II (Angle) cases are found to be Class I (Angle) in resting position. Dockrell queries whether the condyle is anterior in an effort to overcome abnormal occlusion, and suggests gradual joint changes lead to an increased mobility. Campbell considers Thompson's theory to be an overstatement. He thinks there is a certain stability in the position not an unchanging position.

Thompson's analysis of the rest position of sixteen children undergoing orthodontic treatment did not reveal the same high degree of constancy as the original work. Thompson
found slight variation in six cases and a high degree of variation in two cases which he thought was due to tipping of the occlusal plane by intermaxillary elastics. His experimental increases of vertical height and subsequent bone resorption was carried out on adults. Actively growing children who present for orthodontic treatment are in a completely different category.

(f) Conclusion.

i) It appears that the buccal teeth erupt to a position compatible with the morphogenetic muscular pattern.

ii) The majority of deep overbite patients exhibit a normal overbite at rest position with excessive freeway space posteriorly.

iii) Consideration of the path of closure would consider case analysis at the rest position as well as occluded models.

(g) Temporo-mandibular Joint Disturbances.

i. Introduction:

Rix says there is a strange increase in adults who suffer indefinite symptoms centred on the temporo- mandibular joint in Britain. Certain postural defects are resistant to ordinary orthodontic treatment but research may tell us in what direction it is specially advisable to concentrate to avoid later discomfort of the joint.

Batson found clinically an absence of :-

(1) frank ear disease
(2) erupting or diseased molar tooth.
(3) irritation in vicinity of palatine tonsils, that a complaint of pain in the ear was almost diagnostic of loss of vertical dimension of jaws.

In this regard a deep overbite must not be confused with a closed bite. A deep overbite may traumatize the joint by premature cusp contact causing posterior displacement in some Class II Division II (Angle) cases.

While pathologic processes of the joints are not acquired suddenly, unless caused by traumatic injury there are gradual
changes taking place within the capsule as the relation of maxilla
to mandible is disturbed in proportion to the position and number
of teeth lost. It develops slowly if the overbite is left
uncorrected or if molar support continues unrestored.

Campbell after studying 500 patients with facial pain
of an obscure nature, claimed 70% needed treatment by condyle
repositioning.

Costen's publication of his syndrome in North America
led to widespread bite-opening procedures to obviate the senile
changes and finally to an Editorial in the Journal of the
American Dental Association adding a hint of caution.

There is now, however, an increasing awareness in the
literature of young case reports, patients in their teens and
twenties. Campbell quotes distal retraction of the mandibular
teeth having to be terminated by patients complaining of severe
joint pains. Ballard and Grewcock say majority of cases are
in the 20-30 age group, mainly women. Goodfriend claims
abnormalities of dental bite probably influence 40% of all
deafness. In a group of 168 dental students, 55% had dental
malocclusion and the hearing of this group was 13% less than
that of the other 45%.

Stolzenberg treated patients of 20-35 years reporting
satisfactory bite opening from six to nine months in most cases.

Spitz considers bite-raising the province of ortho-
dontics when he declares: "it is biologically wrong to use
crowns or inlays to heighten teeth which have been hindered in
their proper eruption by a deep bite or some other cause. Such
submerged teeth must first be given the opportunity to erupt
by means of orthodontic treatment."

Campbell states the orthodontist can visualize occlusion
and can prognosticate the effect of inclined planes on later
removal of posterior teeth and thereby indicate where backward
displacement of the condyle may occur.
ii. Concept of Occlusion.

In the past, too much emphasis has been placed on occlusion as an anatomical static condition in which normal arch form, proper interproximal contact relationship, correct axial inclination and maximum contact of occlusal surfaces are the sole criteria of the ideal. However, the most important concept is one of function, a dynamic state in which occlusion is part of a functional system, the main parts of which are:

1. Musculature.
2. Teeth and supporting structures.
3. Temporo-mandibular joints.

Musculature:

Sicher adequately describes the individual muscles of mastication. However, it is important to visualize the muscles working in groups and not as individual units. The movements of the mandible are not so much directed by the shape of the articulating bones and articular ligaments but to a far higher degree by the play of the muscles.

The functional concept is stressed by Murlless. Contrary to appearance it has been shown that in a skull of harmonious proportions, the combined action of the muscles of mastication together with the buccinator each in its own direction joins to make a parallelogram of forces which is exerted quite independently of the temporo-mandibular joint and at approximate right angles to the line of contact of full normal upper and lower dentures. Where the denture is normal and complete and properly placed in a symmetrical skull the power of mastication is exerted upon the teeth in a direction which is nearly in line with their individual length i.e., parallel to the long axis of each. The teeth then in the normal denture are, in the act of chewing, pushed directly into their sockets and the condyle in function does not share this pressure with the teeth in function or at rest but merely serves as pivot point. Freedom of condyle movement depends then on functional relationship of
all these structures in which the presence or position of the teeth are an essential part. The force of occlusion is through the second molar in normal occlusion. However, as we all have some degree of malocclusion we all have some force through the joint leading to possible changes.

Harris stresses the skeletal nature of the muscle fibres i.e. tonicity depends on length of fibre. He illustrates diagrammatically in frontal section, that temporal, masseter and internal pterygoid muscle fibres are vertical and external pterygoid fibres are horizontal. With bite closure, the former fibres are shortened and lose tone and the external pterygoid fibres gain in strength. He quotes Wolff's Law of Orthopaedics and postulates changes in condyle and meniscus can therefore be expected.

Greene has demonstrated that the loss of a few mm's between tendon attachments will remove all tonus from the muscle involved, and that the temporomandibular joint tendon tensions vary more than any other joint in the body due to the great changes possible in vertical dimension from serious disturbance of the bite level.

Ballard states musculature represents the most unchanging and inadaptable part of the mechanism. Recent physiologists have little to add to Mershon's statement "muscles have the power to contract or relax, after maturity they cannot be lengthened, except as a result of surgery or disease."

(2) Teeth and Supporting Structures.

In normal occlusion Sichler shows the head of the condyle opposite the posterior slope of the articular tubercle and is not situated in the deepest part of the articular fossa. Harris states equilibrium is by tension of capsular ligament opposing muscle pull. Sichler however attributes equilibrium mainly to interlocking cusps of occluding teeth and the articular disc is an accessory support, filling the space between condyle head and articular fossa. Sichler explains constant position of condyle,
in varying fossa morphology as due to variations in thickness of posterior part of the disc making up the leeway.

Ballard says the teeth and supporting structures are the most labile parts of the functional mechanism. Disharmony during growth can develop between maxillary and mandibular teeth producing premature cusp contact during normal path of closure causing mandible to adopt a bite of convenience with an abnormal mandibulo-cranial relationship; a conditioned reflex most likely moves mandible from rest position direct to eccentric intercusping relationship without reference to centric.

Shoet and Ballard each list the obstacles to correct occlusion:

(a) teeth adjacent to unfilled space migrate, tip and those opposite elongate.

(b) elevated and interfering cusps so produced or from an overcontoured restoration prevent normal excursion of the mandible and in some cases, lateral or protrusive movements are prevented by the locking effect of the cusps of the teeth that have drifted or elongated; forward, lateral or backward displacement may otherwise occur.

Teeth and supporting structures resist stress uncommonly well, as shown by Kronfeld and Emslie.

3) Temporo-Mandibular Joint.

(a) Morphology:

The available evidence shows a confusion of thought, later described, which appears to stem from inadequacies of demonstration techniques; laminography holding out promise in the future and the diametrically opposed teaching, one school favouring orthopaedic principles of form and function going hand in hand. The other school quote T. Wingate Todd "Form does not follow function slavishly" and Angel "genes appear more important determinants than environment." Complicating the picture over all is the wide inherent "normal" variability of man.
Ricketts declares after laminagraphic survey that there was no correlation between size of condyle and size of fossa; some condyles appeared too large for their fossae and others too small. He further refutes Reisner's claim of correlation between type of occlusion and slope of posterior surface of the eminentia articularis; the joint i.e. condyle and eminence in the samples studied showed no tendency to adapt themselves to each other or to the occlusion in Rickett's opinion. The sample was very small and the technique new.

Benson in a careful survey involving reclassification over a long period showed the bite to be related to joint morphology. In deep overbite cases, lateral excursions caused bodily displacement of the mandible, which is reflected in deep fossa and excessive anterior lean of condylar head. With edge to edge bite, the eminentia flattened and there was an upright with tendency to posterior lean of the condylar head.

(b) Movements:

Ricketts admitting the wide variation in normal movements, gave four main deviations:

(i) excessive function i.e. range and position mainly in Cl. II Div. I (Angle).
(ii) displacement distally by incision of anteriors in Cl. II Div. II (Angle).
(iii) occlusal interference in excursion.
(iv) loss of posterior support.

Joint movements are well described in anatomical text books, however Sicher points out anthropological studies have shown the development of the mastoid process in man has necessitated a forward translation of the condyle for wide opening of the jaws. The ape has pure hinge movement, but because, in the human, the movement is necessitated neither by shape of the fossa nor by course of the ligaments, it becomes fixed as a neuromuscular phenomenon and each of the component movements can be enacted independently. Though following a pattern, the masticatory movement is as individualistic as his
gait, and depends on shape and position of the jaws and teeth. The pattern is persistently maintained but loss of teeth or changes in their position is followed by rapid adaptation of the movements to effect maximum affect with minimum effort. Eskimos show very rapid wear, giving increase in mechanical efficiency and the joint does not change.

Sicher claims the post-articular lip prevents direct displacement of condyle on tympanic bone. Ricketts disagrees stating the process is too small or too far above a low positioned condyle to have any effect. He found the condyle moved upward and backward predominately in Cl. II (Angle) cases whereas in Cl. I (Angle) cases movement from rest position to occlusion was with rotation centre at condyle neck. Normally the condyle travels forward to the tip or even beyond the articular eminence in wide mouth opening.

Robinson Sicher and Ricketts are agreed that too much emphasis has been placed on mechanical approach, i.e. condyle-fossa relationship. They consider the muscles almost solely responsible for the movements, which are dictated by the position and shape of the teeth. Since tooth positioning during eruption is dependent on jaw movement, interdependence is clearly recognised.

(c) Anatomy

The anatomy of the joint, the proximity of other structures and pressure possibilities have led to much controversy in the explanations of Costen's Syndrome.

The auriculo-temporal and chorda-tympani nerves and anterior tympanic artery are directly mechanically irritated according to Bleiker, Block and Harris. These are discredited by some investigators, who suggest stretching of capsule fibres and reflex irritation. There is generally conceded a close anatomic relationship of the parts.

Sicher says some authors seem to forget that a condyle can only move as a unit and only in unison with the other condyle.
(d) Abnormal Path of Closure:

Ballard defines the normal path of closure as the pathway taken by the mandible when it moves; almost a hinge from rest position to centric occlusion. Sicher defines centric occlusion as that position of the lower jaw in which teeth, temporomandibular joints and musculature are in perfect balance.

Ballard postulates:

(1) abnormal contact relationship of the teeth can produce abnormal path of closure.

(2) when abnormal patterns of closure result in significant distal displacement of the condyle as judged from true rest position, then joint disturbances may result.

(3) Individuals with abnormal paths of closure do not make the abnormal occlusal contact in ordinary masticatory movements but avoid them subconsciously - "habit movement".

(4) The abnormal contact is made in slow closure from true rest position and perhaps in idle moments night and day. These contacts produce the typical facets.

(5) Remove the abnormal contact and the individual rapidly reverts to a normal path of closure and forgets this habit movement.

(6) As a rule the individual is never conscious of the abnormal contact in spite of the fact that resultant displacement of mandible may be accompanied by severe pain.

(7) Abnormal paths of closure are frequently associated with some degree of overclosure or excessive freeway space.

Ricketts's work substantiates Ballard's explanation of joint symptoms from joint imbalance. Ricketts found the path of closure may not be in the upward and forward direction thought of as normal. He found in one-third of Class II (Angle) malocclusions, a wide freeway space and distal path of closure.
Eastwood analysed the articulation of a group from 3 to 11 years with excellent occlusion. He decided that changing dentition, eruption of teeth, growth of condyles and growth of musculature required or led to a wide range of variation of the position of the condyle in the fossa, and in the type of movement from rest to occlusion in the growing child. As the individual approached adulthood the condyle and muscle growth diminished and a more constant position of the condyle in relation to the eminence was noted. Furthermore, the path of closure approached hinge type, observed in the results of Boman, Alexander, Thompson and King after studying adults and Young adults with excellent occlusion. This is in keeping with our definition; however Hildebrand Posselt and Thorne have indicated in quite normal cases, there may be a slight upward and backward movement i.e. not really a hinge movement. If orthodontic treatment could be considered an additional environmental influence some compensatory adjustments in temporo-mandibular
articulation could be anticipated.

Ballard points to the work of Sherrington and Stewart and says the abnormal path of closure is not the mechanical result of abnormal occlusal contact but rather of abnormal occlusal contact—but rather—a reflex mechanism whereby abnormal contacts cause abnormal stress in the periodontal membrane; these produce afferent impulses which reflexly alter the neuromotor mechanism of closure to avoid this contact if the remainder of the occlusion will permit.

There appears to be a limit to reflex avoiding action. Pfaffman showed nerve endings to have uni-directional sensitivity thereby explaining some cases of traumatic occlusion. Bradlaw disagrees and claims a nerve anastomosis present.

The excessive freeware space associated with the many abnormal patterns of closure can be the result of the vertical component of abnormal muscle activity balancing the inherent vertical development of the dento-alveolar structures at an over-closed position in relation to the physiological rest position.
(e) Symptoms - Temporo-Mandibular Joint Syndrome:

After Costen:

(1) Pain in and about the ears.
(2) Stuffy sensation in ears.
(3) Dizziness.
(4) Crackling snapping noise while chewing.
(5) Tenderness to palpation.
(6) Headache.
(7) Burning sensation of tongue.
(8) Excessive movement of joint.
(9) Dryness of mouth and neuralgia.
(10) Tinnitus and diminished hearing acuity.

Symptoms are widely divergent and criticism can be directed towards inaccuracy of anatomical data and investigations carried out on cadavers in the absence of muscle tone. His appraisal of symptoms is generally considered sound but not his conception of cause and effect. Ballard states a more logical explanation of the symptoms can be found studying the pathology resulting from alteration to mechanical loadings of the joints in imbalance and the causal relationship this bears to the reflex neuralgia produced throughout the distribution of the trigeminal nerve. Brodie considers Costen's syndrome is not the result of a new position assumed by the mandible through loss of dental height but rather is induced by overclosure of the mandible in function. It can be more logically explained on the basis of neuro-muscular than mechanical conditions.

iii. Etiology:

(1) Ear Disturbances:

Many investigators report the anatomy of the area and the main theories as to cause of deafness are:

(1) occlusion of external auditory canal by condyle head.
(2) position of condyle head causes deafness by occlusion of Eustachian tubes from pressure on adjacent soft tissues.
(3) pharyngeal orifice of Eustachian tube is occluded by
decrease in tension of tensor and levator muscles. Ballard considers interference with lymph drainage of Eustachian tube a possibility.

Anatomists have been quick to refute these suggestions. Sichler states in overclosure the external auditory orifice is widened. Junemann has observed that the slightest movement of the mandible causes a dilatation of the Eustachian tube through a synchronous movement of the internal pterygoid muscle. Higley discounts the pressure theories stating a negative pressure exists in the fossa by biting on a hard object in the molar region. The greatest pressure site is the eminentia. Batson from observation on a patient who had lost his external nose, found great tension of the tube musculature at the normal vertical height. Flaccidity of the muscle chain in closed bite cases might be significant and the tube lack patency.

However, Batson strongly refutes improved hearing chains, clearly indicating the inadequacies of audiograms. Most cases of deafness are perceptive and an infirmity of age. To improve
decreased hearing acuity, we have a rare set of clinical conditions:-

(i) a definite conducive deafness.
(ii) absence of active infection and pathologic change such as old adhesions due to old infection.
(iii) absence of fixation of stapes.
(iv) definite evidence of hearing improvement in clinical adjustment of air pressure in middle ear by inflation.

Firm pressure in the pre-auricular area over the condyles as the patient opens and closes his mouth intensifies the pain. A simple diagnostic and prognostic procedure is to place cotton rolls between the jaws, patient bites firmly and often gets distinct relief.

Conclusion.

Much more research is needed into deafness. We still do not know how we hear. Further investigation into swallowing with relation to the Eustachian tube might prove helpful.

The decision to open the bite should rest largely on dental grounds, an increased intermaxillary distance does not increase hearing ability per se, but for reasons unknown relieves tinnitus and pain in the area.

iii. Etiology:

(2) Causes of Traumatic Temporo-Mandibular Joint Disturbances.

(a) Muscular.

Bruxism or forced grinding of teeth from muscular hyperactivity, habits.

There is a pathologic type of joint where the masseter and temporal muscles overpower the balancing external pterygoïd muscle. Get displacement and a snapping noise as the condyle rides over the disc which is in a normal position.

(b) Posterior Displacement.

Following condyle retraction, irritation of the vascular pad of connective tissue between the disc and posterior capsule
leads to neuralgia and progressive destruction of the synovial membrane.

Resistance of articular structures is lowered and there is a degenerative change of soft tissue and finally bone destruction.

(3) Changes in Bony Parts.

Harris in dissection of 50 aged cadavers found the condyle upright with the meniscus sitting squarely on top in good occlusion cases. He demonstrated changes in the condyle and showed the neck of the condyle had a decided bend, in the lower levels of loss of vertical dimensions.

In greater loss of vertical dimension, changes were in the glenoid fossa. The joint structures developed in accord with the development of occlusion since in no case of closed vertical dimension have the glenoid fossa structures presented a normal appearance.

Prentiss claims perforation. Conners and Fisk refute this, claiming the rubbing together of bony areas would produce a highly polished surface and not erosion. There is considerable diversity of opinion as to the areas of pressure in the joint during function. Pringle claims the eminentia gets great pressure on the balancing side and the centre of fossa gets great pressure on the working side, producing a decided central thickening of the disc.

Campbell considers a general lack of muscle tone is the etiological factor, giving a lack of posterior support by the external pterygoid muscle.

iv. Treatment.

(1) Restoration to normal occlusion.

Harris claims restoration of the muscle function would cause the condyle, neck of condyle and meniscus to straighten up. The only positive guide to normal restoration is the amount of freeway space. Patient appearance and comfort and a joint X-ray may assist analysis.
Shohet, in general, warns against bite opening in the extremely young in the presence of:

(1) root not sufficiently supported by bone.
(2) pathological condition.
(3) lack of co-operation.
(4) normal freeway space.

He gives effects of excessively opened bite as:

(1) stiff expression about mouth.
(2) abnormally long appearance of lower 1/3 of profile.
(3) loss of natural curve of upper lip which appears flat and stretched.
(4) Difficulty of taking large bites and fatigue of muscles and pain.
(5) Speaking with clenched teeth.
(6) Inability to assume physiological rest position.
(7) Absorption of alveolar bone, infraocclusion of posterior teeth and injury to pulp and periosteum, tooth loosening and pulp necrosis.

v. Conclusion.

Because of disturbing influences present during formation and tooth development, and detrimental changes after eruption, comparatively few reach ideal development. When deforming influences e.g. abnormal habits, metabolic disturbances have caused a loss of vertical dimension of the face there are evidences of an anatomic relationship which does not permit proper function of the mandible, tongue and adjacent anatomic structures.

Individual variation must be emphasised and shows the danger of accepting conclusions based on average values or from methods that do not accurately reveal conditions in the living. Isolated cases could lead to dogmatic statement, but when a large sample is studied there is scarcely a single generalisation that holds.
(1) occlusion is the basis for joint disturbances in the majority. The sacrifice of teeth as a step in medical diagnosis by exclusion is deplored.

(2) Musculature in the final analysis is treated in the correction of joint disturbances.

(3) We must bear in mind the synchronization and stabilization of musculature through the nervous system.

(4) Orthodontic treatment can prevent or aggravate joint conditions.

(f) Gonial Angle.
As pointed out by Benson, "Gonial Angle" is differentiated and "Condylar Angle" introduced.

Atkinson claims the angle as obtuse at birth coupled with a flat fossa and approaches a right angle later. He is corrected by Brodie who states the gonial angle is unchanging through life. The condylar angle shows variation as the condyle grows up and back. Benson has proved an inverse relationship between incisor angle and gonial angle, and gonial angle must therefore be considered in any analysis of incisor angulation owing to the wide variation in the latter. BIGLEY has agreed that gonial angle might be considered in treatment planning:

(a) Increases in Gonial Angle in the first seven years indicating departure from normal development might arise from:

(1) Forward migration of maxillary teeth and alveolar processes. The anterior component of force overcoming muscle and bone resistance. This results in increased overbite. The mandible has to be positioned forward for contact and increase in gonial angle and posterior slant of condyle head occur.

(2) Failure in ramus growth. Diamond has pointed out the time factor importance:

(i) In Early Years. Result is a deep overbite the teeth never having a chance to erupt.

(ii) At Eruption of Second and Third Molars. Results in open bite.
(iii) In Later Years. Increase in gonial angle results and also open bite if alveolar growth is insufficient to maintain incisal contact.

B. Decreases in the Gonial Angle. Dewey Anderson states the more right-angled the gonial angle, the more there is a deep overbite.

Gilmour found no significant difference in normal and Class II Div. I (Angle) gonial angles. Braun and Schmidt agree. However, Refroe, Jensen and Failing disagree, finding the Class II (Angle) gonial angle in each Division more acute than normal. Blair says the Class II Division II (Angle) gonial angle is more acute than either the normal or Division I Case. Dockrell has suggested a change in growth direction at the condyle carrying the lower incisor up and back, decreasing the gonial angle and deepening the bite. Such an approach is mechanical with no consideration of Nature's ways.

B. DENTAL.

(a) Size, Shape and Position of the Teeth:

Whilst variations in this manner have been given by Haberle as causing deep overbite:—

(a) labioversion of upper anteriors.
(b) underdevelopment or collapsed lower arch.
(c) distal relation of lower arch to the upper or mesial relation of upper arch to the lower,

there is disagreement as to cause-effect:

Bjork states that tooth and arch discrepancies are secondary to those of the jaws.

Blair considers the antero-posterior differences seen in Class II Division I (Angle) cases are restricted largely to the denture. Renfore found the maxillary denture more posterior but Baldridge Riedel Elsasser and Wylie showed no difference in the relationship of the dentition to the maxilla in a Class I (Angle) and Class II (Angle) cephalometric survey.
Attempts have been made to relate facial profile to occlusion. Facial types have been shown with normal or malocclusion. Fischer points to the backward divergent face being less likely to allow correction by labial movement of lower anteriors.

Lindergard has related the size of the teeth and the dental arches with skeletal sturdiness and length factors.

Further studies are necessary to relate cusp height to the depth of overbite and McCoy has emphasized the importance of the inclined planes maintaining a normal or abnormal occlusion.

1) Eruption of Teeth.

Lewis has described the condition of ectopic eruption, the permanent tooth germs becoming displaced before eruption.

Brodie has revealed there is a rebuilding of alveolar process when the permanent teeth erupt, the deciduous alveolus is shed. The amount may be as much as 7 mm. which has to be rebuilt and more, over a 3 to 4 year period to regain the amount lost. In some cases the posterior alveolus rose only 1-2 mm. and in others 10-11 mm. beyond the former level. The major part for increased growth was the incisal region and this would explain the deep overbite found commonly in deciduous dentitions. Brodie doesn't know why the deciduous molars lag behind but he found that early biteplate interference was beneficial. Diamond considers that retardation of ramus growth length submerges the posterior teeth. The longer the retardation the greater the anterior overbite which inhibits forward growth of anterior mandible.

The period of replacement of the deciduous incisors and canines is probably the most critical stage through which the dentition goes. The lips and cheeks have been adapted to the size of the primary arch and their neuromuscular reactions are so conditioned. The muscles are attached to the very bones on which we are depending for increase in size. Any growth slowness will give a muscular pattern too small for the child's age or for the eruption of larger teeth. The permanent germs
are formed deep in the bone which is cleared away to allow them to erupt. Any lagging in growth will result in the permanent germs endeavouring to come up into an arc which is too small to receive them.

