- A CRITICAL REVIEW OF ORTHODONTIC LITERATURE -

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Angle's Class 111 Occlusal Abnormality.

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March, 1957.

Introduction.

Malocclusion has been defined as a departure from an ideal, or more specifically from a practical standpoint, from an accepted or usual form of occlusion.

Dento facial abnormalities may be attributed to hereditary influences, deficient development and growth, disturbed function, untoward environmental forces including accidental factors which may be acquired by the individual. All of these may express their effects individually or in combination.

The aforementioned factors may produce disturbances in structure, form and function of the dento facial components. These disturbances may be symmetrical or asymmetrical and of varying degrees of intensity. They may be confined to (1). one tooth

(2) several teeth

(3) the entire denture

(4) they may involve the bony structure of the jaws alone

(5) or all of the foregoing.

Malocclusion therefore, may involve individual teeth, the dental arches, the alveolar processes, the supporting jaws or all of these.(1)

Science is a knowledge of facts, arranged to find the fixed order of things and the relations of cause and effect. These are Natural Laws.

Until we are familiar with the natural laws of heredity, growth and development, and the environmental forces associated with the dento facial complex, the treatment of malocclusion will remain empirical.

Heredity.

The Mendelian Laws of Transmission have never been applied to the separate parts of the dento facial complex. Thus the suggestions that malocclusion may be due to the inheritance of large teeth from one parent and small jaws from another; that one may inherit a large jaw from one parent and a small jaw from another and similar statements have never been substantiated.

What has been substantiated is that first generation offspring of primitive peoples such as the Eskimo and the Australian aborigine, are afflicted with an increase in malocclusion, pyrrohea, dental caries and a higher percentage of impacted wisdom teeth.(1),(2)

The hereditary picture of these natives is identical with that of their parents. Yet their dental problems have multiplied.

The value of heredity as a major etiological factor in malocclusion is suspect.

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Growth of the Facial Skeleton.

Vital Staining.

During the growth period the facial skeleton increases in all three dimensions of space, in height, in width and in depth. However there is a regularity about this process of growth or the maintenance of the original pattern of the facial skeleton and its relations to the skull.

The more important sites of growth for the maxillary complex are three sutures on each side., the fronto maxillary, the zygomatico maxillary and secondarily the zygomatico temporal and the pterygo palatine. It is significant that these three sutures are parallel to each other and are all directed from above and anteriorly down and posteriorly.

Growth in these sutures will have the effect of shifting the maxillary complex down and anteriorly.

Growth in the described sutures increases height, length or depth that is the vertical and antero posterior dimensions of the nasal parts of the maxillary and palatine bones only. The subnasal part of the maxillary bone increases in height by apposition of bone on the free borders of the alveolar process simultaneously with the eruption of the teeth. In an average skull sutural growth contributes more to the increase in depth and growth on the alveolar border more to the increase in height. In other words sutural growth contributes more to the forward shift, growth at the alveolar border contributes more to the downward shift of the upper jaw.

At the same time regulatory bone apposition and modelling resorption takes place. Sutural growth alone does not evidently suffice to achieve the normal height of the nasal cavity at the same time the orbits nearly of final size at birth, would gain too much in height by the growth at the sutures between frontal bone and zygomatic and maxillary bones. As a correcting process apposition of bone can be observed on the orbital floor, and resorption on the nasal floor. The latter is in turn compensated by apposition on the oral surface of the palate. Thus the palate shifts down by the additive effect of sutural growth and continued rebuilding. The apposition of bone at the orbital floor is also proof for the reality of sutural growth.

The downward and forward growth of the subnasal part of the maxillary body, is accompanied by intensive apposition of bone at the free borders of the alveolar process. The apposition in this area not only contributes to the increase in height of the upper facial skeleton, but also allows for proper adjustment of the alveolar process and the dental arch to the teeth, especially during the eruption of the permanent dentition.

The down shift of the hard palate by resorption on its nasal surface and by apposition in its oral surface tens to obscure the down growth of the alveolar process. Although the median palatine suture provides a site of growth increasing the transverse diameter, maxilla and inter pterygoid width is achieved by the downward divergence of the pterygoid processes. The growth of the pterygoid processes in postnatal life occurs by apposition at the free borders and surfaces and by corresponding modelling resorption. It is evident that growth in the median palatine suture is simultaneous with and correlated to the widening of the down shifting maxillary complex.

The Mechanism of Mandibular Growth. This is entirely different from that of the maxillary part of the face. In the latter the growth is primarily sutural, initiated by proflieration of sutural connective tissue. In the mandible however the main growth centre is the hyaline cartilage in the condyle. That the chief factor of growth is the interstitial growth of connective tissue in the upper facial skeleton but appositional growth of cartilage in the mandible, explains a certain independence of the growth of these two parts of the facial skeleton and their different reactions in certain pathological conditions.

The condylar cartilage cannot be compared with an articular cartilag of long bones or with an epiphyseal plate even though growth of the mandible does occur in the condyle by proflieration of the cartilage and its gradual replacement by bone just as in the cartilages of long bones. The hyaline cartilage of the mandibular condyle is covered by a thick layer of dense connective tissue whereas the articular cartilage of other bones has no covering. This covering of connective tissue enables the hyaline cartilage in the condyle of the mandible to increase in thickness by appositional growth whereas the cartilages both articular and epiphyseal of long bone thicken by interstitial growth. The hyaline cartilage in the head of the condyle therefore holds a unique position and differs widely from that of other cartilage growth centres in its reaction to certain pathologic conditions.