Tooth alignment has been described. However, the greatest etiological factor in overbite production acts by the very absence of the tooth.

ii) Loss of Teeth.

(1) Deciduous Molars:

When only the maxillary deciduous molars are extracted there may be a pseudo-mesio-occlusion, manual retrusion of the mandible being possible. If the permanent maxillary incisors are allowed to erupt and remain in lingual occlusion a true mesio-occlusion may result. If only the maxillary or mandibular deciduous first molars have been extracted, the acquired mesio-occlusion will not show closure of the bite as the second molars will maintain the occlusal height.

The premature loss of the maxillary deciduous molars leads to mesial migration of the maxillary first permanent molar and increased overbite.

In the mandible, premature loss causes the first permanent molar to tip with a little migration but the anterior teeth fail to develop as far labially as they would have done due to the lack of anterior force component and this results in increased overbite and sometimes overjet.
There is a resultant arch collapse, a lessening of the inter-canine width and incisor imbrication. The results are more severe if thumb-sucking or abnormal swallowing is superimposed leading to a Class II (Angle) malocclusion of either Division depending on the muscle action. In both Divisions the deep overbite may continue to develop till the incisal edges of the lower anteriors contact the palatal mucosa.

It might be possible to gain space for the canine and premolars by uprighting the first permanent molar and proclining the lower incisors, correcting the overbite. Third molar extraction may be necessary to make room for uprighting the first permanent molar. In others so much space is lost that extraction is necessary.

Baker, Chapman, Humphrey, Ungar and many others have claimed the early loss of deciduous molars in the most prevalent of all etiologic factors and stressed the importance of their being retained.

(2) First Permanent Molars:

When the first permanent molars are lost and no treatment is undertaken the resultant migration and variation of growth results in an increased overbite as shown.

**RESULT OF LOSS OF FIRST PERMANENT MOLAR**

(b) Permanent Molar Relationship.

1. Upper First Permanent Molar:

Acts to increase overbite by loss or mesial drift. Pringle analysed casts in 1936 and found deep overbite present in 70% where lower teeth lost and in 80% where both arches suffered loss.
It is interesting to note that loss of first permanent maxillary molar was associated with deep overbite in a very small percentage of models.

The position of this tooth has been of vital interest since Angle postulated its constancy of position and Atkinson offered the key ridge in its stead.

(1) Normal Position: We know now from Stoller that the mesio-buccal cusp occludes distally to and not in the buccal groove of the mandibular first permanent molar. Mesial axial inclination is shown with the disto-buccal cusp well down in the lower embrasure. It stands out to give a distinct buccal offset.

(2) Forward Movement:

Henry has described three positions of the maxillary first permanent molar and has found rotation indicating a tendency to mesial movement in 83.5% of the measured cats. Stallard agrees that the posterior teeth have the greatest forward movement tendency. Hemley considers this is a tipping action. Dewel disagrees. Henry found as a rule bodily movement occurred. The lower molar is mesially inclined usually in deep overbite cases and the upper molars tend to align themselves with the lower molars. This points to bodily distal movement rather than tipping as the correct treatment.

Elsasser and Wylie found the upper first permanent molar forward of normal in Class II Division I (Angle) cases. Shoemetter describes the molar more forward in Cl. III (Angle) malocclusions than in Class I or Class II (Angle).

Fischer finds the molar in a mesial position in two-thirds of Class II Division I (Angle) patients.

Strang says that perverted swallowing can cause mesial tipping of buccal teeth.

Swinshart shows the molar forward on the side affected by thumbsucking.

(3) Stability:
The first permanent molars usually have unrestricted space for eruption and does not require the co-ordinated resorption of
any preceding teeth. Impaction can occur from mesial placement of the permanent teeth or failure of mesial growth of the maxillary arch.

Denture balance is maintained through normal proximal contacts and harmoniously distributed forces. It would appear that tooth drifting after extraction is the result of bone re-organisation to restore the denture balance. With the loss of deciduous maxillary molars, the whole upper arch may be drawn forward and an abnormal lip function to worsen the deformity might be produced. There is greater forward movement of the maxillary arch if the mandibular molar is in distal relationship. Mesial drift would appear possible without disturbance of axial inclination.

Baldridge from NS - upper first permanent molar measurements could demonstrate no differences in Class I and Class II (Angle) malocclusions.

Elman studied the relationship of the upper first permanent molar to the Y axis. He showed that NS - upper first permanent molar angle opens steadily till in occlusions. Elman strikingly states from then on an identical or very close relationship between NS-GN and NS - upper first permanent molar is formed and the tooth is found on the Y axis till 8 years of age and even so persisting in later age groups.

Brodie after analysing the same angles in Class I and Class II (Angle) malocclusions concluded; "Thus it is seen that the upper six year molar is not the will-of-the-wisp it has been called. It consistently yields the lowest standard deviation of any of the facial measurements. From the stability shown it is still possible to classify according to the relationship assumed between them and their mandibular antagonists.

ii. Lower First Permanent Molar:

The importance of this tooth has long been emphasized. Wylie has noted a deficiency of molar height which he considers is hereditary in deep overbite cases. The dimensions of the
underlying facial structures are continuous variables. The occlusion of the teeth may be considered a discontinuous variable. When the first permanent molars erupt into occlusion there is an interdigitation of cusps by which the opposing teeth tend to settle into one another by continued mastication. The adjustment for this precise setting takes place in the alveolar process and temporo-mandibular joint. Two individuals with practically the same cranio-facial make-up and measurement could easily fall into different occlusal relationships and be classified as either Angle Class I or II.

Elman has claimed a stability of the lower first permanent molar in Class I (Angle) and Class II Division I (Angle) cases studied. He gives a constant $3/2$ ratio of horizontal/vertical distance from the mandibular borders.

Blair studied forty Class I, forty Class II Division I and Twenty Class II Division II (Angle) children from 10 to 14 years by a cephalometric analysis and concluded that the lower first permanent molar cannot be assumed to maintain a constant relationship to the body and ramus of the mandible throughout the growth period, even though such a constancy was apparent in a restricted age range. However, no differences were shown in the position of this tooth in the mandible as a consequence of different malocclusion classes. Gilmore also denies any consistency of relationship, finding considerable variation in molar position.

Strang gives early loss of the mandibular first permanent molars as a big etiological factor in deep overbite. It establishes by its presence and maintains correct arch and jaw relationship, both mesiodistally and vertically, during the period in which the deciduous teeth are being shed and their permanent successors are erupting and locking. Hence, if these teeth are missing during this critical time, abnormal closure of the bite takes place.
Conclusion:

Whilst the importance of the lower first permanent molar in occlusion is acknowledged the part played by movement in the etiology of malocclusion is variously reported. This may be due to changes in molar position being masked by mean measurements, or differing forces of occlusion peculiar to the individual, determining the movement of the erupted tooth relative to the mandible. Another variable is the relative amount of growth occurring at the posterior border of the ramus, the inferior border of the body and at the alveolus border of the mandible.

iii. Second and Third Permanent Molars:

Stoller has described the supraversion of mandibular second molar (which erupts before the upper second) contacting the distal cusp of the upper first permanent molar. A lack of mesial axial inclination or a drifting forward of the upper first permanent molar allowed supraversion of the lower second molar.

Mildin indicates that loss of third molars does not interfere with the normal proximal contact or bite opening and has no effect on subsequent jaw growth. Henry points out that Fischer ignores the lower third molars in his analysis and treatment of Class II (Angle) malocclusions.

Rothenberg however, claims the presence or absence of malocclusion has no impacting effect on third molars. He states it is impossible to predict if space will be available and advises retaining them as long as possible for growth stimulus. Broadbent agrees illustrating some cases where the congenital lack of the four third molars showed typical defects in face construction and failure in vertical growth. Congenital absence of other teeth (premolars) showed a lack of antero-posterior development. Failure in growth is proportional to the number of teeth congenitally missing or lost early in life. Hellman says “if now, comparisons are made between the group having third molars present, those having them impacted and those with them congenitally missing, the vertical dimensions of the faces are smaller in descending order through the groups.”
(c) **Incisor Inclination**

1. **Description**:

![Diagram of incisor inclination](image)

*Lateral tracing showing normal incisor relationship according to Ballard.*

In 1948 Ballard declared from clinical observation that without doubt any angle above 140° leads to an incisor occlusion which will not maintain a normal overbite, which is increased. Any reduction of the angle below 130° on a normal dental base relationship is a bimaxillary proclination which, although more satisfactory than excessive overbite, is not acceptable aesthetically to the patient.

In 1952 Steadman said the amount of overbite and overjet was the result of the manner in which the upper and lower occlusal curves came together, provided the width of the upper teeth correlated with the width of the lower anterior. Some dentitions had well aligned anteriors and a good relation of buccal teeth and varied from a deep overbite to edge to edge bite.

From measurements of models with good posterior teeth relationship Steadman offered:

\[
\text{overjet} = \frac{1}{2} \text{labio-lingual thickness of upper central measured at level of overbite.}
\]

\[
= \frac{1}{2} \text{labio-lingual thickness of upper central measured at level of overbite.}
\]

\[
\text{sum of mesio-distal diameters of lower incisors and cuspids} + \frac{1}{2} \text{labio-lingual thickness of lower central at incisal edge.}
\]
If this ratio is 1 the overlap would be desirable.
If this ratio is greater than 1 there is an excessive overjet.
If this ratio is less than 1 there is an edge to edge bite.
Neff also claims to be able to foretell the bite relationship from measurement using his tailored anterior co-efficient.
Factors determining the amount of overbite were the inclination of upper to lower incisors and the lingual anatomy of the upper incisors. Where the molars were in good relationship and the anterior widths properly proportioned, undesirable overbite and overjet was present where there was an unfavourable ratio of upper and lower premolar and distal half of upper cuspid width.

Steadman concluded:—
(a) There was no correlation between the amount of overbite and overjet.
(b) Whilst 2/3 fell within a certain range, there was no single angulation of the labial surface of the lower incisor to the lingual of the upper that could be expected to be present.
(c) The width of upper incisors was normally 2.8 mms. greater than the lower, but no correlation existed between width ratio and inclination of incisors.
(d) There was no relation between crown length and inclination.

Ballard considers that excessive overlap of incisors is nearly always the result of abnormal relationship one to the other. He believes it is a misconception to think that incisor relationship is dependent on vertical growth of the teeth.

Bjork supports this statement by saying "in overjet it is not the degree of prognathism that is the deciding factor but the relative difference in prognathism between the jaws." Thompson and Brodie have stated that vertical growth of the dento-alveolar structures does not contribute to face height. It follows logically that the dento-alveolar structures just fill a predetermined intermaxillary space, and that the vertical
relationship of the incisors is determined by the normal or abnormal occlusal relationship which is established as a resultant of dental base and soft tissue behaviour pattern e.g. an anterior open bite is given by either a high FMA (high gonial angle) or giving excessive intermaxillary space which normal vertical development cannot close, or the prevention of development by a behaviour pattern such as tongue thrusting.

Ballard has presented a classification of Skeletal pattern, Skeletal I, II, III using upper incisor - Frankfort horizontal angulation, lower incisor - mandibular border or angulation of incisors one to the other.

Downs' analysis relates the denture to the skeletal pattern under the following headings:

(i) axial inclination of upper to lower incisor.
(ii) axial inclination of lower incisor to mandibular plane.
(iii) axial inclination of lower incisor to occlusal plane.
(iv) protrusion of maxillary incisors.

Means and Standard Deviations are given and with Adams' and Vorhies' application to a Hellman "wriggle graph" the location and amount of disproportion will be seen.

ii. Upper Incisor:

Angle wrote "in Class II Division II the result of retrusion of the upper central incisors is to produce the usual abnormal overbite".

Steadman found the angle of the long axis of the upper central incisor to the floor of the nose to be between remarkably narrow limits in 2/3 of the study, indicating unusual constancy of inclination. Riedel after cephalometric analysis agreed that the relative antero-posterior position of the maxillary central incisor to the cranial base was not significantly different in normal and Class II (Angle) patients. Downs' Points A and B appeared highly constant in normal occlusion - 90° to occlusal plane.

iii. Lower Incisor:
The growth force, together with that of the inclined
planes, tends to drive teeth anteriorly and in the absence of a normal labial musculature, the incisors become inclined labially.

A similar result, according to Greenstein occurs from a lack of growth of the mandible. Benson has stressed that overgrowth of the mandible carrying the apices forward gives lingual inclination. The axial relation can be influenced by abnormal function of tongue and lips and by habits e.g. macroglossia or tongue-thrust can give a labial inclination and lip-biting or thumb-sucking a lingual inclination of the lower incisors. Therefore, axial inclination is the result of bone force modified by muscle force.

The lower incisor angulation to the mandibular plane has been calculated by many investigators and the mean varies from $90^\circ \pm 2.5^\circ$ to $90^\circ \pm 5^\circ$. Tweed’s philosophy of placing the lower incisors over basal bone for a permanent result and pleasing aesthetics in the face of violent criticism has been modified to an FMA evaluation of faces—good and bad and finally to an FMA of one reading to give the straight profile and prominent chin Tweed so desires.

Brodie refutes Tweed’s theory in no uncertain fashion. He points to comparative anatomy and cephalometric studies giving lower incisors at $90^\circ$ which still were markedly procumbent when judged by the rest of the face. Schaeffer at Illinois found these teeth may become more procumbent, less procumbent or may remain at original axial inclination in a cephalometric study of 19 people, 8 - 17 yrs., of late growth changes. The chin point showed forward movement in all cases; the so-called straightening of the profile is an illusion. Wylie on 29 and Stoner and others on 57 of Tweed’s treated patients considered skilful treatment and growth not $65^\circ$ FMA observation were responsible.

Lower incisors can be labially tipped in a favourable fashion when freed from deep overbite. However Herzberg warns against unwitting proclination.

Zingeser has investigated $N$- upper incisor and $N$- upper
first permanent molar and found the two distances are more nearly
equal in Class II Division I than Class I (Angle) children. The
relationship of the depth of bite to these findings has not been
thoroughly assessed. Two observations warrant limited comment:-

i) In all cases N-lower incisor never exceeded N-upper first
permanent molar i.e. the incisal edge below this arc would give an
open bite.

ii) The incisal edge of the upper incisor rarely falls more
than 2 mms. above the arc. With a normal depth of bite the
upper and lower incisors could be expected to bear a close
relationship to the arc of radius N-upper first permanent molar.

Steadman could find no correlation between upper incisor -
floor of the nose angulation to lower incisor - mandibular plane.

It is important to remember that the lower incisor-
mandibular plane angulation will vary inversely as the Frankfort -
mandibular plane angle according to Ballard and Johnson, if
their conception of normal incisal relationships is correct.
Benson has proved a gonial angle - incisor inclination inverse
relationship, and considers that some consideration is due to
other factors when considering incisor angulation. Though
Tweed's mean is too narrow to allow for the normal wide
variation, it is a guide and an aid to have some aim in treatment.

(d) Oclusal Plane:

The deciduous teeth reserve the vertical and horizontal
space for the permanent teeth and thus help to maintain the plane
of occlusion of the dental arch. Tooth eruption diminished when
occlusion was reached and proceeded only as rapidly as the
occlusal plane rose according to Carlson, Hoffman, Shour and
Weinmann.

The anterior point of the occlusal plane is determined by
the incisor relationship and is therefore related to incisor
procumbency.

Brodie has established that the occlusal plane is stable
in growth in its angular relationship to the lower border of the
mandible, the palate and anterior cranial base. In late growth
changes (8-17 yrs.) Brodie found the occlusal plane is stable
in half the 19 people studied but dropped posteriorly in the
remainder.

Downs has included cant of the occlusal plane in his
analysis relating the denture to the skeletal pattern. He found
that as the facial angle increases, the occlusal plane becomes
more parallel to the Frankfort-Horizontal plane. Bjork
substantiates this statement. Renfroe Drelich and Bushra have
commented variously on the angular relationship of the occlusal
plane to the Frankfort-Horizontal in normal and malocclusions.
Downs claimed the occlusal plane was steep in Class II (Angle)
and more horizontal in Class III (Angle) cases.

As intermaxillary elastics result in bite opening it is
interesting to note the conclusions of Brodie, Downs, Goldstein,
and Meyer after the first cephalometric appraisal of orthodontic
results in 1938:-

(1) In all cases in which elastics were worn, there was a
disturbance of occlusal plane - Bolton plane angle. In Class II
(Angle) cases it opened and in Class III (Angle) cases it closed.

(2) There was a tendency for the plane angle to return
to its original size following treatment.

(3) In a number of cases of all classes a part of the
result obtained was shown to be contributed by a change in
mandibular position, most frequently downward and backward.

(4) Changes subsequent to treatment were limited to
shifting of the occlusal plane and changes in the axial
positioning of the teeth in adult cases.

(5) In growing children there were also changes that are
expected in growth and there was a correlation between treatment
success and growth.

Numerous investigators have attempted to explain Class II
(Angle) Cases successfully treated as a change in the level of
the occlusal plane.
Epstein showed Extra-oral anchorage did not produce a change in the plane inclination. Fischer however attributes success in some cases to a repositioning of the mandible to the changed occlusal plane of the maxillary arch. It is considered that successful use of occipital anchorage is dependent upon growth during treatment.

Downs and Wylie have showed a large variation in the occlusal plane. Bjork and Hellman have pointed out that the occlusal plane might compensate for adverse skeletal pattern in part, and in little or no growth cases change in the plane may be the only way response can be given and therefore may be beneficial.

Tovstein states, that where the greatest growth is shown during treatment, there is the least change in the plane. Litowitz and Hedges indicate the greatest reversion to the original plane was in those cases exhibiting the greatest growth. Sleichter in a cephalometric analysis of bite plate therapy of 30 patients with a control of 47 patients and monthly appraisal, found a significant change in the occlusal planes in treatment.

Bjork studied 600 individuals in two groups 12 years and 21-22 years. He claimed a depth of bite correlation with occlusal plane inclination. The angle formed by the occlusal plane and mandibular base was considerably smaller in the group having greatest depth of bite.

(e) Curve of Spee.

i) It establishes correct overbite.

ii) Gives shearing force to anteriors.

iii) Parallel separation of the jaws when opened.

iv) Uniform contact in protrusion.

The Curve of Spee is the result of the functional movements of the mandible. There is no Curve of Spee in the temporary dentition. On the contrary Delabarre stresses the importance
of the deciduous molars in the transition from a plane of occlusion. The pressure of their permanent successors causes an elongation of the deciduous molars and a bite opening and the six year molars erupt to the new level and tilt to give the Curve of Spee. Early loss of deciduous molars interferes with development of the Curve of Spee, permanent molar position and overbite.

Delabarre agrees with Waugh that depth of overbite is due to:

(a) cusp height of posterior teeth.
(b) condyle path.

Steadman also thinks there is some correlation of overbite with cusp height and tooth form.

Dewel stresses the importance of axial inclinations of the teeth in the production of deep overbite and abnormal Curves of Spee.

Teeth tend to tip mesially, contact is maintained by the anterior force component, the muscular propulsion (buccinator etc.) on the posterior ends of the arch, and the shape of the teeth (crown is offset mesially). Weimann and Sicher say there is evidence for believing bone apposition occurs throughout life on the distal wall of each alveolus.

The upper cuspid persists in maintaining abnormal inclination and hence is a more reliable clinical guide due to:

(i) location of apex - deep and stable.
(ii) length of root - opportunity for deviation in proportion to the distance travelled.
(iii) time of eruption - later, more likely to be affected.
(iv) crown contour - tipping of crown does not produce mesial movement of root from occlusion (as in molar.)
The **lower cuspid** is under the control of the upper which jams mesial movement. The lower cuspid occupies a critical position at the junction of the anterior and posterior segments, which seems an area of weakness wherein symptoms are first located. These symptoms are changes in axial inclination and break in arch continuity, vertically or horizontally, giving deep overbite, excessive Curve of Spee and tooth crowding.

Nance gives the widest diameter through the contact points showing that greatest arch length occurs with normal proximal relationships.

Slipped contacts cause a reduction in arch length and in the vertical plane gives depressed and elevated teeth. The reactions are more complicated in the lower due to differences in the Curves of Spee; concave in the lower and convex in the upper arch. Any increased concavity in the lower from a shortening of length by molars or anteriors with premolars located near the centre, will result in premolar depression.

The reduction of arch length occurs because teeth narrow below their contact points and in slipping below neighbouring contact requires less space. If the cuspid retains its normal axial inclination, simple depression of premolars gives reduction and excessive Curve of Spee.

The **cuspids** may tip mesially however, allowing that much more arch reduction, as a narrow cuspid dimension is presented for contacts. The cuspid may slip past the lateral which drifts lingually and erupts further incisally creating a deep overbite.

Dewel claims the premolars erupt before the canine. Mesial tipping of the cuspid could occur from premature cuspid eruption with the wide deciduous molar in situ and later forward molar movement would occur before distal canine movement. However we now know that it is usual for the canine to erupt
before the lower premolars and Dewel's contention is refuted.

The lower cuspid tips distally with equal frequency (in contradistinction to the upper which rarely tips distally) presenting a problem in treatment when extreme. The cuspid elevates, the incisors may be crowded, erect or lingually placed and are usually elevated. The first premolar has a mesial inclination and may be depressed. An excessive Curve of Spee and deep overbite results, which further decreases arch length by pressing the incisors lingually. The lower arch appears to be retarded in development, particularly anteriorly. The cuspid deviation ranges from the moderate almost vertical, to the extreme position depending on the severity of the usually associated muscular perversion.

Some moderate crowding of the lower anterior teeth is possibly characteristic of the human dentition.

The upper first permanent molar is rhomboidal in shape i.e. greatest diameter is not through contact points and this is significant in rotation. Mesial Migration eventually gives the full force of occlusion on the mesial marginal ridge of the lower molar and accentuates the mesial tipping of the lower and the overbite. A mesial movement of the lower posteriors often carries the upper teeth forward to the same extent and degree, but the reverse does not equally apply. The lowers tend to tip whilst bodily movement of the upper more often occurs; this may be due to root shape, (cone against flat wedge), bone differences or downward Curve of Spee.

Another symptom of mesial migration is the early eruption of the upper second permanent molar. These erupt ahead of the lower second as well, which tooth they normally succeed. This is seen clinically in a tentative Class II Subdivision (Angle)
Diagnosis where that side has the second molar erupted well ahead of the other and is really a Class I (Angle) case with the posteriors forward on the affected side. Apparently the second molars are encouraged to erupt and do not have to wait for normal growth posteriorly. The effect of premature eruption on growth retardation requires cephalometric evaluation. However in arches that fail to achieve their full size and development, anteriors are crowded, out of proper alignment and posteriors may be crowded, even where anteriors are relatively well aligned.

**Lower First Permanent Molar** is wider mesio-distally than bucco-lingually and its greatest diameter is through its contact points. Its mesial surface tapers linguually from the buccal-placed contact point. Its distal surface is well rounded with contact somewhat lingually placed.

Space is lost, contrary to the upper molar, when lower molar rotates. The lower first molar occasionally rotates (in an opposite direction to the upper) distal surface lingually, to be followed by the lower second molar erupting later and buccally or lingually to normal arch alignment. This tooth occasionally fails to achieve full eruption but remains partially submerged with only the mesial cusps exposed.

Although the cause of the posterior crowding is not known fully it is possibly an indication of retarded development of posterior supporting structures; antero-posterior in the case of rotated first molars and vertically when the teeth achieve only partial eruption giving an increase in anterior-overbite.

\[ CP \quad \text{'NORMAL' CURVE OF SPEE} \]
\[ CP' \quad \text{EXAGGERATED CURVE OF SPEE DUE TO SUPRACCLUSION OF INCISORS} \]
\[ CP' \quad \text{EXAGGERATED CURVE OF SPEE DUE TO INFRACLUSION OF POSTERIOR TEETH} \]

*NOTE THE IDENTICAL FORMS OF THE CURVES OF SPEE, CP' AND CP*. 
Steadman says the solution of overbite cases lies in diagnosis of the Curve of Spee in relation to the plane of occlusion. Markus, Speidel, Stoner and Corlett have found a wide range in incisor procumbency and Steadman says it is difficult to place the upper centrals, with varying elongation, in a definite position with regard to the Curve of Spee. The Curve of Spee can be advisable, excessive, flat or reversed.

<table>
<thead>
<tr>
<th>LOWER CURVES OF SPEE</th>
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<tbody>
<tr>
<td>1</td>
<td>Advisable</td>
<td>Excessive</td>
<td>Flat</td>
</tr>
<tr>
<td>2</td>
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<th>UPPER CURVES OF SPEE</th>
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<td>1</td>
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<td>2</td>
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<td>4</td>
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<tr>
<th>REVERSE (RARE)</th>
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<tr>
<td>c open bite</td>
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VARIATIONS IN CURVE OF SPEE AND RESULTANT OVERTBITE

**Only a is untreated. 2, 3, c, d, should be corrected to advisable curve of Spee otherwise function will be abnormal, unless tooth form is unusual, even though overbite is acceptable.**

Steadman says correction of the abnormal Curve of Spee will give desirable overbite only if the occlusal relationship is reduced to a Class I (Angle).

There are those who consider that excessive overbite is an indication of incorrect Curves of Spee with supraclusion of incisors or infraclusion of molars or both.

Braun and Schmidt attempted to define their sampling with due regard to size sex and an age when growth finished (18-20),
before carrying out a cephalometric appraisal of the Curve of Spee by plotting contact points and measuring distances from the mandibular borders. In 1956 they reported their findings of Class II Division I and Class I (Angle) cases. This is a well controlled and planned study and is therefore described in some detail:-

(i) ANB gave a significant diagnostic difference in the malocclusion classes studied.

(ii) Ramus height, gonial angle and mandibular length did not differ between classes.

(iii) Curve of Spee did not differ in shape or position of the individual teeth between classes.

They stated "the suggestion that incisors are supraerupted or posteriors infraerupted to produce a different shaped Curve of Spee in Class II Division I is not valid."

The dimensions of the mandible studied exempted it from the source of the difference in Curves of Spee and malocclusion classes.

SW-AB differences confirm the possibility of:-

(i) Differences in position of the jaws relative to cranial base.

(ii) Differences in position of the maxillae relative to the curves of spee.

(iii) Differences in relative position of the jaws to each other.

Sleichter, after an equally careful cephalometric analysis, with adequate control of biteplate results, found alterations in the Curve of Spee which were inevitable with the eruptive changes produced. Uprighting of the lower first permanent molar warrants further investigation in regard to space maintenance needs.

(f) Arch Form.

(i) Gum Pads:

Sillman classified the space anteriorly between the gum pads of 40 babies and found the majority falls into Classes A and B.
Comparison of anterior space and gum pad relationship at birth with eventual deciduous dentition.

<table>
<thead>
<tr>
<th>CLASSIFICATION OF ANTERIOR SPACE.</th>
<th>RELATION OF GUM PADS (Horizontal distance between Maxillary and Mandibular lateral sulci or between distal aspects of upper and lower canines)</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>Deep over-3 (15%) 4(8%) 16%</td>
<td>8(28%)</td>
</tr>
</tbody>
</table>

- **Class A**: Maxillary and mandibular anterior segments in their respective planes.
- **Class B**: Incisal segment higher than canine in maxilla; Anterior segments in the same plane in mandible.
- **Class C**: Incisal segments higher than canine in the upper arch and reversed in the lower.
- **Class D**: Maxillary anterior segments in the same plane, lower canine segments higher than incisal.

Sillman suggests that a child with Class B, C or D anterior space at birth is more likely to develop poor occlusion than a child in Class A. However good occlusion may develop irrespective of the form of the space at birth.

(ii) **Tooth Alignment**:

Mastication provides stresses upon the dento-alveolar structures which serves to keep the radial (labial or buccolingual) position of the upper and lower teeth closely related. Since the combined width of the upper teeth is slightly greater than the width of all the lowers, the uppers are arranged on a slightly larger perimeter producing the usual external upper incisal overlap and external overlap of the buccal cusps of the upper posterior teeth.

A concept of mechanical positioning or relationship of arch form and tooth alignment appears frequently in the literature as the sole factor in deep overbite. There is repeated
listing of:

i) Insufficient eruption of posterior teeth.

ii) Excessive eruption of anterior teeth.

iii) Excessive lingual axial inclination of mandibular and/or maxillary molar and premolar teeth.

iv) Complete lingual occlusion of mandibular teeth.

v) Complete lingual occlusion of maxillary teeth.

vi) Variations of the Curve of Spee;

However, excessive overbite may be but a single manifestation of a more complex problem since the act of bringing the mandibular teeth into occlusion involves the interplay of a number of component parts to produce a functional masticatory unit.

Bjork on the other hand considers the relative difference in jaw length important, while changes in occlusion are of secondary significance.

(iii) Arch Expansion:

It has been suggested that changes in arch form will occur when occlusal interference is eliminated by a biteplate. There are those who point to increase in vertical dental height as a maxillary expansion and mandibular contraction of buccal segments, due to the inclination of the posterior teeth; buccal in the upper and lingual in the lower. Sleichter attributes most of the expansion to a direct inclined plane action of the biteplate causing eruption in a bucco-occlusal direction. This upper arch expansion causes the lingual cusps of the maxillary molars to ride up on the buccal cusps of the mandibular teeth and creates an illusion of spectacularly rapid overbite reduction. Logically over a period of time with extended wearing, lower expansion should follow. This expansion of the upper arch in all cases may explain the lesser degree of vertical response of upper to lower molar as seen in comparative eruption rates during treatment.
(iv) **Arch Length:**

In the majority of cases the mandibular arch length was increased by labial tipping of the lower incisors after a biteplate was worn according to Sleichter, Kloehn and Graber.

(v) **Environment:**

In mastication there is a peak period of stress, and momentary muscle interplay positions food precisely. Swallowing adds its contribution to the moulding forces intermittently at other than mealtimes. Within certain limits, the position of the teeth is the result of a summation of external and internal muscular activity over a period of years of growth.

In a satisfactory environment good radial arch relations can be maintained despite early loss of deciduous teeth.

However, good alignment of upper anteriors demands normal cusp relations of posterior teeth and alignment suffers as the posterior cusp relationship becomes abnormal. It becomes increasingly difficult for the musculature to maintain a good radial relationship of the arches as the fundamental set of the two jaws to one another showed increasing variation in the antero-posterior plane.

3. **SOFT TISSUE MORPHOLOGY AND BEHAVIOUR.**

A. **POSTURE.**

(a) **Anatomy of Muscles:**

The muscular activity within the system of mastication needs greater consideration. The concept is of a system as stressed by Myers, Tully and Eschler giving chains of anatomically joined links which belong functionally together and which are in reciprocal relation to and interdependent of each other.

Lip musculature has three layers:

1) **buccinator** is the deep layer. The tooth arch is greater in size than the bone which supports it and the tonicity of the muscles, causing the lips to part, is prevented by the decussion of the buccinator fibres at the rima oris.
ii) Caninus and risorius are strong muscles in the canine region.

iii) Superficial mimetic (elevator and depressor). These are thin and weak with the exception of the zygomaticus and zygomatic head of the levator which have a broad stronger origin and break the even tension at the lip corner and so allow the more prominent canines.

The lip line may vary from the level of the incisal edges of the upper teeth to well above their gingival margins and the lower lip controls the upper teeth. The teeth and alveolar process are the passive but responsive victims of the continuous interplay of muscular forces and their position is determined by the resultant of the forces so that a state of equilibrium obtains.

(b) Physiology of Muscle:

The muscle fibre is the unit of muscle tissue. When stimulated to a degree that calls forth response, it contracts all or none i.e. it is either fully relaxed or fully contracted. Muscle tissue is always in a state of tone (partial contraction) and this is because muscle fibres do not run the full length of muscle, but are interwoven and connected through their sheaths. Those fully contracted fibres, maintaining each individual's tonicity, fatigue and other fibres go into contraction as the fatigued fibres relax.

In muscle exercises it is not wise to hold the contraction too long, get fatigue and an accumulation of waste products which may be harmful. Therefore allow periods of rest for removal of waste products.

The stretch reflex is a safety valve. The greater the pull the less the degree of distension i.e. more fibres are called into action with each increment of force.

Muscle size is related to function. The larger ones have strength and endurance, the thin spindly muscle has greater range of movement, speed of movement but no endurance. Muscles
are also considered to vary in colour and fibre arrangement depending on their duties.

Muscles are continually working against each other, are always in a state of tension and tend to build up resistance through stretch reflex when an effort is made to lengthen them. Sherrington has shown movements are still possible without maximum effort, for the impulse to contract is accompanied by an inhibitory impulse to its antagonist. Keith says every fibre is arranged with regard to the line of action, the greater the alteration to the latter, the greater the burden we throw on the power of adaption which is inherent in every fibre. When a muscle is laid down it is endowed from the first with the same number of fibres that it will have when fully grown. The difference between infant and adult muscle lies wholly in the length and breadth of the individual fibre. Variation is the invariable rule rather than the exception and muscle is subject to the same laws of variation in total size attainment, rate of growth and to a lesser extent, in form.

(c) Muscle-bone Relationship:

However, muscle has the unique property of its apparent need to contract until it reaches a sufficient degree of resistance to stop its shortening i.e. muscle adaption would tend to maintain a lack of jaw growth.

Mershon has long advocated muscle immutability, defined true closed bite as untreatable. Bahador and Higley disagree, stating an under-developed muscle might conceivably later develop, or a fully developed muscle might be infolded and could lengthen. One continually comes across these hypotheses which consider an engineering rather than biologic principle. They get onto firmer ground and point out some successful bite openings taking advantage of excessive freeway space. Wylie considers that tomus possibly establishes a deep overbite, if a more than average tomus is associated with a relatively short
muscle early in life. Softly points out that balance between muscle action and bone growth is the thing. The eruption of posterior teeth opens the bite which the muscular force tends to close and the bone growth counteracts the depressing action. When there is a balance between the two forces the height is maintained. Any disturbance in vertical growth of alveolar bone causes a deep overbite anteriorly.

The tongue initially is of large size and controls the dentition so that deciduous crowding is not seen. As growth continues muscle control changes from the lingual to labial and buccal aspects.

(d) Anterior Oral Seal:

This may be an etiologic factor by its presence or absence with or without associated skeletal deformity.

(i) Morphologic Factor of Lower Lip (Associated skeletal deformity).

Nicol says that when the occlusion is abnormal the incisors tend to continue their vertical movement accompanied by their supporting structures until stopped. Rix is in doubt about influences controlling the degree to which the upper incisors erupted and he was not sure the lips had anything to do with it. Rix thought the occlusal rise of lower incisors was controlled by the immediate antero-posterior relationship but he did not know if certain conditions fostered increased rise.
The upper incisors come under the control of a greater depth of lower lip. Rushton showed a case of no upper lip with good occlusion. Rix says this bears out Nicol's and Brodie's control by lower lip. The anatomical shape of the inner surface of the lower lip, without changes in posture or muscle activity, tilts these incisors lingually. In sixteen cases of deep overbite, Nicol found the lower lip to cover from half to all the labial surface of the upper incisor. He thinks the lip should be considered in the same way as the tongue is e.g. macroglossia. Nicol attaches great significance to lip shapes. He has demonstrated that an inverted V-shaped lip allowed the lateral incisor to escape the retrusion of the centrals, giving a typical Cl.II Div.II (Angle) type.

(ii) Morphologic Factor of Upper Lip (with or without skeletal deformity).

The aetiology of Class II Division I (Angle) cases is not attributable solely to the most commonly faulty antero-posterior apical base malrelationship, though it may be accompanied by such. Two other factors are:

1. Tooth-apical base relationship.
2. Lip posture.

1. Tooth Apical base Relationship:

Either the teeth are too big or the base is too small. In any reduction of size of the apical base it is almost invariably the upper which suffers most; there may be in fact considerable reduction in the size of the upper apical base with no reduction of the lower at all. The faulty arch relationship is produced by reduction in apical base size and the lack of upper incisal interproximal contact. Each posterior tooth tends to be moved forward by pressure of the developing successors. The lower lip getting between the upper and lower incisors further accentuates the upper incisor inclination, retroclines the lower incisors and also holds back the entire
lower dental arch from its normal forward development. Tilting occurs as the crowns of the upper posteriors move forward. They may later be uprighted by occlusal forces and the apices brought forward. The proclination causes the upper incisors to lose contact with the tongue and they become V-shaped. The incisor relationship is so disturbed that the lower incisors can overerupt and meet either the cingula of the upper incisor or the palate.

(2) Lip Posture:

At the rest position, the tongue is arched and in contact with the soft palate, not entirely in contact with the roof of the mouth, and with the tip of the tongue either just behind the upper incisors against the roof of the mouth, or sometimes behind the lower incisors when there is a high gonial angle. This posture of the lips is called competent by Ballard, Gwynne-Evans.

An abnormal posture of the lips which in the past has been called the adenoidal facies is that which we now call incompetent lip posture. The mandible is in the resting position, there is no abnormal freeway space, the mimetic muscles are at resting tens, but the lips do not meet and the individual can only make them meet by vigorous contraction of the orbicularis oris and mentalis muscles.

Ballard states it is quite incorrect to call them adenoidal as the condition is not the result of chronic nasal obstruction and majority are not mouth-breathers because the tongue and soft palate are in apposition and close off the oral cavity from the oropharynx. The vigorous contraction of the lower lip tends to hold back the lower labial segment and the lower lip lifting up underneath the upper labial segment proclimates the upper incisors. The result is a Class II Div. I (Angle) incisor relation. There is not sufficient clinical evidence to say this will always occur when there is a normal skeletal pattern, but the incompetency will exaggerate a Class II skeletal pattern by increasing the overjet as described.
Obviously any treatment plan proclining lower incisors would end in relapse. Ballard says he often leaves upper anteriors too far forward aesthetically, but to take them back to the lowers would give a relapse. Many people have a slight incompetence without any abnormality (i.e. some contraction of the orbicularis oris and mentalis muscles).

Rix points out with Ballard that failure to seal the lips when at rest has no tendency in itself to produce proclined upper incisors, and illustrates many cases of parted lips with well-positioned incisors. Ballard says the typical open mouth posture is a physiological rest position, is inherited and is not the result of lack of tone. He had been able to demonstrate incompetency in parents of children so diagnosed. Further it was not always related to abnormal skeletal pattern; one gene complex produces the lip pattern and another the skeletal pattern. Ballard states that a high percentage of these cases by mentalis pattern re-education and not by exercises (Rogers) acquire the habit of sealing the lips; not by increasing the tone of the orbicularis oris muscle but rather by a great contracting of the mentales muscle and lifting the lower lip upon the upper. This becomes easier after treatment when incisor position is improved. This was a new muscle pattern which had to be acquired and initially took conscious effort. Hovell refers to the infantile lip posture which he states matures of its own accord. It is common in children, but rare in adults, to see exposed upper anteriors. Such modifications are too late in influencing the alignment of the permanent dentition. Ballard does not care for this term. He is now conducting research into lip maturation. Ballard further states there is a posturing forward of the mandible as an occlusion aid and that an erroneous impression might be obtained of the relationship on a lateral heplate.

Gwynne-Evans indicates that the pattern of oro-facial behaviour used in speech develops as outgrowths from the innate pattern of feeding and expressive behaviour. They are so light
in action so versatile and rapidly executed as to have no bearing on tooth alignment, an exception being a persistent interdental sigmatism maintaining an anterior open bite. Speech can be corrected but alteration or modification of innate pattern difficult.

Leighton has refuted mouth breathing as an etiological factor in malocclusion having perfect arches where posture is normal. Hovell and Ballard have shown that incompetent lips are not necessarily mouth-breathers.

The play of emotional and expressive behaviour of the mimetic muscles over the incisor teeth is important. When all other factors are normal there will be a normal incisor relationship when the lower lip rests over and rarely slips the upper incisal edge, the exception being in strong contraction of orbicularis oris (particularly when swallowing) giving a retroclination of incisors. Gwynne-Evans gives proclination of upper incisor in tongue thrust or post-normal occlusion.

(e) Posterior-Oral Seal:

Ballard says there is a rare case of mouth breather from lack of posterior oral seal, the tongue losing contact with the soft palate.

(f) Temporal Muscle:

Moyers is continuing electromyographic research into the muscles of expression, particularly the orbicularis oris and mentalis and the muscles of mastication. He has demonstrated in both divisions of Class II (Angle) cases that the posterior horizontal fibres of the temporal muscle are used for forceful retraction of the mandible. If when the main masticatory muscles are relaxing there is a sensory stimulus from premature (abnormal) contact, then perhaps not only do the posterior fibres but also some of the vertical fibres of the temporal muscle contract. This would account for a minor posterior displacement (important in a Skeletal II case) and also for the excessive freeway space, because the vertical growth of the dento-alveolar
structures is balanced by the force of occlusion at an over-closed position.

Escalier states there is much to be done and much not understood in electromyographic studies and whilst the electrical phenomenon is individualistic, it depends on many factors, kind of food, caries, posture position of teeth and jaw etc. and caution in interpretation is advised as yet.

(g) Mentalis Muscle:

This muscle assumes great importance from Ballard's work on incompetent lips.

\[
\text{Diagrammatic representation of mentalis muscle.}
\]

\[\text{A. At rest} \quad \text{B. Contracted as in whimpers} \quad \text{C. Combined with lip sucking}\]

This is not one of the lip group of muscles but it can profoundly affect the position of the lips and their resultant action. The mentalis muscle arises in the incisive fossa and runs downwards i.e. away from the lips to be inserted in the integument of the chin area. It can be weak and underdeveloped or strong, bulky and damaging in action. When this muscle contracts, it elevates the lower lip as in a whimpering child. Such habit can cause deformity depending on the level of the lip-line and the jaw relationship. If the force is concentrated on the lower incisor gingival tissues the occlusion may not be disturbed, but the labial plate will be attenuated and the gingival tissue constantly inflamed. Vosnik considers that a perversion of the sucking function will hypertrophy the mentalis causing distoclusion.
(h) Posture Conclusion:
Ballard's work is of tremendous importance throwing some light on those cases whose etiology was inexplicable on a skeletal basis. One gathers that Ballard has had both the material and the period of time to publish his results and feels that much benefit would accrue therefrom.

B. BEHAVIOUR.
(a) Physical
(b) Inherent
(c) Acquired
(a) Physical Behaviour:
Wallace concludes that the tongue by its position, size, shape, strength, co-ordinates dental arch growth and Lowrie has found that a tongue, habitually in the floor of the mouth, produced an enlarged lower arch. Conditions of macroglossia and microglossia have been described affecting arch relationships. Friel found that severe muscular weakness is associated with underdeveloped jaws though not necessarily with any particular form of malocclusion. Where the tongue was weak the arch was narrow.

(b) Inherent:
(1) Development of the Swallow:
In infancy the maxilla is poorly developed relative to the size of the orbital margins and cranial cavity. The hard palate forming the roof of the mouth is broad and flat and the mandible is not well developed and is imbedded in the muscular walls of the oral cavity. The lips, particularly the lower form the anterior boundary, and the soft palate the posterior boundary of the mouth. The large tongue is closely applied to the hard and soft palates filling the vertical space between the margins of the jaws which are widely separated. The tongue meets the cheeks and lips across meagre gum pads and it is noted that the lower lip rather than the upper which makes a broad contact with the tongue anteriorly.
In breast feeding the tongue is moved forward, grooved longitudinally as it is applied to the lower half of the areola of the breast, the upper part of the areola is in contact with the unyielding palate. The mandible is at first depressed. The back of the lower lip remains in apposition with the ventral surface of the tongue but its everted margin lies against the breast to form a seal with it and help support it. The margin of the upper lip completes the seal. Rix says to express milk the shape of the tongue is altered. The longitudinal groove changes at the front as the anterior margin curls up to initiate a wave of pressure on the areola. Films by Gwynne-Evans and the new cineradiographic technique of Ardman and Kemp would seem to deny this initial flip up. Instead there is a wave of pressure from before backwards contacting the palate to force the milk to the back of the mouth. Rix describes this process as an alteration backwards of the longitudinal groove acting as a trough. The mandible is elevated at the same time and the lower gum pad gives support from below to the upward movement.

As the infant passes out of the breast feeding period the behaviour becomes more specialised in response to the changing quality of the diet. The ingestion of food entails more than the primitive compression of the nipple against the palate. With the eruption of the deciduous teeth the time comes to use the developing tactile and muscle senses of the mouth and the suckling rhythm is inhibited in favour of selective movements of the lips and tongue which are directed towards drawing semi-solid or solid food into the oral cavity.

The tongue is no longer closely applied to the hard and soft palate. It develops a tip and becomes more mobile so that it can be protruded and swept from side to side outside the mouth, or retruded to be swept from side to side inside the mouth. These movements play an important role in the gathering and preparing of food before it is swallowed. Nevertheless rhythmic
peristaltic movements of the tongue and muscles of the floor of
the mouth are retained in modified form for life to convey fluids
through the mouth into the pharynx. In sipping or drinking the
lips are sealed over the edge of a cup much in the same way
as they are sealed round the nipple or teat of a feeding bottle
in suckling.

In the gathering of semi-solid or solid food however, the
lips are actively drawn over a spoon or fork to assist the
tongue in the carrying of food into the mouth. The biting
reflex sets up a contraction-relaxation rhythm of the jaw muscles.
Gwynne-Evans further states that the tongue serves the food
between the erupting teeth for mastication and forms a bolus
which is placed posteriorly in the oral cavity between dorsum
and hard palate ready for swallowing. He says the visceral origin
of the lips and facial muscles is well suited to the purpose of
keeping the food in the mouth; irregular wave-like contractions
during the process of chewing are followed by contraction of the
orbicularis oris in sphincteric fashion when swallowing to aid
the backward passage of food towards the pharynx.

By the middle of childhood there has been a downward and
slightly forward growth of the facial skeleton. The roof of
the mouth, no longer broad and flat, is mildly dome-shaped or
highly vaulted according to the form of the growing maxilla and
developing dento-alveolar arch. The muscular walls of the mouth
are separated from the oral cavity itself by the vertical growth
of the dento-alveolar structures. This filling of the inter-
maxillary space brings about further modifications of feeding and
swallowing behaviour.

In chewing the lips and facial muscles largely are freed
of their arduous task of keeping food in the mouth and although
the lips are kept actively closer, the wave-like contraction
among circumoral muscles becomes less and less noticeable.
Moreover some children seem able to chew their food with their
lips widely apart and their facial muscles remain quite
unconcerned. Normally however, the lips and cheeks are relegated to the function of keeping the sulci free from food deposits. The teeth in occlusion when swallowing form a rigid walled cavity and the lips and cheeks remain more or less passive.

The contrast between infancy and childhood is the outgrowth of selective movements among the muscles and is unconnected with feeding. Individual physical lip characteristics develop and the expressive movements are co-ordinated to give speech.

(ii) Normal Swallowing:

Many writers fail to distinguish between the movements necessary to take food into the mouth and swallowing. There are minor variations but in general the pattern is as follows:

The mandible is firmly held by the masticatory muscles at a position just closed from the rest position. This fixation will enable movement of the hyoid bone in swallowing. The teeth are closed in a normal freeway space case or slightly parted when the space is excessive. The tip of the tongue is pressed upward behind the upper incisors against the hard palate. Rix describes the commencement of the peristaltic wave as a flipping up action. Gwynne-Evans attributes it to selective "somatic" muscle type. Ardran and Kemp with beautiful films liken the compression backwards to paste being progressively squeezed from a tube. The soft palate rises and loses contact with the tongue, the mesopharynx narrows and the nasopharynx is closed off. The posterior part of the tongue becomes more vertical the posterior pharyngeal wall comes forward and the tongue arches backwards and the bolus is squeezed into the oesophagus. Re-inflation of the airway occurs, the larynx descends the tongue lowers and moves forward and the hyoid bone descends.

In continual swallowing after the first bolus has passed through the anterior pillars of the fauces, the tongue quickly rises to block the exit from the mouth, the larynx remains closed and the epiglottis stays down. Ardran and Kemp have dis-
proved the negative pressure theory of swallowing and their further work on children will be gladly received.

(iii) Original Comment - Abnormal Swallowing:

The acceptance of swallowing as normal depends on:

(i) teeth closed or slightly apart
(ii) tongue within the dental arch
(iii) more or less passive labial and buccal musculature

There is a gradient variation in intensity and many intermediate types occur. The vast majority can be classified into four main types, two of which are major.
DIAGRAM OF NORMAL SWALLOW AND ABNORMAL TYPES.