Proliferation of the condylar cartilage contributes both to the increase of the mandibular ramus in height and to the increase of the overall length of the mandible. The head of the condyle grows rapidly and continuously in an upward and backward direction thus pushing this bone downward and forward. There is persistent upward growth of the alveolar border and backward growth at the posterior border of the ramus.

Gross Studies on the Growth of the Head. (Dried Skulls)

The advantages of studying dried skulls are:

i. they cannot answer back,

ii. there is no soft tissue to upset the accuracy of the observations,

iii. study of pure ethnic groups such as the Aborigine without any racial intermingling is possible,

iv. study of man at definite stages of his development e.g., stone age man, bronze age man, civilized man etc.

The disadvantages are:

i. vast collections of skulls at different stages of development are necessary for results to be statistically significant,

ii. among the civilized nations it is rare that the bodies of the young are willed to the museums, thus we rarely deal with modern man.

Gross Studies on the Growth of the Head. (Living)

This is done with the anthropologist's head spanner, dividers and scales.

The disadvantages are:

i. only landmarks on the exterior of the head can be approached,

ii. these are covered by soft tissue thus introducing an error,

iii. soft tissue is not the same depth over the various points measured,

iv. to compensate for error a vast amount of material must be handled.

Advantages and Shortcomings of Single Methods of Investigation.

1. Vital Staining. (Qualitative and Quantitative). This shows where growth occurs and by indirect methods of feeding or multiple injections will yield results on growth rates and amounts over short periods of time. After this the stain is lost by bone resorption. Chief disadvantage is that the animal must be sacrificed.

11. Microscopy. (Qualitative). This is the only method showing cellular activity involved in bone growth but it gives findings only at the instant of death. There is also the constant danger of artefacts introduced by methods of preparation.

111. Study of Dried Skull Series. (Quantitative). This gives a good generalised picture of quantitative aspects of growth and also of trends or tendencies. Its chief disadvantage lies in the fact that since variation in all measurements is so great, it is impossible to draw lines between the normal and abnormal in any given individual when he is compared with the mean of the group.

1V. Serial Roentgenology. (Quantitative). This is the only method which permits of following the individual through the entire growth period. It is capable of telling in what direction and how much growth is occurring but fails to reveal where the growth is taking place.

<u>The Broadbent-Bolton Roentgenographic Cephalometer.</u>

The device is a headholder to which are adapted to two x ray tubes which bear a fixed relation to it. Since this relation is a fixed one the patient is positioned to the entire system rather than arranging the system to the patient, as is usually done in radiology.

The base of the cephalometer is designed to hold a dental chair and after the patient is seated the chair is raised until the ear holes are opposite the ear posts of the machine. These ear posts are calibrated in the same manner as those of a face bow used in denture prosthesis and after seating them in the patients ears the head is centred. This makes the mid sagittal plane of the head coincide with the mid plane of the head holder and this common plane is exactly five feet from the anode spot of the lateral x ray tube.

With the head held by the two ear posts it would obviously be possible for the head to rotate round the ear hole axis i.e. the chin could be held high or low. Subsequent pictures of the same patient would be strictly comparable and could be superimposed meremly by rotating the film around the ear hole. It would not be possible to separate the images of the right and left sides however in any such picture, and this is frequently necessary. To do this we need a film taken at right angles to the first one and with the head in the same position.
This is accomplished as follows;
After placing and centreing the head with the ear post the patient is asked to raise or lower the chin until a pointer on the machine can be placed at the left orbital point. This pointer lies at the same level

as the superior surfaces of the ear rods so that the head is thus brought to the Frankfort plane. In this position it is locked by means of a nasal rest which is carried back against the bridge of the nose.

Two cassette grooves complete the set up. One of these lie at the side of the head away from the tube and parallel to the mid sagittal plane, while the other lies in front of the head and at right angles to the first or in other words parallel to the ear hole axis. The tube for the taking of the frontal picture is placed exactly five feet in back of the ear rod axis.

In the preliminary adjustment of the tubes to the machine it is necessary in addition to establishing the five foot distance, to adjust them so that the central rays are correctly directed at the object and the film surfaces. This is done according to the rule of optics and results in the lateral tube casting its central ray along the superior surfaces of the two ear posts. Thus it meets the midsagittal plane and the film surface at right angles. The frontal tube is oriented in a similar manner so that is ray is cast at right angles to the ear posts at and at the same level as that of the lateral ray. In this way it meets the frontal film surface at right angle.

To make the picture the lateral cassette is placed first and a lead millimetre scale is fastened to the nasal rest with its zero point at Frankfort. Since this scale casts a shadow, that is enlarged to the same degree as are midsagittal structures it is possible to make correct readings on the film by meremly employing this scale for the work.

With the lateral film exposed, its cassette is removed and the frontal cassette is placed, current is directed to the frontal tube by an overhead switch and this exposure made.

1. <u>Principles of Roentgen Ray Anthropometry of the Head</u>.

A. <u>Control of Angulation</u>.

i. axis ray must be at true right angle to film surface.

ii. axis ray must be at true right angle to some basic plane of reference in the head....usually the sagittal plane.

iii. axis ray must pass through point of intersection of the three planes.

iv. an additional exposure must be made with the axis ray film surface and object at a true right angle to the first. This is a frontal.

B. <u>Control of Distortion</u>.

i. distance from anode target to object must be great enough to avoid over enlargement.

ii. control object or scale must be added at the base plane sagittaly to permit corrected measurements.

C. <u>Control of Object to be Taken i.e. the Head</u>.

i. midsagittal plane of head must be made to coincide with the midsagittal plane of the machine-accomplished by calibrated ear posts.

ii. head must be oriented around transmeatal axis until brought into correct relation with a second plane of reference...Frankfort horizontal, left and right porion points and left orbital point.

iii. movement must be inhibited between taking lf lateral and frontal pictures.

11. <u>Anatomical Landmarks used in the Cephalometric Appraisal</u>.

<u>nasion</u> - intersection of the midsagittal plane and the fronto nasal suture.

anterior nasal spine - apex used in the roentgenogram only.

orbitale - the lowest point in the infraorbital margin. This can be determined with only a fair degree of accuracy in the living, but can be located more easily in the lateral and frontal roentgenograms.

posterior nasal spine - since this shows some variation the staphylion, a point at the base of the posterior nasal spine is used ofte

gnathion or menton - said to be the lowest most anterior point at the midline of the mandible. This can be palpated only fairly reliably in the living. On the lateral head plate it is, by definition, the mid point between the most anterior and inferior points on the bony chin.

pogonion - the most anterior poin on the bony chin.

gonion - defined as the most inferior and posterior point at the angle formed by the ramus and body of the mandible. This can be located by palpation in the living. In a lateral head plate it is found by bisecting the angle formed by tangents to the posterior and inferior borders of the mandible.

tragion - the most forward point in the supratragal notch. Used in the living in place of the porion to form the Frankfort plane.

porion - the most lateral point on the roof of the external auditory meatus directly over the middle of the meatus. In the lateral headplate the porion is located by using the uppermost point of the shadow of the ear rod.

Bolton point - highest point in the profile of the notches at the posterior end of the condyles of the occipital bone. Seen only in the lateral head plate.

registration point (R) - point on a perpendicular midway from the centre of sella turcica to the Bolton Plane. Seen in the lateral head plate only.

<u>sella</u> (S) - exact centre of the shadow of sella turcica in the lateral head plate.

<u>A point</u> - the most posterior point in the depth of the concavity of the maxillary alveolar process on the labial surface above the central incisors.

<u>B point</u> - similar point in the mandible.

<u>Planes of the Head</u>.

<u>Frankfort plane</u> - a plane joining tragion and orbitale in the living and porion and orbitale on the skull or in the lateral head plate.

<u>Midsagittal plane</u> - a plane bisecting the skull into two lateral halves.

<u>Orbital plane</u> - formed by dropping a perpendicular to the Frankfort plane at the orbitale. Can only be approximated in the living, but is accurately located in the lateral head plate.

<u>Bolton plane</u> - a plane joing the Bolton point and nasion in the lateral head plate.

<u>Mandibular plane</u> - a line tangent to the inferior border of the mandible passing through the most inferior point at the symphysis of the chin and the most inferior point of the lower border of the mandible just anterior to the angle of the mandible.

Cephalometric Roentgenographic Studies on the Growth of the Face.

1. Study of individual areas.

A. The Nose.

1. Bounded above by S-N, anteriorly by N-ANS and inferiorly by ANS-PNS.

2. Superposed on S-N with S registered.

3. Findings.

a. Floor of nose or hard palate descends in a parallel manner.

b. Line from N-ANS goes forward in a parallel manner.

c. Rates of both are constantly proportioned so that ANS goes downward and forward on a straight line.

d. PNS and PTN appear to go forward and downward during the first year but thereafter go straight down.

B. Upper dental region (maxillary and alveolar process)

1. Bounded above by ANS-PNS (of corresponding age) anteriorly by ANS, and inferiorly by occlusal plane.

2. Superposed on ANS-PNS with PNS registered because of its straight downward course.

3. Findings.

a. Until approximately two years no occlusal plane is present. Measurements during this time are restricted to the relation of the upper deciduous central incisor to ANS-PNS. These successive relations indicate that this tooth travels downward and forward on a straight line.

b. After the second deciduous molar erupts it is possible to establish and study an occlusal plane. Once established this plane remains parallel to itself in successive stages.

c. After the central comes into occlusion it remains on the same line of eruption but the rate of its downward and forward progress is slowed to a degree where its angular relation to ANS-PNS remains constant.

C. <u>The mandible</u> (superposed on Go-Gn registered)

1. The occlusal plane goes upward in parallel stages maintaining a constant angual relation with Go-Gn. At first, the chin point goes forward at a slightly faster rate than that of the anterior end of the occlusal plane but they finally maintain a constant ratio.

2. The lower deciduous central incisor goes forward and upward on a straight line followed by its permanent successor.

3. The angle formed by the body and ramus of the mandible does not change with growth although the condyle is given off at a constantly higher level.

11. <u>Recapitulation of findings derived from cephalometric roentgenograms</u>.