The following explanatory comments on this diagram are offered with great humility. For many reasons notwithstanding the paucity of American literature and interest, I felt the great potentialities of the muscular field were not being fully used clinically. In seeking an explanation I concluded that clarification in terminology, treatment and results was necessary. The literature is sprinkled with clashing references to somatic, visceral, abnormal, atypical, tooth apart, perverted, infantile suckling and infantile tongue posture swallowing. The treatment is vaguely referred to as a pattern re-education. In spite of the opportunities that must have occurred, I could find no publication, in definite terms, of the incidence of the abnormal pattern or the results attained after treatment.

I could do no better than follow Angle's lead. I described the normal and defined the abnormal as a tooth-apart swallow. On this basis I classified:

Type 1
Division 1
Division 2
Division 3

Type 2
Type 3
Type 4

With the greatest of respect to those British and other workers in this field and with full cognizance of the difficulties involved, I had intended carrying out a survey of children by X-ray and observation, having recourse to the files of the United Dental Hospital and private practice.

I had intended illustrating the incidence, type of treatment and prognosis and result of each type.

For example in Type 3, the tongue lying within the dental arch, treatment would be limited. However, I felt that the tooth apart swallow was related to the excessive freeway space and therefore to deep overbite. However, due to circumstances beyond my control and lack of material, particularly evident in the files, the survey has reluctantly been postponed to a
future date.

(1) **Type I**.

Here the infantile suckling pattern maturates late and
the tongue is either -

(a) thrust forward and/or in contact with the
lower lip
(b) bulges passively between the arches
(c) protrudes between buccal teeth, not anteriorly

(a) **Division I**.

(1) **Anterior Open Bite**:

Rix shows that instead of excessive overbite a certain
proportion show varying degrees of anterior open bite
accompanying the increased overjet of the above division type.
These children exhibit sucking behaviour of the tongue during
swallowing and the tongue posture remains infantile throughout.
There is a continued contact between the tongue and lower lip;
the front of the tongue does not retreat within the dental arches.
It remains forward with the ventral surface in contact with the
lower lip, forming a pitched roof over the lower incisors. This
contact can easily be maintained while the mandible moves during
changes of facial expression. During smiling when the lip seal
is broken the tongue can be seen in contact with the lower lip.
Sometimes even during speech there is a reluctance to forsake
the tongue-lower lip contact and a characteristic change is
produced in the sound of sibilants - interdental signism.
Ballard emphasizes the tongue thrust forward against the lips
to initiate the peristaltic wave. The tongue - lower lip
posture is present in many. The deformity produced varies
according to :-

(a) dental base relationship
(b) basic position of labial segments in soft tissue
    behaviour on which the abnormal swallow is super-
    imposed.
1) if there is an overjet the tongue proclines
the upper and the lower lip contracts against
the lowers and get an increase in overjet.

ii) if normal overjet, there is no space between
upper and lower incisors vertically through
which the tongue can thrust and the tendency
is to produce a reduced overbite or open bite.

Ballard thinks it is an innate behaviour and not a pattern as:
(a) familial demonstrated
(b) has to be present at birth
(c) difficult to eliminate.

He has found that speech therapists can eliminate the sigmatism
but tongue re-education prognosis was poorer in the presence of
sigmatism and tongue thrust continues. Rix states that if the
lower lip was pulled away, the tongue recedes and this might
indicate some nervous control keeping the tongue and lower lip
in contact. Ballard considers this is a reflex contraction of
the orbicularis oris and mentalis to balance the tongue thrust.
Lower incisors erupting under these conditions are impeded, the
uppers also, but less so, with the more forward position given
by the suckling action. Fortunately the infant behaviour
characteristic tends to be forsaken as the years go by and a
proportion of these anterior open bites improve without treatment.

(2) Cross Bite Posteriorly:

These are seen where suckling characteristics persist in
swallowing. The bulk of the tongue is brought forward during
swallowing and the cheeks are put into tension. The continuous
muscular band stretching right around the dental arches from one
pterygo-mandibular raphe to the other would tend to impinge more
upon the upper buccal teeth than the lowers, as the uppers sit
wider and the raphe passes diagonally from the hamulus of the
medial pterygoid plate to the more laterally situated posterior
end of the mylo-hyoid line below. The constricting forces
operate while the tongue is forward and unable to exert lateral
balancing thrust. Few cross-bites are to be found in the deciduous dentition when the antero-posterior arch relationship is normal.

Many cross bites, limiting room for good incisor alignment, occur gradually from 5 to 6 years in the continued presence of this abnormal swallowing. The developmental defect which leads to the persistence of the poor oral behaviour is prone to lead also to persistent sucking habits; tongue and finger sucking show similar deforming effects but more often, says Rix, exacerbate than initiate the trouble. Hovell says where thumb-sucking has produced a deformity, the tongue, unused to working in a closed cavity, will enter the space and perpetuate the condition.

(b) Division II.

The suckling tongue behaviour tapers away in some to a closing of the teeth on a soft bulging tongue. Neither lip is active, there is no eversion of the lower lip margin and no tensing or forward movement of the tongue. The whole act is not reminiscent of suckling except for the tongue seen between the arches if the lips are parted with the fingers.

(c) Division III.

The tongue protrudes between the buccal teeth, not anteriorly. This type of swallowing bears no resemblance to the behaviour of suckling but is related to postural prenormal occlusion. It is here classified on a cause-effect basis. There is a wide separation of the arches during swallowing which reduces the excessive overbite to nil. Since postural pre-normal occlusion can be accidently produced by the early loss of deciduous molars it would seem the mode of swallowing is secondary to the position of the teeth.

(2) Type II.

(a) Anterior Teeth:

This is called abnormal swallowing by Rix. Ballard disagrees and states we now know the tongue must come forward
between teeth and not upward. Perverted swallowing might be the better term.

Rix says that many retain characteristics of infant swallow. In preparing to swallow the child of say 6 years fleetingly appears to encircle the areola, the mandible is depressed, the tongue is pushed forward and narrowed, the lower lip is drawn in against the ventral surface of the tongue, however maintaining contact with the upper lip by eversion of the upper margin of the lower lip. The upper lip is pursed rather than drawn back against the surface of the upper deciduous incisors. The lower lip exhibits more tension than the upper forming a taut sling with the aid of the mimetic muscles. This *preliminary* stage now changes to a *positive pressure* stage wherein the parallel to infant suckling persists. While still being held forward the tongue presses up against the palate in the region of the oncoming permanent incisors. The tensing of the mylohyoids elevates the mandible from the depressed position of the preparatory stage. It is not elevated enough, however, to bring the teeth into occlusion. The lower lip is momentarily drawn back still more firmly against the ventral surface of the tongue thus forming a resistant wall to aid the thrust of the anterior part of the tongue against the palate in the region of the expected incisors. The emerging permanent lower incisors are repeatedly subjected to pressure from the taut lower lip while the mass of the tongue has moved upwards and forwards away from their lingual sides and the lower incisors thus do not move adequately forward. There is a tendency for them to be retroclined, flattened or imbricated as they are prevented from moving forward in a smooth curve. Some months later the erupting incisors are prevented from becoming closely allied to the lower incisors by the repeated thrust of the tongue. Therefore, there are discrepancies in incisor position in the antero-posterior plane. There is an adaptive adjustment in the occlusal level which enables the lower incisors to maintain occlusal contact i.e. the establishment of
a deep overbite and exaggerated Curve of Spee. Rix says this is common in Britain. Hovell calls it the National Deformity. No percentages of abnormal swallows in normal and malocclusion have been given. Rix says another feature to notice is the way in which the antero-posterior relation becomes worse the nearer the teeth are to the front of the mouth where tongue and lower lip are exerting their adverse influence.

(b) Posterior Teeth:

Though the backwash of pressure has petered out by the time the six year molars are reached posteriorly, Rix considers they too may be affected to show errors in the antero-posterior plane. The normal occlusal adjustment of the molars from six to thirteen years might be affected. The forward migration of the lower molars on shedding of the deciduous molars might be prevented and thus giving a distal migration of premolars instead. In the upper the check to forward migration would be removed as the upper teeth are urged forward. In such a way Ballard has shown a Class II relationship imposed on a Skeletal I or Skeletal II. Gwynne-Evans says the pattern is usually associated with Class II Division I (Angle) malocclusion with marked overbite and overjet.

(3) Type III.

The tongue stays within the dental arches and the teeth are slightly open in this type.

The tension of the sealed lips forces the teeth back to the withdrawn tongue and there is lingual inclination of upper and lower incisor teeth. Variation in skeletal pattern, lip line etc. could give an increased overbite and overlapping of mandibular incisors.

(4) Type IV.

In this type there is a lack of anterior seal. Failure to seal the lips when at rest has no tendency in itself to produce proclined upper incisors says Rix.

The upper lip does not always contribute to an anterior seal during swallowing and may at last cease to endeavour to
make contact with the lower lip and during swallowing a part of
the upper incisors remains visible; the suckling characteristic
during swallowing creating the taut lower lip and the "smile".
The everted margin of the taut lower lip makes a seal with the
upper incisal edges and the ventral surface of the tongue which
is pressed against the lingual surface of the upper anteriors.
This late inability of the upper lip to remain normally covering
the upper incisors can thus be secondary. The deciduous incisors
had been covered but now the tongue seals, instead of the upper
lip which ceases gradually to make contact. There is a discrep-
ancy in the incisor relationship but not because of primary
failure of the upper lip which has become physiologically
redundant. However, there are upper lips which are short and
poor deciduous incisor relationship can cause the upper lip to
fall into disuse in the first years of life.

**Lower Lip Behaviour:**

When swallowing without using the upper lip thus exposing
the upper incisor the lower lip in forming a seal is either -

(a) Drawn back and up, forming a taut sling in laborious
action. The tongue has moved forward through the separated
incisors to recreate the old infantile contact between lower lip
and tongue leading to a proclination of upper incisors and
tendency to open bite anteriorly.

(b) The lower lip moves behind the upper incisors with
little effort and the tongue has not moved forward in the child
with this inert lip. The teeth are not separated much, if at
all, and the lip is merely trapped between the incisors tending
to procline the upper incisors. This condition is more readily
improved by treatment.

**Intermediate Types:**

The two main types I and II are associated with contrasting
trends in position and relationship of the teeth. There are
other irregular swallowing modes which vary in intensity, Tully
and Gwynne-Evans now believe there exists an atypical gradient
of development where orofacial muscles respond in infantile manner even into adult life.

Rix states response to treatment is irregular; sometimes we can correct abnormal action partially or wholly but in any case early treatment to break the vicious circle is important.

(iv) Factors Influencing the Abnormal Swallow:

Ballard, as described, considers abnormal swallowing inherited. He disagrees with Rix who has said that abnormal swallow is a continuation of the infantile pattern. This is hair-splitting for Ballard states abnormal swallow is where the tongue comes forward not upward.

With abnormal swallowing, the post-normality was dependent on the size of the dentition to the apical base; if the incisal segment altered, the maxillary buccal segment might or might not come forward.

Gwynne-Evans says the period of changing the food pattern is important. He doesn't know whether atypical swallowing is encouraged by soft mushy foods or the vigorous chewing associated with dry foods through muscle behaviour can influence dental alignment.

Ballard has emphasized that middle class (orthodontic) children are not breast fed in America. Straub considers methods of bottle-feeding at fault. The infant loses the sucking pressure and must protrude the tongue particularly with an overlarge hole in the feeding teat, to control the flow of fluid as it runs down. Many have claimed no relation between malocclusion and type of infant feeding, however, it would seem that proper attention to size, shape of feeding teat and size of orifice to promote sucking pressure and exhaustion might be beneficial.

Strang has demonstrated anaesthesia of oropharynx (no gag reflex) in some tongue thrusters.

Kincaid investigated frequency of swallowing in relation to deep overbite; the over frequent contacting of buccal teeth in swallowing preventing their eruption to full height and
permitting overclosure was his theory. Results ranged from 15 to 75/ hour with the greatest number in the lower levels.
Variations occurred with sex, time of day and saliva-flow.
Kincaid could not distinguish between cause and effect in his findings, to which no significance is attached.

(c) Acquired Behaviour (Habits):

(i) Thumb Sucking.

The pattern producing the deformity often produces habits. Therefore thumb sucking can be superimposed on an incisal malrelationship to help perpetuate it or the deformity produced by initial thumb sucking can be preserved by tongue habits in the space created.

Swinehart in a study of the thumb-suckers of a malocclusion group where normally deep overbite was usually prevalent, found deep overbite in only 10% and concluded that thumb sucking predisposes to an open-bite condition.

(ii) Lip Sucking.

Effects are according to Strang:

(a) Narrowing of both arches canine - premolar and perhaps in maxillary molar area.

(b) Break in arch continuity at canine - lateral and mesial position of crowns of posteriors in both arches or the upper only.

(c) Incisors may be overlapped, rotated, or with some lingual and mesial axial inclination.

(d) Bite will be closed as a result of lip pressure on the lower incisors which forces them into lingual axial inclination and also causes them to be in supra-occlusion.

Gwynne-Evans claims there are children who frequently retain unusually late various patterns of sucking behaviour associated with infancy. These may have little or no influence on the dentition unless the form they take is repeated consistently over a long period of time or they are accompanied by atypical forms of swallowing or expressive behaviour.
Normally purely infantile behaviour such as lip or tongue, finger or thumb sucking is inhibited spontaneously but if persistent will often respond to suggestive or psychological treatment without resort to orthodontic appliances.

(iii) Sucking and Biting of Foreign Bodies:
Suckling is definitely influenced by method of application, intensity, period of stimulus, time enacted etc. for type and degree of deformity. Sillman found deep overbite of common incidence in the habit (4/17) and non-habit (4/23) group. He noted the habit was strongest with parental interference and advocates "hands off" till 4 years.

(iv) Mouth Breathing:
Cooke says adenoidal hypertrophy whether due to heredity, nutrition or infection obstructs proper nasal function which leads to arrested facial development giving a septal deflection, narrow high arched palate and an overdevelopment of the anterior part of the maxilla. Strang considers mouth breathing causes a posterior location of the mandible. Research deductions now indicate mandibular growth pattern is not affected by functional stress, however changes in tooth position occur and there is an exaggerated Curve of Spee and excessive overbite.

Humphreys suggests mouth breathing must no longer be considered tenable as an aetiological factor. Only 6 out of 1033 children were true mouth-breathers and enlargement of palatine tonsils was observed in approximately equal numbers of normal and post-normal children. Keeping the mouth open doesn't mean they are mouth-breathers. Humphreys considers there is a definite association between keeping the mouth open and post-normality which still lacks an explanation. The habit may be the result of the occlusion just as well as the cause.

Sillman after a serial study of children from birth to 5 years agreed there was no relation between mouth breathing and deep overbite. 6/8 mouth breathers, 1 had a deep overbite whereas 7 out of 32 nose breathers had a deep overbite.
C. BITING FORCE.

Many investigators have attempted to relate biting stress with degree of overbite. In 1935 Taylor recorded readings with a gnathodynamometer. Edge-to-edge bites gave low readings, the normal overbite exhibits a wide range of pressures with a slightly higher average than slight overbite. While marked overbite showed average to low readings there were some notable exceptions (all in children of above average height and weight). Johnson, Hatfield, Worner, Anderson, Brawley, Sidwell all measured biting forces over varying age ranges but with the instruments used, the problems arising from differences of age, sex, social conditions, state of health, pain, learning factor were further accentuated by excessive bulk of 16-22 mms. usually between the bite pads. Compression bars and springs, torsion bars hydraulic and electronic strain gauges fall short of the ideal instrument for comparative measurement of the occlusal stresses in near tooth contact before and after orthodontic correction of deep overbite.

In view of the commonly accepted dynamic equilibrium theory it is interesting to speculate whether occlusal stresses would be less after treatment especially as Storey and Smith found there was an optimum range of force values which should be used to produce a maximum rate of tooth movement.

Would excessive biting stress depress teeth appreciably beyond that given by optimal force?

**Tooth-muscle Equilibrium:**

If this theory is correct then successful retention of treated overbite must result in alteration of environmental musculature or muscle force. Hains believes muscle fibres grow along their whole length in response to traction set up by the growth of bones to which the muscle is attached and that excess muscle substance is converted into tendon.
Scott at Belfast postulates that growth of muscle is regulated by nerve reflexes developing in association with the development of the dentition. He produces evidence to support a theory of functional and developmental association between growth of the dentition, growth of the muscles of mastication and certain structural characters of cranio-facial pattern.

Donovan substantiates this interplay between components during growth. Tooth eruption, growth of condyle and musculature lead to wide range of positions of condyle and path of closure in 3 - 11 year group.

Breitner claims a proper relation between bone resistance and muscle tension is essential for normal occlusion. Overactivity or overtension favours distocclusion while weakness of muscle favour mesiocclusion as long as the mechanical arrangement of the masticatory apparatus is unchanged. He states there is a relationship between vertical dimension and muscular tension and vertical dimension and mesio-distal jaw relationship.

Conclusion:

The muscular tension and strength of the skeleton are dependent on systemic factors. The number of cases induced by faulty muscle-bone relationship influencing vertical dimension and jaw position has not been determined. A systemic evaluation and biting power tests with better equipment may throw some light on the problem.

4. CONSTITUTIONAL.

(a) Pathologic - endocrines, severe illness, allergy etc.
(b) Constitutional and hereditary.
(c) Phylogenetic.

A. PATHOLOGIC.

(a) Endocrines:

Todd writes "Broadbent's study analyses the consequences of disturbed growth, provided we realize that facial dimension and form represent an achievement influenced, not only by the un-
folding of the hereditary pattern but also by the temporary inhibition of ill-health and the permanent restriction of a deviation from normal endocrine control.

Schour and Massler with vital-staining techniques increased knowledge of temporary growth inhibitions of the facial and dental (arch-tooth) structures;"the rate and progress of the formation of enamel and dentine are less affected than the eruption of the teeth or the growth of cranio-facial bones." There is an accelerated and supra-eruption of teeth in hyperpituitarism. The jaw bases are too small for the unaffected teeth in hypothyroidism.

Salzmann believes that while disturbances in the direction and rate of jaw growth do occur, an atypical eruption is frequently pathognomonic of endocrine deficiencies. Teeth may suffer secondarily from endocrinopathies changing periodontal tissues or systemic disturbances. Though sub-clinical or transitory, the endocrine disturbance may leave its mark on the development and occlusion of the dentition.

Cross considers alveolar rarefaction can occur and suggests carpal X-rays as a guide to skeletal maturation.

Schour and Massler conclude that in the majority of malocclusions no endocrinopathies can be demonstrated or even suspected.

(b) Severe Illness:

Sillman found that deep overbite in the illness group had a ratio of eight to one. This may be significant though little is known as to the effect of disease on growth and development of the jaws, exceptions being the open-bite of congenital syphilis. Strang describes anaemia as being accompanied by poor and retarded calcification of bones and this might give infra occlusion of posterior teeth. Unless detected and blood quality improved a recurrence of excessive overbite would be expected after retention.

Todd says "growth pattern may be expedited, interrupted, retarded, warped or inhibited by misadventures of health."
(c) **Allergy:**

(i) **Nasal:**

Fuchs gives an unusual frequency of dental deformities in nasal allergy patients. Todd agrees saying that growth retardation results in a narrow pinched nose and upper dental arch constriction giving inadequate space for the teeth. There is frequently a deep overbite and V-shaped palate.

Diskin working with cast material on a limited group found the palate height and tapering identical in the allergic and non-allergic. He further disagreed with Todd and claimed his (Todd's) bone scorings were found in either group. Young and Miller support Diskin claiming bone development is unaffected by upper respiratory allergy.

(ii) **Food:**

Straub considers food allergy is more important in the delay of bone maturation - he gives 62% with constricted upper arches.

(B) **Constitutional and Hereditary.**

Stillman gave an analysis of type of delivery at birth and method of feeding.

<table>
<thead>
<tr>
<th>TYPE OF DELIVERY</th>
<th>FEEDING</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Breast</td>
</tr>
<tr>
<td>Deep Overbite</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>3 (21%)</td>
</tr>
<tr>
<td></td>
<td>1 (50%)</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

Distribution of deep overbite is fairly uniform and therefore no especial association with trauma or method of feeding. Other pre-natal and nutritional influences require further investigation.

There is a type where the bone is lacking in quality and nature attempts correction by increasing the bulk evidenced by bony bosses in the mouth. Prognosis is poor. Stillman illustrates two sisters each with a deep overbite and one with a habit. Correction of the habit had no effect and Stillman thinks heredity is the most important factor.
(C) **Phylogenetic:**

Present day skulls are appreciably smaller and teeth are much the same size. There may also be sex differences, the female skull being smaller and teeth much the same size. Coupled with Abel's work in 1931 showing separate inheritance of teeth and jaws, disrelation of teeth and arches leading to deep overbite could commonly occur. It is concluded that the etiological factor of disease in deep overbite needs further investigation and that the importance of heredity cannot be overlooked.

5. **CONCLUSION.**

The etiology of deep overbite shows the static principles of tooth alignment and arch form being injected with the biologic concept. We are beginning to hear of behaviour patterns, maturation and muscle chains rather than individual muscles.

There is a newer understanding of a dynamic anatomical and functional equilibrium, where close adaption and interplay finds ready victims in the passive teeth and alveolar processes.

There is much yet to be understood and much yet to be done and above all lies the unknown of inheritance and the invariable variability of the individual.
IV. CASE ANALYSIS.

1. EXTENT OF ANALYSIS.

A. GENERAL EXAMINATION:
   (a) Posture, physique
   (b) Developmental age, chronological age.
   (c) General health.

B. EXAMINATION OF THE FACE:
   (a) Physiological
      i. Muscle tone, especially of the lips.
      ii. Breathing.
      iii. Swallowing.
      iv. Speech.
      v. Habits and Mannerisms.
   (b) Morphological
      i. Full Face.
         1. Facial Type
         2. Symmetry
      ii. Profile.
         1. Antero-posterior proportions
         2. Vertical proportions
         3. Frankfort mandibular plane angle.

C. EXAMINATION OF THE MOUTH:
   (a) Soft Tissues:
      i. Gingival Tissues
      ii. Frenum
      iii. Tongue
   (b) Arches Separately (Teeth):
      i. Caries
      ii. Identification of teeth present
      iii. Abnormal movement of the teeth and loss of space
      iv. Dental age
      v. Relationship of tooth size to arch size
      vi. Shape of dental arches
IV. CASE ANALYSIS (Contd.)

C. EXAMINATION OF THE MOUTH (Contd.):

(c) Arches in Occlusion:

i. Transverse relation

ii. Vertical relation

iii. Antero-posterior relation

2. PLAN OF ANALYSIS.

Strang brings out two very important points in treatment analysis:

A. The plan must aim to preserve the conditions that simulate the normal:

(a) Undergrown osseous supporting base.

(b) Balance and harmony of abnormal environmental tissues.

B. The plan must eliminate the conditions that are abnormal:

(a) Incorrect inclined plane adjustment

(b) Faulty axial positioning

(c) Tooth rotation

(d) Excessive overbite

3. STEPS IN CLASSIFICATION:

From a study of:

A. Plaster casts

B. Photographs

C. Intra-oral X-rays

D. Patient

E. Lateral headplate

The following eight steps in the process of classification are carefully carried out in proper sequence:

(a) A study of the inclined plane relationship.

(b) A study of the axial inclination of each dental unit.

(c) An analysis of the relationship and position of the median line of each arch.

(d) The noting of rotated buccal teeth, especially the maxillary molars.
If a deep overbite is present and it usually is, examination to locate the denture area at fault.

Examination for prematurely lost or extracted teeth and a study of intraoral radiograms for detecting the congenital absence of teeth and for the presence of supernumerary teeth.

A study of the facial photographs, both the front view and each profile picture.

A study of profile radiograms.

The Angle classification does not account for all cases of malocclusion. Abnormalities in vertical relation are not given a place. The possibility of complete mesial placement of the maxillary arch without axial persion is not considered and Class II (Angle) cases now are viewed individually on their merits. However it is beneficial to have a starting point of tentative classification and some goal in treatment.