A. <u>Cranium and upper face</u> (superposed on S-N with S register)

1. Cranium exhibits incremental pattern with diminishing rate gradient. Frontal and occipital areas seem to grow almost evenly until about the sixth year. At this time the frontal area slows down and thereafter the occipital area accounts for most of the increase in the anteroposterior dimension. This continues to adulthood.

2. The hard palate descends in a parallel manner

maintaining a constant angular relation with S-N. The anterior boundary of the nasal area (N-ANS) maintains parallelism as it goes forward. In this manner the point ANS, common to both lines, follows a straight downward and forward course.

The posterior nasal spine (PNS) goes straight downward as does also the point indicating the pterygomaxillary fissure (PTN), junction between pterygoid process and maxillary tuberosity.

3. The occlusal plane descends in a parallel manner, maintaining a constant angular relation with the nasal floor. The maxillary deciduous central incisor goes downward and forward on a straight line and its permanent successor follows on the same path.

B. <u>The mandible</u> (when superpositioning is on S-N)

1. Lower border goes downward in a parallel manner maintaining stable angular relations with S-N, N-S-PNS, and with Go-Gn.

2. Occlusal plane behaves same as in upper area (same plane).

3. Gn goes downward and forward on a straight line

4. Go goes downward and backward on a straight line.

5. Angle of mandible does not change.

Discussion and Assessment.

The material Brodie used consisted of fourteen sets of serial head plates taken on 21 different children and extending from three months to eight years of life. These individuals, all males, were x rayed at quarterly intervals during the first year of life, and semi annually from one year to five years. From then on they were x rayed annually.

He concludes " from all of the evidence it seems that the morphogenetic pattern of the human skull is established at a very early age and that once attained it does not change.....each part and probably each bone is growing at a constantly diminishing rate. These various rates however, are so integrated that the growth progress of the various anatomical points falls on a series of straight lines."

Thus the pattern concept of Brodie was mad on patients up to and not beyond the age of eight years.

Brodies work was accepted as law despite the fact that it was based on the study of 21 children and the conclusions drawn were applied to individuals beyond his three month to eight year age group.

In 1947 Bjork published his studies of the face in profile. He challenged the satisfyingly simple dogmas of Brodie and he outgunned him by using 322 head films of twelve year old boys and 281 head films of army conscripts between the ages of 21 -22 years. He showed that the average change in shape of the cranial base is very slight and the same is true of the inclination of the ramus and the size of the jaw angle. The profile on the other hand exhibits an appreciable change with increased prognathism of both jaws somewhat greater in the lower than in the upper. The corresponding angles between his juvenile and adult patients are the same except fro an increased angle of facial prognathism and a reduced chin angle in the adults. The mandibular prognathism is relatively greater in the adults than in the boys which gives rise to a displacement of the occlusion and results in a reduction of overjet and overbite.

The mean values indicate that variation in maxillary and mandibular overbite are mainly the secondary effects of a relative difference in the prognathism of the jaw bases.

Although Bjork also bases his conclusion on composites he accepted the great variation to be found within the individual patient. Lande's work supports Bjork's contention that the mandible becomes more prognathic with advancing age and this increase is associated with a decrease in the angulation of the lower border as well as a decrease in the angle of convexity. Both found the most significant changes after seven years of age. (1),(2)