A. ANALYSIS OF PLASTER CASTS.

(a) Inclined plane relationship:

Whilst plaster casts in occlusion are a static and not a functional analysis, the value of study models is readily conceded.

Study models give the lingual cusp relationship which can't be seen in the mouth. Stoller has emphasized the importance of viewing the inclined plane relationship at the correct angle and models are therefore necessary to avoid errors of parallax.

Bucco-lingual variation from normal inclined plane adjustment is not a factor in classification, only mesio-distal relationship being of basic significance.

The first permanent molars and canines are the most important inclined plane studies. We now know the mesio-buccal cusp of the upper first permanent molar occludes just distally to the buccal groove of the lower first permanent molar.
A tentative classification of the teeth (not the jaws as Angle intended) must be further verified in every case, for example:-

**Inclined Plane Relationship:**

i) **Class I:**

1. Have both the upper and lower buccal segments moved forward?

2. Or is it a Class II case with forward movement of the mandibular posteriors?

3. Or is it a Class III case with the maxillary posteriors forward?

ii) **Class II:**

Is it really a Class II case or a Class I malocclusion with forward movement of maxillary posteriors?

iii) **Class III:**

Is it really a Class III case or a Class I malocclusion with forward movement of mandibular posteriors?

Forward drift of the posterior teeth must be ascertained for proper classification and to avoid finishing the case too far forward.

(b) **Axial Inclination:**

Strang considers the study of the axial inclination the most important step in the procedure of classification, for it determines quite conclusively whether there has been a forward movement of posterior teeth and gives positive evidence of the tooth movements required in treatment.

Dewel states, "the fact that teeth tend to tip beyond accepted limits, when they assume positions other than the normal accounts for the clinical importance of axial inclination."

Some teeth are more persistent than others in maintaining an increased inclination once it is taken.

The stable nature of the apex of the canine and other factors emphasizing the importance of the axial inclination of this tooth has been described elsewhere. The lower canine must be equally examined.
Axial inclination gives some idea of growth as well. There is an evident lateral flaring of the crowns if the apices are held in a restricted base. Tooth material must be clinically appraised in the light of available bone. Nance Howes have offered measurements to aid in determining extraction need. A Class I (Angle) case, with either a forward movement of posterior teeth or a deficient apical base giving crowding of anteriors, looks the same and is treated similarly as a candidate for extraction rather than carry both arches back or risk potential bimaxillary protrusion.

(c) Median Line Disharmony:

Median line study is important for disharmony indicates that there is malrelationship of teeth or dental arches. A shift in the maxilla is due to tooth variation and altered axial inclination of several incisors or break in arch continuity is noticed.

In the mandible, as well, there may be a lateral shift of the mandible from a habit or to secure better occlusion. This must be checked in the mouth and evidence of facial disharmony and lateral shift noted. The side towards which the median line deviation has occurred will be found in buccal occlusion and mental repositioning must be made for correct classification.

(d) Rotated buccal teeth:

Stoller and Henry have clarified maxillary molar relationship. Forward movement occurs first as a rotation around the mesio-lingual cusp then the tooth comes forward with the mesio-lingual cusp on the marginal ridge. Rotation has occurred when it is in line with the canine.

Henry has estimated that 1 mm can be gained by correction of the rotation. Mental repositioning must be made for proper classification.

If other teeth require rotation we must consider how space can be gained for their rotation.
(e) Location of the Denture area at Fault and Responsible for Deep Overbite.

(i) Marked bony ridge lingual to the molars. This indicates poorly calcified bone and is a positive sign of infraocclusion of posteriors.

(ii) Length of Clinical Crowns.

An excessive shortness of all the posteriors is indicated by the close approximation of the gingivae tissues to the occlusal surface of these teeth. The gingivae are hypertrophied and congested. This is a positive sign of posterior infraocclusion.

(iii) Marked Malalignment of Incisors:

Strang considers overlapping and lingual displacement of mandibular incisors as indicative of supraocclusion.

Prakash and Margolis have proved the lower incisors are rarely in supraeruption.

Steadman has pointed out that excessive overjet results in deep overbite or imbrication of anteriors. For a given overjet, he relates overbite by considering the angulation of the lingual surface of the upper incisor to the labial surface of the lower incisor and the incisor tooth masses. Where this angulation exceeds 180°, mathematically he has found marked increase in overbite for slight increases in overjet. This may explain the deeper overbite of Class II Division II (Angle) cases. He considers his formula useful in pre-determination. If maxillary incisors are too far forward in relation to the bony base, can they be moved lingually without extraction of first premolars or is extraction indicated?

(iv) Curve of Spee:

An exaggerated compensating curve is associated with Class II (Angle) malocclusions. There is supraocclusion of anteriors and maxillary premolars and infraocclusion of mandibular premolars and first permanent molar.

Assessment of the Curve of Spee from a study model will not indicate whether there is supraeruption of anteriors or infraeruption of posteriors.
(v) **Lingual Axial Inclination:**

Rarely deep overbite may be caused by lingual axial inclination or even a complete lingual occlusion of the molar and premolar teeth of the mandibular denture.

**B. PHOTOGRAPHS.**

Analysis of facial lines is aided by study of front view and profile photographs. The main purpose is to determine the degree and distribution of growth in the body of the mandible. Deceptive evidence may be produced by overlying muscle. Angle relied on his artistic appreciation to appraise facial harmony.

Photographs, if standardized, are useful for treatment records.

If the photographs show facial harmony below the nose the overbite is considered an anterior supraocclusion.

A lack of vertical growth in the oral area is an indication that the overbite is due, at least in part, to posterior infraocclusion.

Brodie considers that in normal vertical height (i.e., rest position), the distance from nasion to anterior nasal spine is 43% of nasion - chin point measurement.

Broadbent and others have attested to the constancy of this percentage.

**C. INTRA-ORAL X-RAYS.**

Full mouth X-rays are essential. Partial anodontia is more frequent than it is generally considered. Unerupted teeth, supernumerary teeth, cysts, caries, periapical abscesses abnormal position or abnormal development of teeth may disturb the relation of the erupted teeth and make a classification misleading. They will reveal the presence of third molars and their position. X-rays periodically throughout treatment are advised, revealing e.g.
(a) root resorption which may occur from systemic causes and we would therefore proceed carefully.

(b) incidence of caries when bands are removed say after six months. If hygiene is poor, may have to reband for shorter period or advise a short course of treatment.

Faulty axial positioning will occur as teeth adjacent to extraction spaces naturally tend to close. Such teeth will require mental reposition for correct classification.

Supernumerary teeth are more a problem of treatment than case analysis.

A study of intra-oral X-rays will reveal faulty axial positions and rotations of unerupted teeth affecting the time of treatment and prognosis.

Intra-oral X-rays will serve to reveal the tooth material that will require accommodation in the jaws on eruption.

Tweed and Nance measure unerupted canines and premolars from an X-ray. Wylie uses a prediction scale after having determined the mandibular incisors' width.

D. PATIENT.

(a) musculature.

(b) face height.

(c) profile check.

(a) Musculature.

(i) Introduction:

Ballard believes that the dental base relationship is inherited, that normal growth will not improve the relationship and that the changes as a result of treatment, with the exception of minor postural abnormalities, are confined to the dento-alveolar bases. These changes are mainly labial lingual alterations of the axial inclination of the labial dento-alveolar segment and antero-posterior movement of buccal segments to maintain arch form. Ballard considers that Tweed's
concept is fundamental in case analysis; the stability being given in soft tissue behaviour and not over basal bone.

Ballard leaves one with a feeling that little can be done in many cases when he further stresses the inheritance of muscle behaviour and the patchy re-education response.

If the bases are unchanging and the dento-alveolar structures are in balance with soft tissue behaviour, we must know for case analysis and treatment planning, how the soft tissue has produced or contributed to the abnormality, when this is basically the result of an abnormal base relationship and further, how the soft tissue behaviour can be modified to stabilize the result after treatment.

(ii) Labial Segment Relationship:

Ballard bases his case analysis and treatment planning on this relationship. He has defined an acceptable incisor relationship and mentally repositions them to their correct inclination by rotation around the apices. As the bases cannot be altered the degree of abnormality of the overjet so obtained affects the prognosis.

Soft tissue behaviour governs the labial segment relationship. In a discrepancy case the anteriors are crowded and the posteriors have moved forward. If the soft tissue behaviour has lead to a proclination of the labial segment, the posteriors may or may not have moved forward. Expansion will lead to relapse and distal movement of buccal teeth is usually difficult unless teeth are removed at the back of the mouth. We are otherwise faced with a possible retreatment with extractions ordered. Early treatment might be the answer.
Rogers taught that posture and behaviour could be readily changed by function and that function would change form. Ballard flatly denies this concept. Several years of clinical observation have convinced him that patients with incompetent lips may teach themselves to maintain the lips in a closed posture but quite often give up the struggle against the inherent pattern in later years and revert to the lips apart posture.
Gwynne-Evans has pointed out that the incisor proclination is not always associated with the incompetent lip posture.

Ballard has stressed the significant thing about incompetent lips and the labial segment is that in overcoming the incompetence it is mainly the orbicularis oris and mentalis muscles which contract and lift up the lower lip.

In case analysis then, it is important to distinguish whether the lips are competent when there is an extreme Skeletal II (Ballard). Many people without abnormalities have slight incompetence of lip action i.e. some contraction of the orbicularis oris and mentalis muscles. If the individual is truly incompetent the lower incisors cannot be proclinated to reduce the overjet associated with the Skeletal II pattern or a relapse will occur. If the lip action is competent and the lower lip is behind the upper anteriors because of skeletal morphology malrelationship then the treatment is different. Retract the upper incisors to a satisfactory inclination and procline the lower labial segment to them bringing the lower posteriors forward for support. Ballard illustrates stable results with the lower incisor inclination increased 10° to 102°.

Rix has stimulated interest by his paper on abnormal swallowing. The apical base relation alters the response of the labial segment to the differing swallowing patterns:-

**Infantile Swallow**:
(i) Skeletal II Base. There is more severe overjet, less tendency to cross bite and less retroclination of lower incisors.

(ii) Skeletal III Base. There is a cross bite more readily and less overjet.

**Perverted Swallow**:
Skeletal II apical base relationship would give more marked retroclination of upper incisors and excessive overbite
which would make treatment difficult.

Rix states that many postnormal occlusions are secondary to the incisal overjet produced by the tongue. Treatment then must plan to take back the maxillary posteriors to their original position before correcting the labial segment and not to bring the mandible (if one believed this could be done) or mandibular teeth forward.

Strang describes a buckling and breaking of arch continuity when posteriors move forward against a hypertonic or habit spasm, labial musculature. He draws attention to the need for checking biting and sucking and posture habits in case analysis.

Downs has pointed out that osseous dysplasias in different areas may lead to a similar dental arrangement. Myers has therefore found that patients with the same orthodontic classification may present radically varying muscle patterns as observed electromyographically.

Ballard judges dental base relationship by various angles and planes; by correcting the upper incisor - Frankfort plane to 107° and correcting the angulation between the long axes of the incisors to 136°. If the long axis of the lower incisor passes between the tip and cingulum of the upper incisor then it is a Skeletal I case. If the axis is behind the cingulum it is a Skeletal II and if before it is a Skeletal III.

Alternatively the lower incisor-mandibular plane correction to 90° and the 107° angle could be used. It is acknowledged that Angle's classification is now confined to the teeth and not the jaws as Angle intended.

Walther investigated skeletal form and muscle behaviour pattern on 375 Eastman Dental Hospital patients. He found that the relationship of the dental bases was not easily assessed from the labial segment presupposing standard inclinations and immobility of apical points. Walther showed a
different skeletal classification for the same case by using alternative angles as Ballard described. Walther concluded that the skeletal relationship would appear to be more easily assessed from a standard.

He investigated incompetent lips, thumb sucking, infantile and perverted swallowing.

Clinical assessment of muscle pattern is open to error however these four patterns appeared to be associated more with the occlusion presenting, than with skeletal bases. Class II Division II (Angle) was closely associated with competent lips and abnormal swallows were found in 92% of Class II Division I (Angle) patients.

Bimaxillary protrusion must be forever envisaged as the lower arch may be carried forward with the upper in various behaviour patterns and incorrect case analysis will leave the case finished too far forward.

Labial Frenum:

Deep overbite causing the central incisors to flare out should not be confused with an abnormal labial frenum giving a diastema between the centrals. Diastema can also be due to unerupted, missing or peg shaped lateral incisors. Some hereditary influence is seen and radiographically where there is a dense bar of bone between the centrals the condition is not treated.

Frenectomy can be ordered where there is a broad fibrous attachment which blanches between the teeth when the lip is pulled up, the lateral incisors have erupted and radiographically there is a groove between the central incisors. Any bony spicules present should be removed.

(b) Face Height:

Examination should be made with the teeth in centric occlusion, in functional movements and in the rest position, supplemented by X-rays.

Johnson uses biteblocks over posterior teeth and calipers and Strang uses cotton rolls to prop the jaws apart. If in
centric occlusion the appearance is one of pouting lips, strained musculature and deepened labiomental sulcus and a noticeable improvement occurs in propping open the jaws Strang considers this is evidence of molar infraclusion.

In 1946 Thompson offered rest position as the most accurate and reliable basis for case analysis.

- **Small freeway space**
  - Due to over-erupted anterior
  - Treat by depressing anteriors as increase in vertical dimension would collapse.

- **Deep Overbite**
  - Large freeway space
  - Due to insufficiently erupted posteriors
  - Not bite opening but a filling-in posteriorly to restore space to normal required.

He said dental science had been hampered by the teaching that the teeth contribute to face height and he showed that it was impossible to open the bite more than was allowed by the rest position of the mandible.

Wylie analysed malocclusion cases in rest position and in centric occlusion and found a reduction of face height and freeway space in 80%. Strang says treatment planning must envisage depression of incisors as other measures may be expected to be opposed by the musculature. In the other 20% who did not show a reduction in face height in both positions elevation of posterior teeth would be indicated.

Where the freeway space is excessive Sly considers the muscles are undeveloped from lack of normal function and simple bite opening without myofunctional therapy is successful. Sleightler states that the dental height gained may be expected to be retained if skeletal and muscle growth progress sufficiently to accommodate the treated occlusion.

Diamond has concluded that a delayed eruption of permanent incisors and a lack of intermaxillary space (i.e. contact) between posterior edentulous gum pads is pathognomonic
of developing deep overbite and orthodontic interference is indicated.

Softly on the other hand, considers that an excessive freeway space cannot be treated. He describes a muscle balance in the vertical plane similar to that existing bucco-lingually, and feels that any disturbance will result in collapse.

Ballard states that the proprioceptive fibres in the supporting structures of the teeth are very sensitive to abnormal contact. It is possible e.g. in some Class II Division II (Angle) for the mandible to be taken distally one or two mms. to eliminate the abnormal contact.

The distal displacement will affect the classification of the case and must be taken into account. In abnormal swallowing the maxillary arch is frequently slightly contracted and the mandible may shift laterally. In a large overjet the mandible may be postured forward to help close the lips and will affect case classification. X-ray of the rest position and study of functional movements is essential for proper classification.

Wylie and Johnson have shown that the prognosis tends towards "poor" when the lower face height becomes large, the ramus height becomes short and the angle of the ramus becomes large.

Where does it all lead? The conclusions drawn by the various investigators can only be based on the assumption that the normal freeway space is a relatively constant figure.

In case analysis the difficulty of accurately determining the amount of freeway space is no different from any other norm. Furthermore it may be that variation from the accepted 3 mms. may still be normal for that particular individual.

In case analysis then of deep overbite, freeway space and face height must be evaluated:

(i) If the freeway space is small, the face height is less than normal (if one can judge such clinically having regard to
individual variation) in both the rest and centric positions, and treatment is limited to a depression of the anteriors. Where there is a flat compensating curve and the freeway space is somewhat higher than usual, having regard to the difficulties and limitations of teeth depression, the deep overbite cannot be treated.

(ii) If the freeway space is excessive, the face height is far less in centric occlusion than in the rest position and treatment by elevation of the posteriors is indicated, having regard to possible individual variation of the freeway space reading, and growth response and muscle adaption to the height gained.

(c) Profile.

We do not now think as Angle taught that all retruding profiles were Class II malocclusions. Strang states that some retardation of growth of the mandible can be expected when lack of function occurs from the malpairing of inclined planes and therefore a Class I case may produce a profile closely simulating a Class II case. Hypertrophied muscle tissue may mask the defect in the facial lines.

Profile examination helps relate the maxillary teeth to the skull and indicates whether the body of the mandible as shown by the position of the chin is in distal relation to the cranial anatomy.

Downs and Fischer have classified faces; implying maxillary protraction in the convex type, where however any profile can occur. This is complicated by general face types. Some limitation may be placed on tooth movement in excessive facial types.

Brodie claims that Class II (Angle) cases show a change in the position of the body of the mandible probably due to a posterior positioning of the glenoid fossa by failure in forward growth of cranial base. Fischer considers the majority of Class II Division I (Angle) cases are maxillary protrusions.
Whilst we look at the profile first for some idea of the relative jaw positioning, the profile does not necessarily indicate a definite malocclusion type; however we now have cephalometrics to aid us in our case analysis.

E. LATERAL HEADPLATE.

(a) Introduction:

Cephalometrics is a subject in itself and its importance cannot be over-emphasized. Brief mention of the subject matter can only be made.

There have been a number of analyses geared towards determining facial pattern, pointing out dental abnormalities and predicting treatment aims, aids and limitations.

There has been an attempt to constitute a norm or standard, but Wylie points out no single figure in itself means much; what counts is the manner in which they all fit together.

(b) Down's Analysis:

Downs says that case analysis includes the study of the relationship of the various parts of the face to appraise balance and harmony.

Normal readings will be obtained if skeletal pattern is good and the relation of the denture to that pattern is good. If the relationship is faulty the readings will locate and give the amount of the discrepancy.

Downs uses the Frankfort-horizontal as a base line. The Angle of Convexity HAP is a measure of the maxillary protrusion. The mandibular plane angle is a measure of mandibular retrusion.

The apical base difference is always greater with the maxilla protracted. Facial convexity and incisor procumbency are also trends. Where there is maxillary retraction, the incisors are more upright and apical base discrepancy is less.

(c) Graber's Method:

Graber considers the mandibular plane angle has not been substantiated clinically in Class II (Angle) cases as a basis.
of antero-posterior dysplasia. He condemns Tweed's subservience to a single angle in case analysis. Graber asks why incisors should be retracted, increasing overbite, overjet and possibly creating temporo-mandibular joint pathology irrespective of the pattern of the face, teeth and musculature.

Graber recognises the difficulty clinicians have pinpointing landmarks. The cranial base is stable at 7 years of age so SN is used as the base line. Graber's method appears easier for clinical application.

He uses the angle of facial convexity NAP, the mandiblar plane angle and the SN plane to Down's points A and B to give the:-

(i) **Skeletal pattern:**

Lande has shown the A and B points to be remarkably stable from 3 to 17 years. They are therefore useful for the anterior parts of the denture bases.

Mean figures are SMA 80.79°; SNB 78.02°; Difference 2.7.

SNA range determines normal position of maxilla to cranial base.
SNB range determines normal position of mandible to cranial base.
SNA-SNB difference gives the relationship of the base bone of the maxilla to the mandible.

If SNA is in the higher levels, the SNA-SNB difference can be higher without poorer prognosis.

If SNA is low, any appreciable difference may impose severe limitations on the adjustment of a Class II (Angle) malocclusion.

(ii) **Dental Pattern:**

The long axis of the upper incisor to SN averages 103°.
The long axis of the lower incisor to the mandibular base is 90° ± 5° average.

Axial inclination is a measure of tooth movement. If there has been forward movement of the teeth, then the teeth are flared forward.

Where the lower jaw is overgrown the spines are carried forward and the lower incisors are inclined backward i.e. 85° or lower levels.
(d) Overbite:

Steep mandibular plane angulation (35°+) imposes severe limitation on the correction of excessive overbite. The change in the occlusal plane induced by elastics is seldom permanent.

Downs and Bjork have shown that as the facial angle increases the occlusal plane becomes more parallel to the Frankfort horizontal. Zingesser claims that an increase of Nasion-upper incisor measurement over Nasion-upper first permanent molar holds promise as a differential diagnosis of deep overbite and the amount of freeway space.

Johnson has proved a correlation between Frankfort-Mandibular Plane Angle and typical occlusal abnormalities (Angle).

Brodie describes a significant difference in the relation of the condyles to the Frankfort plane in typical Class II Division I (Angle) and Class II Division II (Angle) cases, i.e. a vertical skeletal change in deep overbite cases.

(e) Incisor inclination and apical base malrelation:

Graber has found that the inclination of the lower incisors varies more than the upper incisors in excellent occlusions studied. He considers it is the combination of factors which is important rather than the single lower incisor angulation, in any case analysis e.g. an upright lower incisor in a backward divergent face with a Class II (Angle) malocclusion and high apical base difference is a vastly different proposition to an upright incisor with forward divergent face, Class I (Angle) malocclusion with low apical base difference.

Apical base malrelationship may be so severe that full correction is impossible if the labial segments are to be left in balance. Many cases show better stability if the Class II buccal segments are left in position and extraction of first premolars gains space to retract the anterior.

Hovell describes the varying combinations of bases, teeth and musculature :-
Class II Division I (Angle) tooth relationship can be superimposed on a Skeletal I or III base by a deficient base or forward drift of posteriors, or there could be a Skeletal II base relation. Where the apical base is postnormal if the lip posture is normal, the result is an intermediate type of Angle Class II case with postnormal tooth relationship, normally inclined upper incisors and increased overbite.

With abnormal apical base relationship the normal incisal relationship can never be obtained. Gross alteration from the normal axial inclination of the posterior teeth may be necessary to obtain normal antero-posterior relation.

Ballard states that the smaller difference in SNA-SNB indicates a trend to Skeletal III and the larger difference a trend to Skeletal II.

An occlusal abnormality on a Skeletal I (normal) base has a good prognosis provided re-education of muscles can be carried out. Many lateral tracings show the lower incisors proclinated at say 90°. This proclination is stable and should be left alone thereby improving prognosis in a Skeletal II case.

Prognosis could be poor where the SNA-SNB difference is 12° in a Skeletal II and upper incisors would be retroclinated after treatment.

Where there is a double retro-clination with small SNA SNB difference prognosis could be poor. It would depend on a change in muscle pattern to improve the incisor relationship and deep overbite.

Ballard feels that in spite of its limitations a case analysis based on such an assessment of dental base relationship must be sound.

(f) Conclusion:

Whilst cephalometrics gives accurate data on growth centres, deep areas of deficient development, means and ranges for various diagnostic planes and angles and age factors projecting future growth possibilities; whilst its value is
unquestioned it is advantageous to combine it with clinical observation; changes in the inclination of teeth are often symptoms of disturbances in growth of structures quite removed from the teeth and alveolar process and properly are in the province of cephalometrics.

Cephalometrics is an aid, it does not supplant other methods. It will not provide all the answers, but properly used will smooth the path of case analysis.

To get the most out of cephalometrics it should be used and evaluated for oneself. I have taken lateral headplates and checked the readings of the existing files at the United Dental Hospital against the normal. It is felt that one would get the most out of them by continued use and therefore an increasing usage in clinical practice can be forecast in the years ahead.

4. **DIFFERENTIAL DIAGNOSIS.**

A. **CLASS I:**

(a) forward movement of posteriors.

(b) deficient apical base.

These look the same and are treated the same clinically.

B. **CLASS II and CLASS I WITH FORWARD DRIFT OF POSTERIORS:**

(i) **Axial Inclination of Maxillary Canine:**

This is perpendicular in Class II and mesial in Class I usually, though drift without axial pervention can occur.

(ii) **Overbite and Compensating Curve:**

This is commonly deep in Class II. It also occurs in Class I but less frequently.

(iii) **Facial Pattern and Profile:**

This is more commonly backward divergent in Class II but it can be forward divergent. Class I, from lack of function, can exhibit an underdeveloped mandible.

(iv) **Cephalometric X-Rays:**

SNA higher in Class II

SNB lower in Class II

SNA-SNB difference greater in Class II.
C. CLASS II DIVISION I and CLASS II DIVISION II:

(i) Central Incisor Angulation:
Labial inclination in Division I, upright or lingual inclination in Division II.