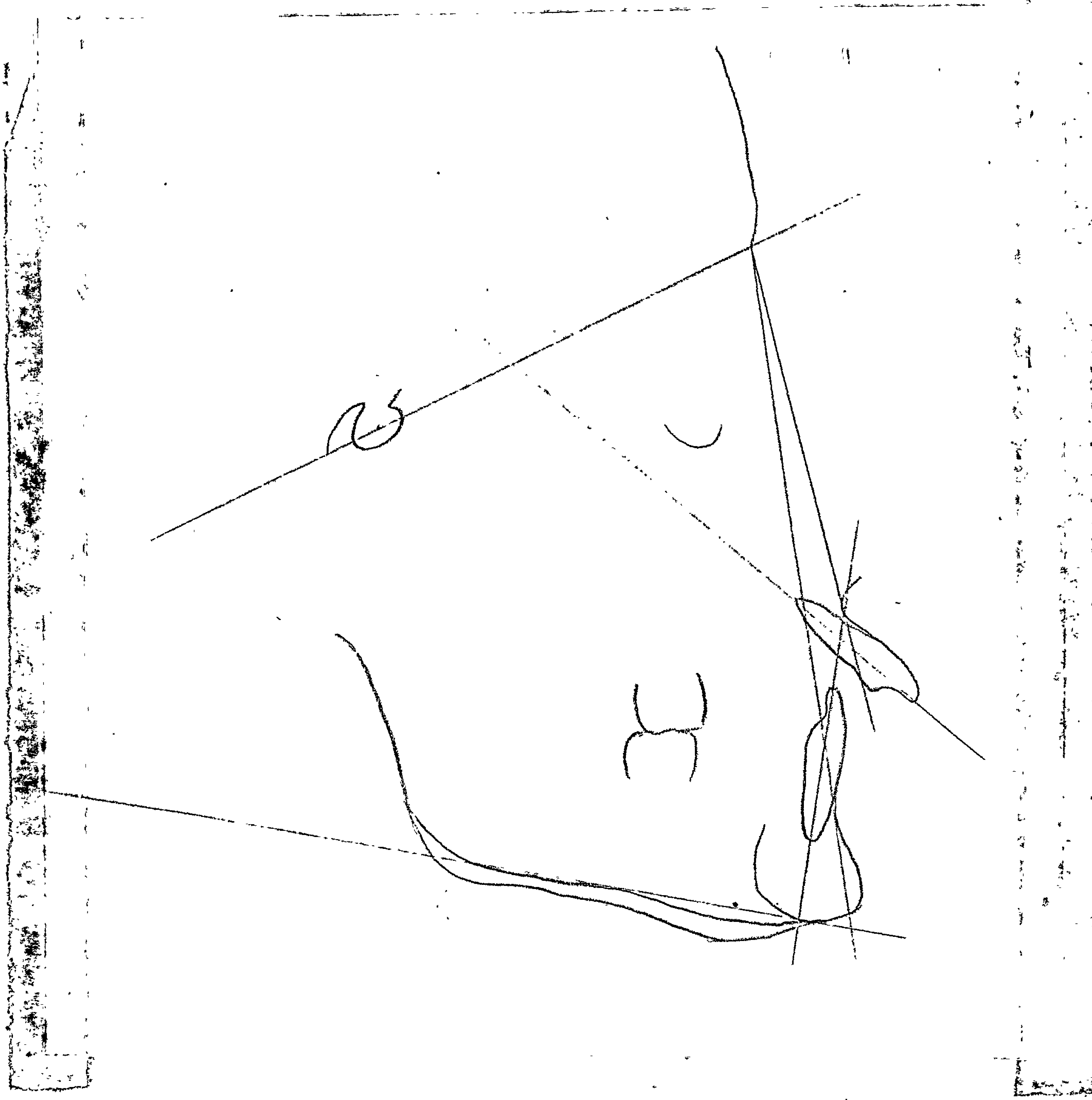
In a later paper Brodie joins forces with Bjork and Lande and describes a decrease in the prominence of the denture arch and its supporting bone. In an exhaustive study Brodie checks the various points and angles he examined in his earlier work and concludes that individual variation is the only thing that remained constant. However "findings such as these would be very discouraging were it not for one fact. That is the marked consistency and stability of the individual pattern. One cannot but be impressed with the orderly development of the various types of face and the adherence to an original proportion which seems to be characteristic of each"(3)

Thus we need not fear that should we be born with the face of Apollo we would end our days with the face of Frankenstein. Barring pathology the infant Apollo or the infant Frankenstein, cooing in his respective cradle, would each be recognisable from a picture of the matured result. There is a marked consistency and stability of the individuals pattern.

That the relationship of the various reference points should change is not really surprising. As we have seen the maxilla grows by sutural growth downward and forward and is modelled by surface apposition and absorption. Assume for a moment that these two rates are not synchronous at the moment the lateral head film was taken. Then the relationships if two head films were taken months apart, would not coincide angle for angle, linear proportion to linear proportion. Now the mandible grows by appositional growth of condylar cartilage tissue with corresponding remodelling apposition and absorption. Each may be out of phase with the other and these may, in turn, be developing at a different rate to the maxilla. As the lateral x rays record a moment in time, one or other of the many features may be resting or ahead of the others. Thus there would not be any agreement in the proportions. This does not mean necessarily, that there are radical alterations in the basic facial skeleton.

The only ideal method of assessment would be lateral rays at the moment of birth and the instant of cessation of growth. Only then could we see factors at there ultimate in development.