(ii) Arch Shape:
Frequently narrowed posteriorly, V-shaped with high palate in Division I. Simulates the normal broad arch more often in Division II.

(iii) Overbite and Compensating Curve:
Exaggerated Curve of Spee in Division I commonly. Division II has a deeper overbite and greater freeway space and quite often has flat compensating curves.

(iv) Musculature:
Division I is frequently associated with abnormal swallowing and incompetent lips.
Division II is associated with competent lips.

(v) Gonial Angle:
There is an inverse relationship between lower incisor inclination and gonial angle in Division I. No such correlation can be found in Division II.
Division II commonly shows normal growth and development.

D. CLASS II DIVISION I:

<table>
<thead>
<tr>
<th>Maxillary Protrusion</th>
<th>Bimaxillary Protrusion</th>
<th>Mandibular Retrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I or II Protrusion of upper lip, fullness around mouth</td>
<td>Fullness around mouth always present</td>
<td>II Chinless</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary</th>
<th>Case Analysis (Fischer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dento Facial Relation Type</td>
<td>Facial Dental</td>
</tr>
<tr>
<td>Protruding maxillary incisors. Great variation in incisor-mandibular plane angle overjet marked to extreme</td>
<td>Protrusion of upper lip, fullness around mouth</td>
</tr>
<tr>
<td>Overjet slight to extreme</td>
<td>Overbite usually slight</td>
</tr>
<tr>
<td>Overjet marked to extreme</td>
<td>Overjet slight</td>
</tr>
</tbody>
</table>

| Protrusion Type | | |
|-----------------| | |
| Overjet slight to extreme | | |
D. CLASS II DIVISION I (Contd.):

SUMMARY OF CASE ANALYSIS (FISCHER) (Contd.)

<table>
<thead>
<tr>
<th>Dento Facial Relation</th>
<th>Facial Type</th>
<th>Facial</th>
<th>Dental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrusion of Mandibular Dental Arch</td>
<td>I</td>
<td>Good chin lower lip against incisal edge of upper front teeth deepened labio-mental sulcus</td>
<td>Pronounced retraction of lower dentures with upper normal</td>
</tr>
</tbody>
</table>

If we have a Class II case we think of maxillary protrusion first. Look at the lower arch first to see if it is normal or not. If the lower anteriors are crowded or the patient is a thumb-sucker at 7 years of age, think of bimaxillary protrusion.

Mandibular Retrusion (i.e. a true Angle Class II case).

Structural retraction may be an underdeveloped or distally positioned mandible.

To distinguish between functional and structural retraction take X-rays in centric and rest position.

If there is a reduction in SNB from the normal there is a structural retraction present.

If there is a reduction in SNB from the rest position to centric occlusion, there is a functional retraction present, which may or may not be chinless. Treatment is simply to put in a biteplate. There is some doubt as to whether alveolar retraction (muscular) can occur.

D. CLASS II:

(i) There is a common tendency to lingual inclination of the lower incisors as the apices are carried forward in the over-developing mandible.

(ii) SNA-SNB would tend to show a reduction in SNA, an increase in SNB and close approximation of SNA SNB or SNB exceeding SNA.

(iii) Profile would tend to show prominence of chin point and long mandibular body.
(iv) There would tend to be a constriction of the maxilla from the lingual and backward pounding, which would result in the lingual movement of the apices and alveolar process for adjustment.

5. **CONCLUSION**

Second only to malrelationship of the dental bases in the production of malocclusion is abnormal behaviour of the lip and tongue.

An abnormal incisor relationship can be imposed on normal dental bases as the result of abnormal soft tissue behaviour; if the dental base relationship is abnormal we must know how the soft tissue behaviour is related to such abnormality.

Cephalometrics must be used with a clear idea of the limits of appliance therapy imposed by heredity and interplay of causative factors.

There must be an individual appraisal of case analysis. Can any change be expected in skeletal pattern as a result of treatment or growth? Can we change, and to what extent, the abnormal muscle pattern?

The relation of the face to the cranium, the relation of the profile contour to the teeth and facial pattern individually differ. We must consider in case analysis:

(i) The skeletal pattern and the relation of the denture to it.

(ii) The occlusion and the function of the teeth.

(iii) The function of the facial muscles; to get the total picture of denture and facial balance and harmony.
V. **PROGNOSIS.**

1. Is Treatment Necessary?

2. Probable Outcome of Treatment.

1. **IS TREATMENT NECESSARY?**
   
   A. Abortive and Unnecessary.
   
   B. Essential.

A. **TREATMENT - ABORTIVE AND UNNECESSARY.**

(a) **EVOLUTIONARY.**

Humphreys in a deliberate provocative vein considers there has been an evolutionary trend over some fifty generations from an edge to edge bite to the overbite of today, that is, from Anglo-Saxon England, genetic transmission has given the overlap commonly found in British and Western European stock today. Some primitive races today still exhibit this edge to edge occlusion. He therefore asks why should we consider overbites infringe our concepts of desirable occlusal standards and treat a natural evolutionary trend.

Colyer and others disagree. They state that an edge to edge occlusion is acquired, due to wear and is present only with marked attrition.

(b) **PERIODONTAL.**

Overbite when excessive has been considered to be a causative factor in periodontal disease.

Rix takes a broad view and continues to doubt that excessive incisor overbites are in the top class of damaging occlusal relationship, except for that more limited variety where the gingival margin itself receives trauma from the incisal edges.

Emslie has shown that periodontal abscess formation can occur by forcing infected material deeper.

Unfortunately there are some overbites which cannot be improved permanently by orthodontic tooth movements alone and semi-permanent wearing of a bite-opener might be necessary.
Hovell states that all variations from a "normal" occlusion do not necessarily involve either a faulty position of alveolar bone or of teeth relative to masticatory forces, and that such a malocclusion will have no effect upon the periodontal condition of the patient.

The degree of cuspal interference during movement varies to such excessive overlap that locking is complete and there is no possibility of lateral or protrusive movement of the mandible.

Hovell states that where a very deep overbite exists without actual traumatisation of the tissues or allied abnormal path of closure, the gingival health is good, locking being so complete that excessive strains are not thrown on to the teeth.

Emslie and Parfitt quite agree that acute gingivitis is less common in closed bite cases. It has been noted by Parfitt that over half the number of patients attending Guy's Hospital Dental Department for the treatment of acute gingivitis had an edge-to-edge or nearly edge-to-edge bite.

Hellegrém has found, that clinical experience seems to indicate, that certain abnormal forms of occlusion may contribute to the occurrence of injuries in the periodontium, but there is no scientific proof. Clinical experience also shows that some cases of excessive overbite are unaffected by incorrect loading. These are sometimes called "constitutionally resistant dentitions." It seems that we have at present little opportunity of deciding whether or not cases of excessive overbite are resistant to periodontal disease at the ages suitable for the treatment of this malocclusion. If the prognosis were good and the disadvantages of treatment insignificant, treatment could be recommended. But this is seldom the case.

Among the disadvantages is the long period of treatment. It is possible that prolonged treatment may impair the periodontal tissues and this is particularly true of the less resistant dentitions. The forces to which the teeth are subjected in
treatment are of the same kind as those that act in incorrect loading. On the other hand it may be asserted that the treatment period is limited to some years and that the tissues in the child are more easily adaptable to the new loading conditions than those of the adult; but it is still impossible to rule out the possibility that prolonged orthodontic treatment may have a detrimental effect on the periodontal tissues.

When we are evaluating the indications relating to periodontal disease for the treatment of excessive overbite there are several unknown factors to be taken into account and it seems very doubtful whether treatment of these dentitions should be recommended for the reason of preventing periodontal disease.

Stillman considers that "jiggling" is pathognomonic of traumatic occlusion. Emslie disagrees saying that the most common recession sites, the palatal tissues of the upper molar and labial tissues of the lower incisor are those with very thin bone. Hovell showed that some "jiggling" could be the result of muscle forces entirely. Tulley flatly denied any possibility of periodontal involvement in these cases and in view of the many unchangeable factors states that deep overbite, providing it is not traumatic, may well be left alone.

Hovell states that the ideal incisor relationship is with an angle of 135° - 140° between the long axes of the upper and lower incisors and an overbite of one-third the labial surface of the lower incisor together with a normal antero-posterior apical base relationship and Frankfort-mandibular plane angle. The relationship is such that during protrusive movement the incisors are maintained in light contact as the jaws are separated by the occlusal planes of the posterior teeth.

The axial inclinations necessary to bring this about vary greatly with the skeletal pattern and muscular behaviour according to Ballard.
Figs. 1-6 show variations in incisor relationship due to variations in the axial relationship of the teeth on normal antero-posterior dental base relationship.

Figs. 7-12 show variations in incisor relationship on a Class II dental base relationship.

1. is normal incisor relationship.

2. shows the incisor relationship which can occur as the result of a simple proclination of the maxillary labial segment. Causes may be impotence of the upper lip, tongue thrust, etc.

3. shows the incisor relationship which occurs as the result of early loss of teeth in the lower buccal segments with a consequent lingual collapse of the labial segment. The excessive incisor overbite is the result of the change of angles and not an occlusion on cheek teeth occlusion.

4. shows the incisor relationship of an Angle's Class II, Division 2 occlusion when this is entirely the result of soft tissue balance on a normal skeletal pattern; a bimaxillary retroclination. This relationship might also occur as the result of a collapsed lower arch as described for (3), with the upper incisors dropping lingually as well.

5. is the relationship in a typical bimaxillary proclination. This is as a rule in balance in soft tissue behaviour, and not very amenable to treatment.

6. shows a typical Class II, Division 1 incisor relationship on a normal skeletal pattern. If the buccal segments are in contact relationship with these labial segments the molar occlusion will be postnormal. The cause of such a relationship is usually an abnormality of behaviour of tongue and lips, perhaps associated with finger- or thumb-sucking. All these abnormalities so far described are on a normal dental base relationship.
(7) shows a Class II, Division I incisor relationship as the result of a Skeletal II pattern (mandibular dental base retrusion), with upper and lower labial segments in normal axial inclination to basal bone. There must be some abnormality of soft tissue posture in such a case otherwise the relationship would have been as in (9) or (10).

(8) shows a greater overbite and overjet than (7) which may be the result of incompetent lips tongue thrust, or fingersucking on a Class II dental base relationship.

(9) and (10) show possible optimum incisor relationships with normal soft tissue behaviour patterns on Class II dental base relationship. In (9) soft tissue balance has resulted in a retroinclined upper labial segment to compensate for the skeletal variation, and in (10) soft tissue balance has resulted in a proclined lower labial segment.

(11) shows the incisor relationship of an Angle's Class II, Division 2 type on a Class II dental base relationship.

(12) shows excessive incisor overbite due to abnormal anatomy of upper incisors. The crown is lingually inclined on the root. This is untreatable orthodontically.

Emslie points out that this balanced relationship of Hovell's is seldom found in the natural dentition.

In 1953 Jankelson, Hoffman and Hedron in their report on 35 patients' chewing movements with some equilibrated occlusion found very little occlusal contact which only seemed to serve as a proprioceptive warning of stroke termination. They concluded that tooth balance was not a physiological necessity.

The actual direction of the masticatory force is affected by the incisor inclination to each other, there being normally a large vertical and small labial force component at the normal 130°-140° angulation. Baum in a cephalometric study of 62 white children aged 12-14 years with excellent occlusion found 126° in males and 129° in females, tending to increase with growth.

Bjork compared the Bantu, 120° with the Swedes 130° and found a range of 100°-125° in the Bantu.

Much individual variation in these angulations is shown by Ballard and there is little evidence that excessive angulation predisposes to gingivitis from trauma. Possible lack of oral seal in extreme incisor angulations may account for the inflammation.
(c) **MUSCULAR.**

Mershon stresses the dominance muscle has over bone. He is against the idea of opening the bite and says "If the closed bite is only a stage, normal growth processes will correct it. There is nothing known to Science which will correct a true closed bite either during development or after maturity."

Hemley, Breitner and others claim that muscle adaption is possible.

(d) **CLINICAL.**

Kelsey has pointed to many deep overbites which seem to be a natural age or developmental level and are self-corrective. Further he stresses the uncertainty of getting a response to bite opening in many cases and in others having obtained the desirable result, it is difficult to prevent relapse of all or part of it.

**B. TREATMENT - ESSENTIAL.**

(a) **NORMAL OCCLUSION.**

Downs quotes "Occlusion is the purpose of all Dentistry" as the most important sentence in dental literature.

Strang agrees that a deep overbite from detrimental malrelationship that may exist when considered from the viewpoint of future health and longevity of the dental units.

Callaway emphasizes that function is essential to promote growth and that deep overbite may interfere with the ability to occlude the teeth properly, which in turn gives rise to a post normal position of the mandible when the opposing arches are in occlusion.

The evidence of facets or SNA-SNB evaluation is of great diagnostic aid differentiating functional mandibular retrusion.

Harris concurs that proper function of the mandible tongue and adjacent structures is inhibited.

Sleichter further points to the disturbance of function when the mandible, restrained in its lateral excursions, is forced to function in an almost vertical manner, bringing undue
stress on certain teeth while leaving others almost functionless. Strang states emphatically that abnormal overbite must be corrected to assure stability.

(b) PREVENTION.

Spring has stated that more recently attention has been directed towards the possible effects of the deep overbite on normal development of the dental arches and alveolar processes. In man the lower dental arch closes within the upper arch, setting up labial forces on the upper and lingual forces on the lower incisors. The extent of this closure is dependent on the level at which the premolar and molar teeth contact. Since the anterior teeth taper from their gingival portions it follows that the deeper the overbite, the smaller the arc to which the lower incisors must accommodate and hence the greater the lingual forces operating on the lower incisors. This factor becomes of extreme importance during the transition from the primary to the permanent dentition.

The lower incisor segment of the dental arch must accommodate the permanent teeth which are almost one-third larger than their predecessors. Robbed of this possibility of making sufficient adjustment to this demand by a deep overbite, the permanent incisors are forced to erupt into insufficient space with a resulting crowding, rotation or the complete blocking out of the entire teeth.

The permanent teeth of the upper arch tend to conform to the smaller size of the mandibular arch and a pattern of malocclusion is set up that is extremely difficult to manage by anything but prolonged and intricate therapy.

Kloehn and others have reported on cases where following the placement of bite planes, the crowded conditions of the lower incisor area has been partly or completely relieved. This has pointed to the possibility of control of the overbite by very simple procedures, which might prevent in large measure the development of some of the more severe types of malocclusion.
(c) TEMPORO-MANDIBULAR JOINT DISTURBANCES.

Dental literature repeatedly has emphasized complications, caused by shortening the intermaxillary distance, giving temporomandibular joint disturbance.

Recently case reports of teen-age patients have appeared.

C. CONCLUSION.

It would appear that the weight of evidence favours treatment of deep overbite per se, but individual clinical evaluation must be made.
2. PROBABLE OUTCOME OF TREATMENT.

Conditions influencing prognosis:

A. ETIOLOGY OF MALOCCLUSION:

(a) If the deformity has been produced by a cause that has ceased to be active, the prognosis is favourable.

(b) If the cause is still active but is such that it is possible to remove it permanently, the prognosis is favourable.

(c) If the cause is active, but can only be partially controlled or not even changed at all the prognosis is unfavourable.

(d) If the etiology cannot be determined the prognosis must be signed as uncertain.

Prakash and Margolis state, that it is generally agreed that a thorough comprehension of the nature and the site of the anomaly is essential to determine the choice of therapy and establish the prognosis.

B. TYPE OF PATIENT.

(a) Mental Attitude:

Noyes and Sleichter have both stressed that co-operation of the patient is the most important factor for a favourable prognosis.

Strang feels that the prognosis also is greatly affected by the degree of control and co-operation of the parents.

(b) Physical Constitution:

Bjork has claimed a body-build-bite relationship, the prognosis for bite-opening in sturdily-built children being better.

Strang agrees that a healthy robust child gives every indication of more active cellular response than a weak, anaemic, nervous one. The highly-strung, nervous, habit-ridden patient bespeaks a very unfavourable prognosis.

C. BONE STABILITY.

Todd has shown that bulky masses of bone lingually and buccally to the molar teeth, both permanent and deciduous, show
insufficient calcification of the alveolar processes. Strang is of the opinion that this gives rise to an excessive overbite and offers a very unfavourable prognosis.

D. SKELETAL PATTERN.

(a) Dental.

(1) Position of the Teeth:

Ballard has said, "In any analysis of the skeletal pattern, we are concerned with the dental base relationship, whether it is normal or abnormal and if abnormal, what is the prognosis?"

Prognosis varies with the degree of deviation from the normal skeletal pattern.

Prognosis and treatment of deep overbite depend on etiology as follows -

(1) Prognosis Good:

There is an exaggerated Curve of Spee more clearly detected in the lower arch. Stability is certain if the arch is levelled off.

(2) Prognosis Fair:

The incisors are supraoccluding and require depression. Strang states biteplate therapy would be wrong in (1) or (2), muscle balance would later collapse the elevated buccal teeth. Cole and Litowitz question whether depression is possible.

(3) Prognosis Poor:

In this type the mandibular buccal teeth appear partly erupted while the mandibular incisors have erupted to a much higher plane. Associated with this is a decided lack of vertical growth in the oral area of the face.

Biteplate therapy will temporarily overcome this overbite but final stability is unobtainable. Mesio-distal variation can be corrected and stabilized, but not the overbite.
(ii) Freeway Space:
Hotz and Winfield say that prognosis is better in cases where there is a large freeway space.

(b) Cranio-Facial

(i) Form of Mandible:
Anderson has found that the more right-angled, the angle of the mandible, the more often is there a deep overbite. This kind of overbite resulting from mandibular form is difficult to treat favourably by change in tooth position and that correction of the overbite and maintenance of correction is extremely doubtful.

(ii) Apical Base Variation:
Hovell shows that prognosis varies with the degree of apical base malrelationship.

If severe he claims that:

1. It is not possible to obtain a normal incisal relationship.
2. Mechanical interference by a faulty skeletal pattern may, if severe, prevent maturation of the normal lip posture.

(iii) Frankfort Mandibular Plane Angle:
Graber measures the angle of inclination of the mandibular plane to the cranial base plane and he has found that a steep mandibular plane angle imposes severe limitations on the correction of deep overbite.

He also states that the axial inclination of the incisors and their antero-posterior position in the face is important in an analysis.

E.g. A Class II Division I malocclusion with upright incisors and no spaces has a poorer prognosis than a Class II Division I malocclusion with a labial inclination and spacing of the maxillary incisors.

E. SOFT TISSUE PATTERN:
Prognosis will depend on many variables - the degree of the deformity, the period over which it has been acting, the
manner and force of the application and the time it is applied as well as the age of the patient, that is whether he is capable of understanding and optimum tissue response.

However, the soft tissue pattern determining the environment will be uncertain in its natural or trained modification and prognosis limits to treatment must be envisaged.

Tweed stresses the stability of the lower incisor position over basal bone.

Ballard emphasizes the part played by the soft tissue production or contribution to the abnormality, when this deformity is basically the result of abnormal base relation. The possibility of the soft tissue behaviour being modified to stabilise the result after treatment must be considered in prognosis.

Rix feels that early treatment by re-education rather than by exercises improve prognosis. These vicious circles can be broken into with success but results are generally patchy. Rix further asks "How can we tell what slow changes may come about naturally in the incisor area or what modification can be achieved in muscle behaviour to affect prognosis?"

F. CONCLUSION.

The more that is known of interplay of skeletal growth with muscular behaviour, the more clearly can it be seen that feasible compromise with nature must be made and some limitation of tooth movement in treatment visualised.

TREATMENT OF DEEP OVERBITE.

1. PRINCIPLES OF TREATMENT.

There are two schools of thought at present :-

(a) Empirical:

Profoundly influenced by Tweed and still cling to aesthetic viewpoint and treat by uprighting lower incisors and getting straight faces. However, results in other hands still reveal difficulties in maintaining a reduced overbite, contacts at extraction sites and lack of incisal imbrication.
(b) **Rational:**

Through a knowledge of physiology, pathology and etiology, treatment approaches the ideal.

Downs and Wylie did much to restore rational thinking by seeking standards and guides of a quantitative morphological nature.

A. **FUNDAMENTAL RULES OF TREATMENT:**

(a) err on the side of overtreatment.

(b) all points of interference to tooth movement should be removed.

(c) in deep overbite extraction is contra indicated, for any extraction of upper premolars or molars to facilitate the retraction of incisors limits the amount of bite opening that can be attained.

(d) If we have to move the upper arch back and must extract to reduce tooth tissue in order to eliminate cause of forward drift, determination of which premolar or molar to extract depends on many factors; the degree of forward drift of the upper inclination of buccal teeth, holding back of lower, caries, extraction spaces on opposing arch, whether short course of treatment necessary, degree of overbite, presence of third molars etc.

B. **BASIS OF TREATMENT:**

It is generally agreed that –

(a) The growth plan of the face is established very early in life.

(b) The basal bone of the face is not and the alveolar bone is capable of orthodontic alteration.

(c) The mandibular dental arch is at any time balanced where it is found, or is unbalanced and is moving to a balanced position. It is known that if the mandibular arch is moved from where it is found or where it would have been but for extraction, it tends to relapse towards its former position.
(d) There is an extrusive force tending to move posterior maxillary teeth, mesially. If they move or are moved mesially they are balanced and tend to remain in a stable position. If they are moved distally they tend to move mesially again.

(e) Stimulation of bone cells causes bone changes and thereby tooth movement. Light intermittent forces or strong forces over a short period have been advocated. According to Breitner the influence of force on a tooth depends on -

(i) Biologic Factors -

(1) Ability of bone deposition and resorption.
(2) Speed and grade of calcification.
(3) Connective tissue reactions.

(ii) Physical Factors -

(1) Shape and length of the root.
(2) Resistance of surrounding tissues varies at different levels and distribution determines resulting movement.
(3) Manner of application - simple or stationary anchorage.
(4) Intensity of force.
(5) Direction of force.
(6) Location of application of force

C. REQUIREMENTS OF TREATMENT:

It is abundantly clear that levelling off the mandibular arch contributes much to the correction of the overbite. The bite can be appreciably opened by buccal tipping of lingually tipped or lingually placed premolars and molars. Wedging action, when the posteriors move distally or are uprighted, reduces the overbite.

Treatment varies with each case depending on which teeth must be elevated or depressed. The requirements seem to be correction of the arch form, arch length and rotation, reduction of the case to Cl.I (Angle) relationship and changing the Curve of Spee to the desired shape.
Steadman claims if the Curve of Spee is correct and the tooth alignment in Cl.I (Angle) case is established, the overbite will be corrected automatically.

2. **APPLIANCE TYPES:**

Moyers says the ideal appliance would have a range of action of 0.2 mms i.e. the approximate periodontal membrane width with an intermittent force of 15 to 25 gms. This latter is the normal capillary blood pressure. If this force is exceeded there is interference with the blood supply which determines the response of alveolus and periodontal membrane.

Graber points out that the present high level of appliance construction and comparative efficiency of tooth movement have only accentuated the diversity between treatment objectives and treatment results. In our search for the unattainable ideal of Moyers and a single appliance that will manage all malocclusions, the trend has been strongly towards more and more control of individual teeth. The pendulum has swung all the way. The resulting complexity of appliances, while solving many problems of mechanotherapy especially in Cl.I (Angle) cases, has introduced new and more far-reaching problems and has pointed to the inadequacies of conventional fixed and Class II (Angle) cases.

Less control allowing possible growth interference has been much advocated. Breitner claims to avoid tipping movement and get bodily movement by weak forces applied near gingival margin in a pulling manner and in a direction never pointing towards the root. In a questionnaire majority of Americans preferred to use fixed appliances in overbite treatment rather than rely on biteplates. Porter feels that principles are more important than appliance type but often gets same result as a full edgewise mechanism with more simplicity, and fewer bandings.

Choice of appliances:

(a) Fixed.

(b) Fixed-removable.

(c) Removable.
It would appear from the findings of Sleichter, Bahador, Higley and Marshon that any malocclusion, requiring a depression of lower incisors, would necessitate a full banded lower appliance.

Strang advises banding twelve-year molars and if not erupted, if possible wait till they can be banded.

Steadman says if there is an advisable Curve of Spee on one side and the error is on the other side only, the use of biteplate, occlusal plane or cement-block is contra-indicated. Can only use these where an identical change would be produced bilaterally in each of the faulty Curves of Spee and just where it was needed. The advantage of the edgewise mechanism is given as accomplishing all the required movements simultaneously. However, when Curve of Spee alterations are necessary, individual tooth banding is the thing to do, irrespective of the arch-wire type as long as an advisable Curve of Spee is placed in the arch-wire. Distal bends could be inserted in order to obtain elevation of posterior teeth or depression of incisors. From the mechanical leverage effect it might be expected that more movement would occur in the anterior section due to smaller incisor teeth acting against the progressively larger posterior teeth. Litowitz, Cole and Aisenberg question the permanency of depression of lower incisors.

Ballard believes it is possible to alter incisal overlap without increasing or decreasing vertical height by altering axial inclination of upper and lower incisors. However, alteration of axial inclination alone would often result in poor aesthetics and this phase is often only a subsidiary factor in treatment analysis.

Successful results have been reported time and again with all the various treatment approaches, in spite of criticisms of the particular appliance and apparent physiological limit of possible treatment changes, as follows:
A. **Fixed Appliances:**

Most popular in America are:-

(a) **Edgewise Appliance:**

Forces are high, but with small distances and tremendous control, great success is given. It was Angle's latest and best appliance when introduced and has been highly developed by Tweed. Tweed, in severe overbite cases, advocates the use of bite blocks with posterior vertical elastics. Such a positive action, while direct in approach, may well be queried by Thompson and Wylie. It requires greater care than round arch as root resorption is more prevalent and bodily movement causes greater damage than tipping movement and requires longer regeneration.

(b) **Twin Wire Appliance:**

Closest to ideal force but acts over long distances and can be most harmful if misused. Tipping and rotation, mainly of anterior teeth is acknowledged but the effect on posteriors is questionable, particularly if the second permanent molar is impinging on the first.

Johnson claims not to have used a biteplate for the past six years. In the process of treatment and arch expansion overbite is seen to be correcting, and with distal movement of molars becomes acceptable. Where the four canines are blocked out, deep overbite is advantageous to lock mandibular anteriors whilst he drives mandibular posteriors back. If anchorage is not good enough he reinforces with Class III rubbers. The bite opens especially in those cases in which an upper lingual arch is not indicated i.e. when expansion not needed, at least in the beginning of treatment. He lines up anteriors first, drives molars back by coil spring then uses elastics at night. He claims greater elongation of molars this way. If he wants the bite opened quickly e.g. there may be a jacket crown anteriorly, he starts elastics the same day as the bands are on. In deep overbite cases it is helpful to place arch gingivally to brackets, this is limited by possibility of molar tipping or bending of the end tube. Johnson lists many cases of deep
overbite quickly treated, ready for retention under 12 months.

(c) Labio lingual Appliances:

Gentle continuous force acting through great distance gives tipping mainly. There is not great control but teeth, not held rigidly, get any beneficial muscular effects.

Oliver Irish and Wood developed the occlusal guide plane attached to arch in a precision-like way. The better results over a removable biteplate being due to a lack of bulk not so likely to produce a dual bite and the fact that they cannot be removed by the patient. Not widely received in America, though felt to have some use in Angle Class II cases where mandible under-developed (Lischer). Hopkins says not all cases are satisfactory; he prefers to wait till 12 year molar is erupted and then allow guideplane to place the teeth, bones and musculature in an advantageous position for encouragement of rapid normal growth and development.

Possibly because of the numbers seeking treatment the British prefer simpler appliances and fewer bandings. Round upper labial arch and lower lingual arch with six-year molars banded. They recognise anchorage limitations by taking a few teeth back at a time, extract and reinforce with extra-oral anchorage if necessary.

(d) Miscellaneous Appliances:

Spencer Atkinson treats deep overbite with his Universal Appliance by attention to Curve of Spee of archwire.

In McCoy’s Open Tube Appliance he uses distal bends to elevate molars and depress anteriors.

Chapman uses upper and lower bite raisers. Porter uses sidehooks; Webster buccal planes; Leech flapper springs; Carey sliding twin wire and Thornton Taylor offers the curved tube spring when usual banding cannot be utilized.

Stoller draws attention to first permanent molar drifting and allowing over-eruption of second molar. He corrects and minimizes archwire bend by placing tube towards mesial and
mesially inclined on the first molar and towards the occlusal on the second molar.

**OVERT BITE CORRECTION WITH ELASTICS**

- [Image of dental diagram]

**EXTRACTION**

**NO EXTRACTION**

INTERMAXILLARY FORCE IS APPLIED IF THE POSTERIOR TEETH TEND TO MOVE TOO FAR MESially.

Hellman considers the object not to stimulate growth but to interfere as little as possible with it. He prefers developmental supervision giving help when the need is evident. Where retardation of developmental shows in comparison with his tables, he prefers to wait if possible. Treating cases in the period of maximum facial growth should give quicker and more satisfactory results.

**Extra-oral Anchorage:**

Fischer's work has seen a renewed application in treatment therapy. Epstein says in some cases the maxillary molars move distally, in others the maxillary molars are held stationary in the forward growing maxilla, while the mandible grows forward. In some cases, and sometimes unilateral for an unknown reason, the teeth do not move. Have a longer period of treatment than intermaxillary anchorage, though the hours of applied force are less. Nelson illustrates a case of re-treatment due to uncorrected overbite. He placed two tubes on the molars and used intra-oral anchorage by day and extra-oral at night. A clip-on extra-oral arch would have obviated the need for two tubes. Graber uses a biteplate to obtain clearance to retract the maxillary incisors.
B. FIXED-REMOVABLE APPLIANCE:

Can be worn together to speed up treatment or remove interference, or can follow the other as stages of treatment. Henry shows Cl. II (Angle) cases successfully treated after extraction of first permanent molar. Jackson uses biteplate in conjunction with fixed labial appliance.

Haberle uses lingual arch on the lower for expansion when deep overbite prevents placing a labial lower arch. He places an upper posterior biteplate to prevent jamming.

C. REMOVABLE APPLIANCES:

(a) Kesling Tooth Positioner has been advocated for minor changes in tooth position and is more associated with retention. The cutting off the model of the plaster teeth and resetting in wax deserves merit in diagnosis.

(b) Andresen Method.

This has a widespread use in Europe. It can be used in conjunction with other appliances e.g. headcap treatment. A construction bite is taken at the required occlusion. The activator is trimmed as shown to allow posterior teeth to erupt. The bite is opened in deep overbite cases up to or even beyond the rest position.

Diagrammatic representation of activator in treatment of deep overbite.
The lower denture is locked to the upper denture and the force returning the mandible to its original position carries the maxillary teeth distally over a period of one or two years.

Haupl has claimed changes in the glenoid fossa after animal experimentation. Thompson says there is no possibility of jumping the mandible forward except in a case of functional mandibular displacement. Ricketts considers there may be excessive joint mobility. Bjork cephalometrically has shown the changes are confined to the alveolar arch reshaping in common with fixed appliances. However, he showed greater effect possible by activator at an early age (4-7 yrs.) than by intermaxillary elastics later. The activator is more effective in the tooth erupting period taking advantage of the eruptive force than in the later permanent dentition. When the normal occlusal development is interfered with by the incisal overbite, early treatment will have a most favourable developmental effect. Patient co-operation is essential and age and crowding of arches limit its use.

(c) Acrylic Plates:

Adams' clasps have so increased retention that these plates are used for attachment of intermaxillary elastics. Molar tubes are commonly soldered to Adams clasps in Britain.

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>POST</th>
<th>OVERBITE</th>
<th>SPACING</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral screen</td>
<td>Slight</td>
<td>Increased</td>
<td>Anteriors</td>
<td>Insufficient eruption of buccal teeth for retention. Won't move teeth back unless spaces present.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>space created by extraction</td>
<td></td>
</tr>
<tr>
<td>Intermaxillary Traction</td>
<td></td>
<td>No spaces</td>
<td></td>
<td>Lower incisors retroclined. If upper third molars present extract these or second molars. Where teeth erupted and regular</td>
</tr>
<tr>
<td>Andersen</td>
<td></td>
<td></td>
<td></td>
<td>Lower incisors proclined and imbricated and patient has incompetent lips, leave lower incisors alone(no intermaxillary traction.</td>
</tr>
<tr>
<td>Acrylic Plates</td>
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<tr>
<td>(1) extract upper first bicuspids.</td>
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<tr>
<td>(2) retract canines</td>
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<tr>
<td>(3) another plate with labial bow spring to retract upper incisors.</td>
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</tbody>
</table>
(d) **Biteplates:**

**Terminology:**

Some confusion exists in the literature. Biteplate should refer to those with platform which just slopes forward a little. Biteplanes are those with a definite inclined plane incorporated to help position the mandible forward. Biteplates are generally preferred.

Carey prefers flat biteplate to be worn when using intermaxillary elastics to take the opposing teeth out of occlusion. Lewis prefers the flat plate to prevent any unnecessary tipping of the lower incisor teeth.

However, unless lower incisors are in contact with lingual surfaces of uppers when the plate is removed a further continuous eruption should be expected on the part of the anterior teeth on the same principle. Case considers the inclined plane may be better for this reason, particularly when mandible is functionally displaced in some Class II Div. II (Angle) Cases.

**Types:**

Simple bite blocks or removable biteplates have been described far back in the dental literature. Angle on finding the bite too short after treatment says "the only method which has proved satisfactory to the author is a vulcanite biteplate with hooks engaging the cutting edge of incisors for stability." They have waxed and waned in popularity over the years. Kingsley popularized them then. Baker's introduction of elastics pushed biteplates into the background from which they emerged with Oppenheim's intermittent force work and modification by Rogers, Hawley and Oliver. They are the most common and universally used orthodontic instrument in the world today.

1. **Hawley Biteplate.**
2. **Gved Biteplate.**

Has a shelf of acrylic over the incisal edge 1/8". More in keeping with the ideas of Prakash and Margolis. However over-erupted upper anteriors are difficult to treat even with
fixed appliance. Some do not produce depression. The fit must be accurate as usually they are not clasped and the fit can be difficult with overlapping teeth. The extra retention is helpful but more important is the quicker response of the teeth, probably due to the growth of upper and lower posteriors, the anterior section preventing any growth of the anteriors because of constant biting pressure.

The Hawley may give transfer of stress to the lingual of the upper incisors resulting in their elongation in the absence of the incisal extension. Both are used for retention. Sved is better aesthetically.

Sved claims tightness of fit is great help in tapering off retention. If the tight feeling returns have to wear for additional period, and can check patient co-operation. Sved draws the long bow and claims reduction of overbite in a few weeks with continual wearing, permanent results and apical base changes. He further does not recommend over-correction as self-correction of the open bite so created does not easily take place.

Philosophy of Biteplate:

Hemley quotes Macewen's work on diminished resistance at the epiphyseal plate being suitable for growth and claims bite opening, throwing the posteriors out of occlusion, provides an area of diminished resistance.

Watschon doubts the initiation of growth in the alveolus, attributing only rebuilding (repair) or direction changes.

Landsberger has proved, when lacking antagonists teeth seek occlusion, the alveolus growing into the gap and carrying the teeth along, the bone so lacking functional stress being weaker.

Weinmann says expected changes are due to continuous eruption process which lasts as long as a tooth is in the oral cavity. However, if the freeway space is excessive, on the basis of Wylie's work, and granting muscle hypertonicity and bone cells unable to withstand normal pressure, one wonders why the
expected eruptive process would not occur prior to insertion of the plate.

**Platform Height:**
This is determined from the freeway space present. Most advocate opening the bite in stages of 1/8" at a time. Depth distally is such that lower incisors cannot strike behind it and equally share the load.

Strang cautions against opening bite posteriorly in retention. The platform should duplicate anatomic form of lingual and occlusal surfaces of upper incisor teeth and be just thick enough to maintain teeth at the level produced by treatment. Posterior tooth elongation would tend to distal relationship of mandibular teeth again.

**Wearing the Biteplate:**

**Patient Instructions:**
Some disagreement but majority think wearing all the time is best. Some tissue damage may result so oral hygiene must be emphasized. After two or three weeks there is generally apparent depression of lower incisors, and can thereby check if patient is co-operating.

**Time of Insertion:**
Some use before, during or after treatment only.
We cannot wait for the normal forces of eruption to accomplish the bite opening for we do not know when or if it will occur. Strang says, in the absence of gingival trauma and mandibular incisors are not behind the incisive papilla, wait till premolars erupt, the vertical growth then occurring may self-correct the overbite. In Cl.II (Angle) cases treat overbite during eruption of premolars or earlier as indicated by the malocclusion.
Period Work:
We can't commit ourselves to the time necessary. It may vary from six months to two years. If changes are to occur they will be evidenced in a short period. If there is no change within six months, discontinue the appliance. This lack of response is thought to be due to the posterior teeth having separated too much or not wearing the plate during mastication. During treatment it can be worn till the posteriors are in contact for some time and teeth being banded give added stability. In retention it is worn at night only. Belger shows no correlation between period of use and amount of height increment.

Uses:
Questionnaire revealed diversified opinion. Henry, Hemley, Callaway, Lewis, Stolzenberg and Spring list :-

Tooth Movement:
(i) Deep overbite cases.
(ii) Cross bite (anterior and bilateral). In anterior cross bite, depth of bite is important. If shallow the addition of posterior overlays is indicated to gain depth for temporary retention.
(iii) Prevent extrusion or to intrude teeth.
(iv) As a stage in treatment with springs and space retainer.

Pre-Treatment:
(v) Remove interference in tooth movement.
(vi) To open bite as a preliminary to band treatment.
In some Cl. II Div. I (Angle) cases it is a great help to wear 3-6 months before treatment proper.
(vii) In uprighting a molar tooth, "Jiggling" results from the continued return to its original position by occlusal stresses, a bite plate will ensure freedom of movement. Similarly for a tooth out of occlusion bucco-lingually.
Mandibular Displacement:
(viii) Posterior mandibular displacement (lowers in vice-like grip).
(ix) Lateral mandibular displacement.
(x) Jumping the bite.
(xi) Stimulate development of upper incisor and other limited areas.

Periodontal:
(xii) Prevention of palatal trauma and an aid in combating periodontal lesions in adult.

Joint Disturbances:
(xiii) Relief of Costen's Syndrome and preparation for bite raising in mouth rehabilitation.

Extra-oral:
(xiv) In conjunction with occipital and cervical traction.

Habits:
(xv) Habit control.

Retention:
(xvi) Retention.

Results of Biteplate Therapy:
On review, the biteplate therapy literature is highly academic with little of practical value. In the main, experienced clinicians' opinions are based on plaster casts indicating nothing more than relative tooth position, incorrect Curves of Spee can't be judged from models alone. Infra-occlusion of molars or supra-occlusion of incisors gives an identical curve. Criticism can be directed at many research workers where lack of control group support indicates recorded changes could have been caused by normal growth.

Claims for the value of biteplates are inconsistent.
Various alterations in the occlusal plane have been suggested and denied. Permanent increase in dental height is mentioned but not substantiated. Local changes reported suffer
almost a common failing in lack of comparable age control group.

1. Anterior Overbite Changes:

That a reduction of anterior overbite can be accomplished is generally conceded by the many empirical and the few scientific observers.

2. Occlusal Plane Changes:

(a) Supraclusion of mandibular and/or maxillary incisors.

(b) Infraclosure of mandibular and/or maxillary molars.

(c) Any combination of these factors.

These causative schools of thought are at variance with each other and the reasons for the overbite reduction have not been firmly established.

(a) Depression of the Mandibular Incisors; is claimed by Marshon, Jackson and Neudstadt. Wolfson claimed scientific corroboration but his method of measurement is open to question.

Hemley denies the possibility of depression of the lower anteriors and quotes Jansen; "functional pressure is a stimulus, bone will withstand tremendous pressure in the direction in which it was built," there is then a natural resistance to depression.

Zingeser, Bahador and Higby agree, though they lack a control. Sleichter, Prakash and Margolis have proved little if any change in the mandibular incisors and their work is accepted by most experienced clinicians.

(b) Elevation of Incisal Teeth:

Hopkins expressed this opinion with no evidence.

Davenport, Chapman, Dunn, Gray and Howes agree. Lewis and Belger substantiated the infraclosure cephalometrically. Hemley cites the mandibular molar alone but his studies did not include the maxillary molar, which Bahador and Higley state is more concerned than the lower. Swain accepts the vertical height presenting as a stable characteristic, which will relapse if heightened and intrudes and grinds the anterior teeth.

(c) Combination:

Angle says "overbite due principally to elevation of lower incisors....while some lower molars occupy a lower plane
than normal." Treatment by a combination of molar elevation and incisor depression is thought to occur by Strang, Salzmann, Sved, Steadman, Howard, Callaway, Bonwell and Breitner. Prakash and Margolis suggest depression of upper incisors, elevation (mainly lower) of the molars.

3. Facial Changes:

It produces changes in the muscles of mastication and secondarily in some muscles of expression for profile improvement according to Salzmann. Rogers used a biteplate in conjunction with myo-functional therapy.

Mershon emphatically denies muscle elongation once fully formed, and as muscle controls face height, any increase could only be temporary. Others feel that stretching or reattachment of muscle is possible. Hemley states the biteplate controls the hypertonic muscles and guards the bone growth till maturity when metabolic disturbances disappear. Strang agrees and having seen many successful bite-opening cases years out of retention, feels that some muscle adjustment is possible, probably in tonicity.

Hellman has shown that normal profile may not necessarily follow the establishment of normal occlusion and improvement would depend on inherent developmental possibilities.

4. Arch Form Changes:

Sleichter with cephalometric X-rays studied 30 biteplate cases, checking against a control of 47 cases monthly and found:

(i) Maxillary expansion in all cases.

(ii) In the majority of cases mandibular dental arch length was increased by labial tipping of the lower incisors. Graber and Kloehn quite agree. Herzberg however, warns against undesirable increase in incisor procumbency and illustrates a 9° increase at the higher levels.

5. Bone Changes:

Breitner has conducted interesting animal experiments.
Histologic evidence would indicate changes in teeth only partly explain the development, to which changes in the joint and "angle" contribute.

(a) Changes at the "angle" of the mandible.

1. INSERTION OF BITE PLANE.

MUSCULAR ACTION, INDICATED BY ARROW, PRODUCES WIDENING OF 'ANGLE', OCCLUSION OF MOLARS AND FORWARD MOVEMENT OF BODY OF MANDIBLE.

The change is due to muscle pull in line with Hershon's ideas. Breitner disagrees with Strang and puts forward the suggestion that increased bite opening at the retention stage would lead to further movement forward of the mandible and reduction of the antero-posterior discrepancy of the arches. A flat plate so used would be preferred to an inclined plane forcing teeth out of alveoli. One must respect Strang's long clinical association and point out the experimental nature of Breitner's work.

Hopkins says as the condyle head slips back into its ordinary position, changes occur in other portions of this bone. McCoy treated children with dwarfed mandible aged 8-13 years with elastic traction followed by biteplates and his measurements showed increase in body, ramus and changes in "angle" of mandible. Investigation with more normal mandibles showed unchanging pattern. Some observers discount bone changes stating there may
be some posterior shifting of maxillary teeth and forward shift of mandibular teeth through the bone. Whatever changes occur are claimed to be similar to those which would gradually take place with elastics alone. Benson has demonstrated posterior positioning of the mandible by alteration in bone form in Class II (Angle) cases at condyle neck involving a lower gonial angle.

(b) Changes in the Temporo-Mandibular Joint:

Breitner indicated that "the condyle apparently is growing disto-cranially." He attributes changes in form to nature's attempt to re-establish original dimensions and balance, and he is in agreement with Todd that morphology is a reflection of environment.

Applebaum and Levy consider the changes are due more to the associated malnutrition.

Salzmann and Hopkins claim the biteplate positions the condyle forward on the eminentia articularis, sliding back when tissue changes have occurred and so deny Breitner's work. Some confusion exists in the literature as each quotes different passages of the same author's writings to substantiate their case. The crux of the whole matter is the degree of jaw opening involved and whether one believes in pure hinge or associated forward condyle translatory movement in minor jaw opening. Anatomists Gray and Cunningham confine movement to a pure hinge in minor opening; wider opening give translatory movement and axis is condyle neck or disc. Lord claims initial forward translation of condyle, stating the axis is in ramus centre by reason of ligamentous attachments. He is sharply brought up by Sicher who states such ligaments play no part whatever. Reisner has attempted to show radiographically that the condyle moves forward immediately. He agrees with Atkinson in refuting the possibility of forward movement of glenoid fossa to accommodate a condyle head that has been forced forward by biteplate and maintained there. They demonstrate an angular readjustment of
head and neck of the condyle or destruction of posterior surface of the articular eminence or anterior margin of the condyle head or both.

Conclusion:
The biteplate is capable of decreasing the amount of overbite through an alteration of the normal process of dental development.

The effect of musculature, occlusal forces and growth upon the permanence of the therapeutic measure is open to speculation, as are the etiological factors involved.

Certainly one factor to be considered is the normal freeway space. It is possible that induced eruption of posterior dental units will allow them to occupy any excessive freeway space available. On the other hand it is difficult to understand why normal eruption doesn't take advantage of the space if it is actually an excess. One has the feeling that freeway space is often normal for the individual even though it may be more than average in height and any attempt to reduce this space will be eventually followed by relapse.

The usefulness of the maxillary biteplate is limited unless accompanied by other measures which will provide normal incisor function in occlusion. Permanency of results may well depend on early treatment, patient co-operation, resultant incisal occlusion, adaptability of interocclusal space and length of the retention period.

3. TREATMENT SUB-DIVISIONS.

A. DECIDUOUS DENTITION:

Deep overbite frequently observed as Brodie has shown in recent tooth eruption work.

There is an uncertainty in the literature with opinion changes over the years. Angle advocated treatment whenever the deformity became apparent. Hershon felt that resorption of the deciduous arch obviated the point of treatment. Hellman states
most treatment is instituted too early without proper regard for the natural processes of growth and development; the developmental stage being more important than the chronological age. Strang takes a broad view. He acknowledges that past results were often not satisfactory; retreatment in the permanent dentition where the malocclusion was often worse. Untreated cases often showed marked improvement. Strang feels some cases must be treated e.g. Cl.II and Cl.III (Angle) and deep overbite where the discrepancy between the arches is marked, interfering with normal function stimulating growth and development and proper positioning of the first permanent molars. One feels that Strang's viewpoint is sound. Dewey Anderson advocates general early treatment, the earlier the better to coincide with growth processes.

There is now a drift back to early treatment.

The object is prevention of deformity in the permanent dentition. If a simple appliance can so act and avoid later complicated treatment the advantages are obvious.

Treatment influences the permanent successors:-

(i) Indirectly - proper arch placement for growth.
(ii) Directly - Breitner experimentally gave histologic evidence of a developing bud following the path of deciduous tooth movement. One quite agrees with Strang that his evidence is inconclusive and prefers to believe there is no influence exerted after deciduous roots are resorbed and permanent buds not enclosed.

The disadvantages of deciduous tooth treatment are:-

(i) prolonged treatment period possible by retreatment.
(ii) permanent dentition result not assured.
(iii) danger of permanent root deformities have been emphasized and illustrated by Kronfeld, Gottlieb and Orban. Baker foresaw the danger and in the treatment of overbite with his elastics
suggested application when there is minimal development of permanent bud i.e., when deciduous roots are fully developed. One must point out that he visualized mechanical impingement rather than interference with the development of Hertwig's Sheath. (iv) variable response of deciduous teeth to therapy. Brodie has recently shown a lagging in molar eruption in the deciduous dentition giving deep overbite. Further work has shown biteplate therapy at a very early age gives posterior eruption invariably. In general Sleichter found the deciduous molars did not erupt as rapidly when released from occlusal forces, as did the permanent molars and premolars.

Waugh feels that early treatment will halve permanent deformities. He lists six other therapies, as well as orthodontic treatment, to be instituted.

Cheney has produced good results in deciduous upper anterior incisors linguoversion by grinding off overbite interference as inclined planes and stabilizing with tongue blade exercises.

B. MIXED DENTITION

There is general disagreement in the literature.

Kelly, Lasher and Bishop are opposed to treatment stating 75% require retreatment.