The academic findings of Bjork, Lande and the later investigations



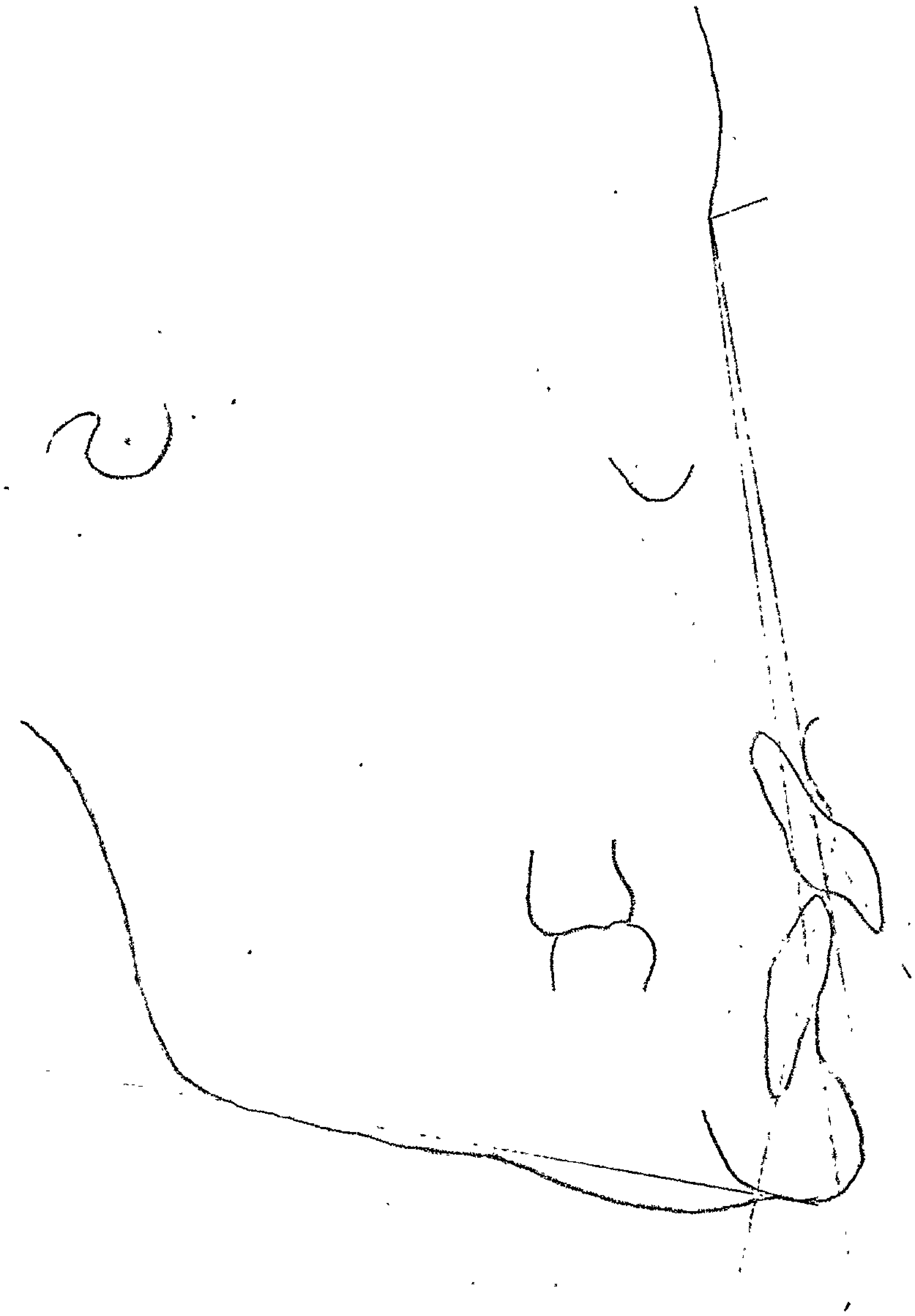
<u>Patient</u>: Lindsay, Miss Barbara

<u>Born</u>: 21.5.39

<u>X-ray taken</u>: 1.9.52

<u>SNA-SNB</u>: 78'-72'

<u>Difference</u>: 6'



<u>X-ray taken</u>: 10.9.56

<u>SNA-SNB</u>: 79'-77'

<u>Difference</u>; 2'

of Brodie have been confirmed in practice. Clinicians take advantage of the non synchronous growth in improving the relationship of maxilla to mandible. In a Class 11 dental base relation case, if we hold the downward and forward growth of the maxilla and at the same time allow the mandible its full growth potential i.e. allow it to become more prognathic with advancing age, then the relation of maxilla to mandible will become more favourable. Both Holdaway(4) and Donovan(5) have confirmed this with examinations of tracings of their own and other orthodontists satisfactorily treated cases. Clinically there is a decrease in the difference between the dental bases. Hence the greater the growth the greater the improvement in apical base relations.

Regardless of what appliance is used or what philosophy of treatment is followed, the only common conclusion which all successful clinicians reach is, that the success of orthodontic treatment is in direct proportion to the amount of growth that occurs during appliance therapy.(see references (6))

Thus the clinician looks to the research worker to answer these questions:

i. Can growth, particularly mandibular growth be induced as Wylie(7) has suggested,

ii. is the rate of growth even, but diminishing, or are there "growth spurts" ?(8),(9)

Until we know at least part of the answers to these fundamentals, the clinical problems of when to commence treatment, what appliance to use and what final, stable result to expect, will remain the bitter contraversial issues they are today.

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Cephalometrics.

The cephalometer is a scientific instrument which records facts. These facts may be useful in:

1. <u>Longtitudinal studies</u>

   A. Qualitative (superposing of tracings) changes in form and proportion in growth.

   B. Quantitative Corrected measurements of growth increments.

   C. Eruption of teeth.

   D. Changes incident to orthodontic tooth movement.

   E. Detection of areas of arrest, effects of neoplasms, and so forth.

   F. Postoperative behaviour in such conditions as bite raisi-ng, prosthetic restorations, condylar and mandibular resections, and so forth.

11. <u>Cross sectional studies</u>.

   A. Facial and cranial proportions (familial, racial).

   B. Characteristics of various pathologies (endocrinapathies, dietary deficiencies, and so forth).

   C. Familial studies on type and heredity.

111. <u>Individual characteristics</u>.

   A. Physiological rest position of parts (mandible, hyoid bone, soft palate and tongue).

   B. Functioning movements of some parts.

   C. Relation of the dental bases.

   D. Relation of the soft tissues.

Its value in cranial studies of growth, development and treatment is unsurpassed. However there are certain difficulties with its use which must be appreciated before its true value can be assessed.

Due to the complex arrangement of the bones of the skull and the fact that we project onto two dimensions which in reality occupies three, certain points are difficult to see. These are;

1. Bolton point.
2. spheno occipital suture.
3. anterior nasal spine.
4. pterygo maxillary fissure.
5. orbitale.
6. porion.
7. gonion. (1), (2)

Thus the accuracy of measurements to the millimetre or to the degree is suspect.