Strang agrees that one of the reasons why treatment was considered useless was that expansion for accommodation led to later collapse.

On the other hand Barich treats all except those with inadequate arch length which are potential extraction cases. Tweed says there is some residual growth up to 12 years of age; he therefore X-rays and measures unerupted canine-premolar dimensions. He positions lower incisors and trims down or extracts deciduous teeth for space. When the permanent canine and premolar are in the arch he uses all the anterior teeth as anchorage to drive the first permanent molar distally.
Terwilliger, Nance, Ebehn and Steadman consider some treatment necessary with simple appliances if possible.

Steadman states he does not treat deep overbite as such in the mixed dentition. Variation in size of the teeth in the different dentitions produces difficulties. Any correction of arch relationship causing interference with development or palatal irritation will automatically correct the overbite.

Treat (Questionnaire):-
Class I (Angle) - observation and Nance treatment.
Class II Div. I (Angle) - where facial appearance bad, psychological effect or risk of tooth fracture. Appliance varies from bite plate and headgear to full edgewise mechanism.
Class II Div. II (Angle) - most contentious. 50% felt biteplate with springs to retract laterals should be used to free mandible.

Class III and cross-bites treated.

Brodie feels that early extra-oral anchorage is most beneficial; the headcap holds the maxillary molar and allows the jaws to grow forward and a Class II (Angle) becomes a Class I (Angle) simply if treated early.

Litowitz showed a rebound of maxillary molar mesially when treated with cervical gear therapy. Those cases which were stable exhibited growth during treatment, i.e. early treatment, soon after the six year molars erupt, is advocated. This is a most important finding.

C. TREATMENT OF DEFORMITIES.

(i) Cleft Palate. Kettle has described a forward position of the probantium as the favourable type of case, the looser lip, tooth apart swallow, and deep overbite play a part in the maintaining this segment forward. In case with a cleft of the palate only, there is seen a reduction of the overbite
at 5-6 years due to a lack of forward and downward growth of the upper arch. In some bilateral cleft of the lip and alveolar process the presence of a large premaxilla produced a marked overjet and overbite in the incisor region. Treatment of this deep overbite is limited by the excessive lingual inclination of the upper anteriors. Because of the cosmetic liability surgeons sometimes are tempted to extipate the premaxilla or else reposition it distally by the removal of a section of vomer.

Pruzansky states such surgical measures are rarely indicated as serious intranasal and dental complications follow and he claims that growth of the maxilla and mandible catches up on the prominent premaxilla by the age of 5 years.

(ii) Micrognathia.
(iii) Mandibular Prognathism.
(iv) Mandibular Deficiency.

Better results are now obtained by working as a team.

D. MYOFUNCTIONAL TREATMENT:

Rogers often uses biteplate to remove interference in conjunction with muscle exercises. Kelsey considers change brought about by alteration of condyle neck. Rix, Ballard, Gwynne-Evans have pointed out that response is patchy though early treatment to break vicious circle is necessary. Ballard is investigating lips apart posture in regard to maturation. He feels same posture will be evident in the adult.

E. TREATMENT OF ADULTS:

We consider here those over 20 years in whom growth has largely ceased. The dentition is now static and judicious grinding can be employed. Goldstein says there is no age limit, the quality of the tissues is the important factor, however, treatment should be cautious because of slow response, no growth help, and lack of retention from wear.

Howes presented two adults, 30 years, with deep overbite successfully treated, using gentle force over a period of three
years.

(i) Where patient once had a desirable overbite which has been lost by reduction of vertical dimension, the problem is not orthodontic.

(ii) Where there never has been a normal overbite due to faulty Curve of Spee or malocclusion, Steadman says he can correct overbite if Curve of Spee is treatable.

F. TREATMENT OF CLASSES OF MALOCCLUSION.

1. CLASS I (ANGLE) - BIMAXILLARY PROTRUSION AND EXTRACTION CASES:

Forward movement of posteriors or deficient apical base resulting in crowding of anteriors look the same and are treated the same clinically. If treated by expansion there is a potential bimaxillary protrusion, therefore, a candidate for extraction.

If you have a thumbsucker of say 7 years think of bimaxillary protrusion as lower arch may be carried forward with upper. Therefore, extract upper first premolar and possibly the lower second premolar for better results.

Strang advocates mild distal tipping bends, which also initiates gingival thrust on anteriors for correction of excessive overbite almost always present.

Taking canines posteriorly into extraction spaces by partial arch wires is warned against by Buchner. Yet tilting of first permanent molar and increase in overbite and tooth position difficult to correct. Where canine is locked in mesial inclination Strang suggests a biteplate to prevent breakdown of anchorage in the buccal segments.

2. CLASS II (ANGLE) CASES:

(i) Mass Depresssion of Teeth:

This is limited to anterior teeth. In case analysis of deep overbite it is most important to determine whether there are sufficient posterior teeth in normal vertical occlusal relationship to furnish depression anchorage.
From Prakash and Margolis some depression of upper incisors is indicated. Whether a Sved biteplate or fixed appliance is used, depression is generally considered difficult to achieve. Strang claims this movement is readily accomplished with edgewise arch. He uses ligature traction first and finishes with extra gingival bends ahead of the first premolar bracket or else uses a vertical loop distal to the canine with the anterior leg shorter, with compensatory lingual torque.

(ii) Mass Elevation of Teeth

(a) Marked Curve of Spee (Division I).

Canines and distal surface of first molars approximate the normal vertical position. Bicusps elevated by placing desired Curve of Spee or flat archwire. Molar teeth must be uprighted and carried distally to avoid prognathous position. A spring ahead of the molar in conjunction with Class II normal elastic traction seems to drive molar distally and results in less extraction. Strang advocates stop springs at mesial of rectangular molar tubes, distal tipping bends reinforced by Class III elastics to take crowns distally.

In the final period of readjustment when distal bends and lingual torque are being removed a Curve of Spee is placed in the archwire to neutralize the anterior depressing effect.

Strang emphasises the ideal position of the second molar, mesially inclined and placed occlusally to the first molar and points out reciprocal archwire effect gives ideal treatment.

(b) No Exaggerated Curve of Spee (Division II).

Molar and premolar teeth are parallel to but below the line of occlusion. Deep overbite is present and is never self-correcting but the incisors are not usually in supraocclusion. Malocclusion is present from an early age due to the lack of face height. There is more lateral mandibular growth than Division I and little forward displacement of incisor teeth. Due to deeper freeways space more posterior displacement of
mandibular arch is commonly noted.

There is not an abundance of literature on this division. Barich suggests gingival placement of archwire anteriorly when Class II elastic are worn to prevent further elongation of incisors. Callaway uses a biteplate with no labial bow in some Division II cases where posteriors are in good cranial relationship and the maxillary anteriors are not tipped too far lingually. The upper anteriors tend to be driven labially stimulating forward mandibular growth and open the bite.

Strang states "we are deprived of reciprocal archwire action" so he uses a biteplate early and overtreats. He gets beneficial vertical growth and in some, forward positioning of the mandible. Tweed recognises the need for a biteplate but uses it in the later part.

Prognosis is extremely doubtful.

(iii) Treatment of Class II Division I (Angle):

From Angle's simple classification and treatment research has added correction and complication. Angle postulated underdevelopment of the mandible. Benson has shown Angle is incorrect and that form changes are responsible. Cephalometrics has added its share of conflicting thought.

Some investigators had claimed and others denied posterior mandibular positioning.

Blair reports only minor differences in skeletal pattern of Class I (Angle) and Class II Division I (Angle).

The results of intermaxillary traction have been roundly questioned. Fischer claims 3/4 are maxillary protrusions and does not recognise possibility of forward mandibular positioning. He is opposed by those who point to Ricketts work in Class II Division I (Angle) showing 2/3 have upward and backward mandibular movement from rest to function and could therefore conceivably come forward to the normal upward and forward movement. Thompson denies any such possibility.
Retardation of maxillary jaw growth seems a definite treatment possibility using Kloehn heavy arch or Class II elastics during early growth period. It has been pointed out by Strang however that 85% of anterior maxillary growth occurs in first four years. We think then, that each case must be treated on its merits, some distal movement and extraction in the upper arch would be required preferably by early extra oral anchorage.

(iv) Treatment of Class II Division II (Angle):
Correction of inclined plane relationship only occurs after Class II elastics commenced and these must be responsible for either -:

(a) Mesial position of the Mandible. This can occur obviously as overjet seen to increase during retention with a perfectly fitting retainer. Vosnik considers it cannot be obtained without accompanying increase in vertical height.

(b) Stimulation of Mandibular Growth. Most authorities have shown tooth movement to be less, than clinically thought, and growth and development have a considerable part in the change.

(c) Mesial Movement of Mandibular Teeth. This is to be guarded against, indicating anchorage giving way and giving a degree of bimaxillary protrusion. Hedges showed 17 out of 23 cases with mandibular molar moved forward.

(d) Retardation of Maxillary Growth. One may see the trend of delaying treatment till eruption of the permanent dentition (when most antero-posterior and lateral growth has ceased) altering to a short course of mixed dentition treatment to get maximum benefit from growth possibilities.

(e) Distal Movement of Maxillary Teeth. Litowitz has shown a rebound unless treated early. Distal tipping of maxillary molars is considered by some not to occur and many are eliminating second order bends and using an exaggerated Curve of Spee.

3. CLASS III (ANGLE) CASES:
Clinically there are two types -
(1) Overdeveloped mandible-spacing, deep overbite.
(ii) Normal mandible—similar but no spacing (may be crowded).

Parker, after a cephalometric analysis of 43 patients, stated the characteristic was anterior positioning of the mandible not always accompanied by more obtuse gonial angle and overdevelopment. Some may be normally placed with a distally placed or micromaxilla.

(a) True Class III (Angle):

(1) Mesial Positioning of the Mandible, Overdeveloped:
Camouflage deformity and restrain mandibular growth by restoring labial overbite. Appliance depends on degree of deformity. Tweed develops great overbite in treatment with Curves of Spee in archwire. Prognosis depends entirely on degree of overbite for locking incisal relationship.

(ii) Mesial Positioning of the Mandible, Normal Size:
Similar treatment. No extractions in maxilla.

Hahn suggests extraction of mandibular incisor to help lingual anterior movement which is limited by lingual cortical plate thickness.

(b) Pseudo Class III - Distally Placed or Micromaxilla:
Really Angle Class I relationship. Treat as (a) but may need extractions in both arches.

4. RETENTION.

(a) Introduction:
Deep overbites demand retention upon correction.

Grieve and Strang emphasize that proper attention to case analysis and treatment will minimize retention problems. Strang for the past five years has not widened inter-canine mandibular width, has widened the lower molar area slightly and adapted the upper arch to this lower. He then claims 95% of his cases require no retention. The 5% are all overbite cases. He further stresses the need for proper overbite correction for any case retained with some degree of overbite will be bound to develop some malocclusion. All agree that holding the height gained is difficult.
Litowitz has shown cephalometrically that depressed teeth may return to or go beyond their original position. This would in some cases make retention or treatment a waste of time. His work lacked control and the increases may have been due to growth changes.

(b) **Appliance Types:**

Generally a lower lingual arch and upper removable are used. The Hawley is adequate for broad flat teeth but the Sved holds canines better, may obviate retreatment and is more in keeping with Prakash and Margolis' work. Sved also claims a better tapering off process, based on the feeling of "fit". The differing views of Strang and Breitner on thickness have been given.

(c) **Classes of Malocclusion:**

(i) **Mixed Dentition:**

Fischer claims most stable results in corrected overbite by moving and holding back the upper and lower permanent molars till the permanent dentition erupts.

(ii) **Class I (Angle):**

No retention in majority of extraction cases says Strang, except where deep overbite has been corrected. Porter agrees that Class I deep overbite treated with biteplate is difficult to hold and needs long retention.

(iii) **Class III Div. I (Angle):**

Porter says where overbite is corrected by elastic traction in distocclusion cases, the bite holds well. Strang observes the case when out of appliances and retains it if upper incisors begin to drift labially causing overbite to recur. Proper reciprocal archwire treatment gives a good prognosis. If the anteriors were expanded instead of depressed overbite would relapse.

(iv) **Class II Div. II (Angle):**

Over-treat the open bite 1/8" anteriorly. Poor prognosis.

(d) **Factors in Retention:**

(i) **Mechanical:**

Fisk observes better stability where case shows an
appreciable flattening of the Curve of Spee.

Softly gives the eruption of the second and third molars as important factors in maintaining the height gained by the biteplate. Some permanence of the occlusal plane and cuspid eruption have been mentioned.

(ii) Constitutional:

Rix points out that certain oro-facial musculature can cause return of overbite no matter how long retained. Diet is considered by Porter to be more important producing more substantial bone structure during bite-raising. Strang agrees and issues a warning for poor prognosis and long retention in those showing typical bony "bosses" where nature has given quantity to endeavour to make up for poor quality of bone.

(e) Time Worn:

Hellman and Oppenheim cut down the wearing of elastics so that there is a tapering off of active appliances and no retention per se. McCoy, after myofunctional therapy and elastics, retains with biteplate till the third molar has erupted. Tweed overtreats to edge to edge relationship then uses biteplate night and day for a few weeks, then at night only for 6-12 months.

(f) Conclusion:

Retention of acquired height depends on growth, muscle pressure and bone stability. In the light of very similar cases of deep overbite showing different reactions during and after retention, the general instability of results when biteplates are used, and granting their great value, one feels a new approach must be tried. Stability of distal movement of first permanent molar when treated early one feels might hold promise in correction of deep overbite cases.

5. RESULTS OF APPLIANCE THERAPY:

This section is to be read in conjunction with biteplate therapy results given previously.
(1) Anterior Overbite Changes:
Bite opening is generally claimed readily attainable.

(2) Occlusal Plane Changes:
Downs and Wylie showed there is a large variation in the occlusal plane. Correction by Class II elastic treatment has been credited to one or a combination of:
(a) Movement of maxillary teeth from their alveoli.
(b) Movement of mandibular teeth from their alveoli.
(c) Repositioning of mandible by reorientation of glenoid fossa without change in shape of mandible.
(d) Repositioning of mandible by reorientation of "angle" and head of condyle.
(e) Growth changes.
(f) Changes in occlusal plane.

Brodie has shown that intermaxillary elastics changed occlusal plane and tooth inclination and that there was a strong tendency to return to original position. Tovstein agrees stating the greatest growth cases in treatment showed the greatest tendency to revert. Epstein demonstrated cases treated solely with extra-oral anchorage and showed no alteration in occlusal plane. Stoner in a cephalometric appraisal of Tweed's treated
cases acknowledged height increases. He said the upper occlusal plane descended in a parallel fashion but the lower tipped up posteriorly and down anteriorly and this explains the improve-
ment in overbite.

Hedges proved that treatment without growth shows tipping and where the most growth occurred the occlusal plane altered least. He agrees with Bjork that in the absence of growth, this may be the only way possible for treatment in the presence of unfavourable skeletal features.

(3) Facial Changes:

(i) Soft Tissue Changes:

Stoner has commented on the facial improvement in Tweed's cases though pointing out that all were not in the same muscular repose when the lateral headplate was taken. Most facial change was due to a skeletal alteration. There was a recontouring of the lips, which were thinned because of the great lingual movement of upper incisors (ANT reduced as much as 7°), increase in height and alteration of lower incisor angulation.
(ii) Hard Tissue Changes:

Bjork found the sturdy-built child responded better to bite opening due to greater growth activity.

Lande has shown Downs A and B points vary little in growth from 3 to 17 years though gnathion grows relatively forward. Tovstein states, however, that those cases showing the greatest growth are allied to the greatest change in the AB plane with no tendency to reversion.

Clinically it is observed that severe overbite with low FMA is more difficult to treat than those with severe FIA which tend to develop open bite in treatment. It was thought that more vertical increase could be demonstrated in the latter but Stoner found no correlation. After six months biteplate use Henry demonstrated a $3.2^\circ$ increase in FIA, $1.5^\circ$ of which was held.

Wylie claims FMA improvements are slight, ranging either side with an average of $0.15^\circ$.

Tweed has postulated that an achieving of $65^\circ$ FMA will ensure good results.

Brodie flatly condemns this conception.

Wylie, analysed 29 Tweed treated cases and concluded that clinical ability was more evident than any single angulation confirmation. Stoner used 57 of Tweed's treated cases and cephalometric appraisal revealed:

(a) FMA varied inversely with the facial angle FHP. The smaller the FMA, the more vertical the facial plane.

(b) FMA varies directly with the facial plane. The more upright the incisor, the more forward the chin point.

Stoner agrees that Tweed gets results in facial contour improvement which those, following his methods, do not achieve. Growth plays a big part and Tweed has "an ability to seemingly elicit growth." Stoner states that FMA improvement rather allows other changes for profile improvement; the posterior movement of upper incisors, forward positioning of chin point in some and reduction of overbite.
(4) Arch Form Changes:

Walter showed by model measurement that 94% of treated cases showed reduced overbite and 70% of the increase was retained. Opinions vary and there is much yet to be done but increased arch length could be expected more commonly than thought.

(5) Bone Changes - Changes in the Temporo-Mandibular Joint:

Strang states that "if an increase in dental height can be gained and the growth centres in the condyle stimulated, a great improvement in facial contour results." Bahador and Higley cephalometrically substantiated the vertical dimension increase but within the technique limits could not determine measurable bone changes. Breitner has followed Oppenheim's principles and with Class II rubbers experimentally, on histologic evidence claims a mesial repositioning of the fossa by appropriate resorption and apposition. Those advocating myofunctional therapy point to the evidence of patients swallowing and masticating correctly after treatment and say bone changes must occur.

Rickett's uses radiography and says that the Class II Div. I (Angle) condyle is forward positioned on eminencia and is seated normally after treatment by changes in the condyle head and neck. Tovstein found in those cases exhibiting little or no growth during treatment, the mandible was distally positioned with Class II elastics, the reverse to what might be expected.

Conclusion:

Much conflicting thought exists.

One would conclude from the great weight of evidence that the changes produced by treatment are confined to the alveolar process and that tooth movement per se was the lesser role, the changes being mainly due to growth and development.
VII. **EPILOGUE.**

1. **SUMMARY OF PRESENTATION:**

A broad picture has been presented. Within the limitations of canvas there is much detail that might have been sketched in and additionally some of the material included is pure background. In the search of the literature, that which has appealed has possibly been overstated.

The abnormality has been described. The fundamentals to our understanding have been briefly related. The need for determining the etiology, so that the cause may be removed for successful treatment, is acknowledged. Rather than a classification based on when the causes are operative and the site of the action; the broad view has been given, considering the etiology in the labial segment as an interplay of factors.

Temporo-mandibular joint disturbance has been included by reason of the newer concept of abnormal path of closure and overclosure in function, rather than loss of dental height.

Case analysis and treatment have been considered from the wider field of malocclusion classes, and an attempt has been made to link overbite with the various classes of malocclusion.

Prognosis has included a discussion evaluating the opinions of those who continue to doubt that deep overbite is in the top flight of damaging occlusal relationships.

The conclusion is an analysis of the thought current in the literature.

2. **CONCLUSION:**

"It is of quite as much importance that the proper length of bite be established as it is that any other phase of malocclusion be corrected." E.H. Angle.

Angle may be considered to have used two standards of importance, for disharmony of the vertical relationship of the jaws is not given a place in his classification of malocclusion.

It is abundantly clear that an equal superficial consideration of overbite exists in the literature today.
The heart of the overbite problem is fundamentally tooth eruption:

(i) the force of eruption is not sufficient to increase jaw height - hence the overbite.

(ii) the continuous process of eruption, with orthodontic interference, may be expected to increase jaw height - hence the treatment.

That an insufficient elevation in the height of the tooth occurs, has been widely attributed to the factors of:

(a) bone stability.

(b) muscle pattern.

(a) Bone Stability - Poor:

The importance of diet has been stressed to promote good bone structure, though it is acknowledged that the skeletal strength is systemically not a treatment variable by nutrition or medication.

Research must evaluate biting force and the type of food in the dynamics of occlusion.

(b) Muscle Pattern - Short Underdeveloped or Hypertonic:

The inherent need for muscle fibres to contract till firm resistance is reached, is used by some to prove that once bone development fails to keep pace with muscle development, overclosure of the jaws will be maintained. The degree of tonicity is claimed to be of separate inheritance in individual muscles to explain hypertonicity causing jaw overclosure.

Others prefer to believe there is an adaption inherent in every muscle fibre, limited only by the degree of change in the line of action.

Research on animals analysing changes in muscle tension by medication is still in the experimental stage.

Balance of Dento-Alveolar Structures:

The dento-alveolar structures are in balance, whether normal or abnormal, in a position in soft tissue behaviour, antero-posteriorly laterally and vertically and have grown from bases, the size, position and relationship of which is genetically determined.
At this stage there is a feeling that little can be done to promote bite opening in the face of this muscle - bone balance. However, we have to consider the beneficial effects in some cases of the physiological rest position and growth.

**Physiological Rest Position:**

If we accept Thompson's evidence that the vertical growth of the dento-alveolar structures does not contribute to the face height, it follows logically that the vertical growth of the dento-alveolar structures just fills in a pre-determined inter-maxillary space with a normal or abnormal occlusal relationship which is established, as a resultant of the dental base relation and soft tissue behaviour.

Rest position is the essential factor in the analysis, for the vast majority of deep overbite patients show a normal overbite anteriorly in the rest position with the posteriors separated by an excessive freeway space. It has been shown that treatment can increase the jaw height in many patients with an excessive freeway space.

Excessive freeway space has been attributed to premature contact associated with an abnormal path of closure.

It has also been noted that in abnormal swallowing behaviour that, where the widest separation occurred, was seen the deepest overbite. This warrants further investigation.

Criticism has been levelled at the constancy of the rest position and the limitations such acceptance place on bite opening.

The view is advanced that a certain stability exists in rest position rather than a constant position. Some people have altered their neuro-muscular pattern to produce a new rest position whilst others markedly resist such change. It is pointed out that experiments on orthodontic patients did not show the same constancy of results as the initial experiment. Further excessive bite opening leading to bone resorption occurred in elderly patients and comparison with young ortho-
dentic patients was unreal.

The inability to encroach on some apparently excessive freeway spaces in treatment or by natural eruption has been explained as a natural variation.

It is pointed out that freeway space like any other norm is difficult to assess and that the reading, though excessive by our standards, may be perfectly normal for the individual.

Further it is demonstrated that people appear to move out of their rest position.

Are we accepting too literally the dogmas of muscle immutability and bone pattern?

Orthoptists commonly correct squints by re-education to a new neuro-muscular pattern. Orthopaedists have no doubt that muscle will adapt itself to a shortened limb. Primitive races produce tiny feet or elongated necks by binding.

This comment is deliberately controversial for it is abundantly clear that our present approach is not on firm ground and that many unsolved problems bar the path of progress.

We must become aware of the morphological pattern and study growth and development and in utilizing cephalometric appraisal keep the concept of the individual before us.

Research must be conducted in order:—

(i) To improve knowledge of the changes in skeletal growth.

(ii) To relate better the dento-alveolar structures to cranial form.

(iii) To understand better abnormal muscle pattern behaviour and its control and reduction.

(iv) To understand better the potential of growth adjustment that is inherent in muscle tissue and whether it is brought about by arch adjustment and the limits thereto.

**Growth:**

The influence of increasing amounts and direction of vertical growth is an important part of the correction of deep overbite. Fixed appliances would not elevate the posteriors
with the limitation of anterior anchorage and growth must play a substantial part in the tooth movement. If the growth potential is not present to allow adjustment of the inhibitory and extrusive forces, the correction must be all of a depressive nature and slowly attained if at all.

It is Concluded that:

(1) Occlusion is the basis of all dentistry. The importance of maintaining arch integrity by preventive procedures in the formative years cannot be over-stated so that the individual may be given the opportunity of attaining his full growth potential.

(ii) Physiological rest position is the essential factor in the analyses of deep overbite.

(iii) Correction of vertical height shows great instability in present treatment.

(iv) New methods should be tried.

(a) The patients should be examined early and growth trends watched as to direction and timing.

(b) Consideration should be given the part played by the first permanent molar. Early treatment by extra-oral anchorage would appear preferable.

(v) The amount and timing of growth is of the greatest importance in successful treatment.
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