To overcome the errors inherent in the technique it is advisable for the one operator to take the film, trace the film using the same cephalostat and machine. In that way we standardise our variables.

Growth, no matter what part of the organism, is merely relative and never absolute since there are no two points so far as we know which stand in unvarying relation to one another. Thus no one dimension, no one angle, no difference of a few millimetres or of a few degrees in an angle, can assume a type difference that is of absolute diagnostic value.(3)

Analyses of Facial Type. Angle was the first to suggest that an ideal occlusion was associated with an ideal face and for his ideals he chose the occlusion of "old glory", the skull of a coloured male and the profile of Apollo Belevedere, the stature of a Caucasian male. This absurdity did not remain unchallenged but there has been a carry over of this idea into orthodontic thinking to the present day.(4)

Tweed(5), Margolis(6), Downs(7) and more recently Sassouni(8) have attempted to show with the aid of the cephalometer that there is a relation between a specific face and normal occlusion. Each has done this in his own way but there are three basic methods of investigation;

i. a specific face can be compared to an ideal and the decision is left to the orthodontist.

Tweed selected a series of faces and occlusions that appealed to him and analysed them. The best in facial esthetics occurred when the Frankfort-Mandibular-Incisor angle was 65'.

The average was	Frankfort-mandibular angle(FMA)	24.57'
	Incisor-mandibular-plane-angle(IMPA)	86.93'
	Frankfort-mandibular-incisor(FMIA)	68.2'

He based his results on 37 examples.

When it is necessary to exceed 62' in the FMIA he extracts.

He claims that facial change has been spectacular in 30 percent of his cases, and previously this is not greater than 10 percent. If he fails to attain an FMIA of 65 then facial improvement is poor.

ii. a specific face can be compared to an average face based on the concept that the majority is the normal and the type is derived from the majority of people.

Margolis bases his work on 30 Indian skulls each of which has excellent occlusion and development of skull.

Added to this are 100 living children between the ages of 6-19 selected on the same basis. He claims that separating according to age, sex or national origin has no effect on statistical values.

From this data he composed a maxillo facial triangle, which is a basic pattern common to all normal occlusions irrespective of racial or ethnic background.

We can assess from this triangle where our patients facial pattern is at fault.

Downs chose 20 living individuals between 12-17 all possessing clinically excellent occlusions. Ten angles, lines, planes and measurements relate the skeletal pattern and the denture.

This 1. evaluates the facial pattern with respect to a normal range of variation,

2. appraises changes during growth or orthodontic treatment.

Though its aims are similar to the Margolis analysis it is more accurate in its assessments and more flexible in its use.

Wylies analysis of antero posterior dysplasia, assesses the discrepancy in an antero posterior plane of the facial bones and localizes the deficiency.

It is useless in before and after treatment studies since the pterygo maxillary fissure to the <u>6</u> is the only measurement to change.

iii. a specific face can be compared to the optimum for that specific face. Here the decision is set by the architecture of the patient's face itself.

Using the last method Sassouni in an examination of 100 cases, 50 normal occlusions, 20 with Class 1 occlusion, and 10 with Class 111 found that a well proportioned face invariably has normal occlusion. However the corollary is not necessarily true, normal occlusion alone is not sufficient to define or establish a well proportioned face.

Margolis, Tweed and Downs restricted their cephalometric investigations to normal occlusions and each evolved a pattern of normality from these. They then assumed that any patient who did not fit the pattern could not have a balanced face and was the victim of facial disproportion.

No controls were used to check the validity of their conclusions. This is statistically inaccurate and an example will show why.

If one were investigating the relationship between severe coughing and its thoracic radiographic picture, yet restricted our material to patients from a T.B. sanatorium, then most of the x rays would show a basic pattern of lobar T.B. From the sample we could then conclude that there is a direct relation between severe coughing and lobar T.B. and we would be right as far as our data goes.

But what of the thousand and one other causes of coughing that range from a mild chest cold to acute bronchiectasis. How would we put these into the picture?

There are two ways 1. by not restricting the sample to any particular group yet increasing the numbers so that the particular group we are interested in will be statistically significant.

2. by restricting the sample to the group we are interested in, yet using a control group large enoughtto show any

other relationships that may be statistically significant.

Tweed, Margolis and Downs used the second method but ignored control groups. Thus their work remains a series of unsubstantiated hypotheses with no scientific standing whatsoever.

Though we can challenge Sassouni's work on the grounds that he used insufficient material, and his results were therefore statistically insignificant, his approach is basically sound and carries some weight for that reason.

By different methods, and at different times, Sanborn(10), Altemus (11), and Blair(12) with cephalometric examinations of a total 200 Class 11 cases have shown that a Class 11 malocclusion does not imply a typical facial skeletal pattern. The skeletal profiles showed considerable variation. It is entirely possible that a purely dental malocclusion may not be reflected to the point of significance in the facial skeletal complex. This would mean that if one were to mask the occlusion in a lateral skull x ray it would be impossible to tell from the facial skeletal pattern, except in cases with severe pathological disturbances such as acromegaly or early bilateral condylar ankylosis, what the occlusion would be.

The obvious conclusion is this: there is no facial skeleton that is invariably associated with any particular type of malocclusion; there is no facial skeleton that is associated with normal occlusion.

Coben(13) says "when one considers the variation seen in the cranial base, and the variation in every structure composing the dento facial complex, it would seem that there could not be any rigid combination of factors associated with any particular malocclusion."

The cephalometric analyses of Wylie and Margolis claim they can localize and assess discrepancies in the antero posterior plane of the facial bones. However it is rare that one particular feature is responsible for a facial disproportion and if it were the cause is usually obvious.

Johnson(14) challenges their hypotheses and states that "undesirable facial patterns are often the random combination of separate facial parts each of which is normal in conformation and size but in toto (results in) an undesirable facial pattern".

Wylie in a restatement of his hypothesis supports him.(15) "I see malocclusion as a disproportion between facial parts which in themselves may be within the limits of normal variation, but which are disproportionate when combined with other facial structures and lead therefore, to a disproportionate whole. The hypothesis is that nature has combined the parts of the face in a random fashion with little regard for how well they go together and that the efforts of the orthodontist will be better rewarded if they are directed towards working out the best clinical procedures for dealing with accepted disproportions than if they are expended on speculation as to why disproportion is encountered in the face of man when in truth infinite variety is a fundamental fact of nature."

It is obvious that some cases offer a better prognosis for clinical success than others. Yet it has been shown that except for extremes no direct relation between occlusion and facial type has been proven. It is the extremes that offer a pointer to the problem.

In a bilateral ankylosis of the joint there is failure of mandibular

Bilateral ankylosis of the mandible.

An extreme example of Class 11 dental base relation, with incompetence of the anterior oral musculature due to the skeletal deformity.

growth. In the acromegalic there is excessive overgrowth at the condylar cartilage. Each is an extremem of facial type and each is untreatable orthodontically for directly opposed reasons.

What is it they share in common?

It is a malrelationship between dental bases which precludes any attempts to reach an orthodontic normal occlusion.

Lundstrom(16) defined the dental base in 1925 as "the bandlike area extending alon the dental arch and alveolar process parallel to the crowns of the teeth and the alveolar process may be called the dentofacial zone. This zone may be divided into an apical and a coronal zone the former being described as the narrow bandlike area extending along the gingiva parallel to the apices of the teeth.

The immediate adjoining section upon which the region that is limited by the apical zones rests or to which it is attached may be called the apical base.

The alveolar process has been regarded as a region in certain respects independent of the jaw bones and intimately connected with the presence of the teeth. From the description of certain peculiarities in the pathological anatomy of the region in question, it would appear that the alveolar process a nd the position of the teeth are dependent upon the form of the apical base.

When the latter is normal and only then is a normal position and a normal occlusion of the teeth possible."

Ideal relationship of the dental base is one which allows normal occlusion of the teeth without undue deviation from the mean axial inclination.....mean values we are using only apply to the ethnic group from which the material is drawn.(17)

Apart from the dynamic studies of growth and development and the effects of treatment procedures the prime clinical use of the cephalometer is in the assessment of dental base relations.

Assessment of dental base relations. There are two main methods in use for assessing the relation of the dental bases to each other one American, the other English.

1. SNA-SNB difference. The technique was first used at Northwestern University, Chicago.

A and B points: the most posterior point in the depth of the concavity of the alveolar processes on the labial surfaces above the central incisors.

S-N Plane: this is the Broadbent plane. It extends from nasion picked up on the lateral x ray as the most anterior point on the naso frontal suture, to sella mid point of the sella turcica, located by visual inspection only. This plane has a validity in that it is in morphologic substance the floor of the anterior cranial fossa, as such it is directly related to neuro orbital growth which is very rapid in infancy and early childhood; early cessation of growth changes thus grants this dimension considerable relative stability.

The Broadbent or nasion sella plane is not to be considered an axis of cephalofacial transition. It is far more an early stabilized dimension of upper facial depth so that further facial growth must, by definition grow forward and downward. This plane in essence is the roentgenographic counterpart of the craniometric nasion parallel , obviating howeger the apparent instability of the porion. There can be no doubt that nasion in superimposition is a key point: morphologically it is the focal point (or better, locus) of cephalo facial junction.

SNA, SNB give a rough indication of dental base relation but with alteration in the size of the face during growth and the variation in the length of the face of different individuals no precise difference between these angles can be used for assessing the relationship.

2. The second method was developed at the Institute of Dental Surgery, Eastman Dental Hospital, London.(see references 18)

Many investigators in America have found that in normal occlusions the mean value of the axial inclination of the lower incisors to the mandibular plane is 90'. This angle will vary inversely as the Frankfort mandibular plane angle in normal occlusions. Tweed was the first clinician to discuss prognosis in terms of the Frankfort mandibular plane angle and many have since realised its significance. Various workers have produced mean values for this angle and it probably varies because national groups are composed from different proportions of racial types. For the purpose of the diagnostic method which is being described 27' is regarded as a mean value.

One other angel which comes into the picture that is being constructed, is that of the upper incisor to the Frankfort plane. The mean value is 107'. Other investigations and clinical observations suggest that the axial inclination of the upper incisors does not lie outside the range 105' -110' to the Frankfort plane without appearing to be tooo labioclinated on the one hand and linguoclinated on the other.

We have now constructed a picture of the average on which a diagnostic and prognostic clinical approach to cases can be based, it being remembered that the dental base relationship, the Frankfort mandibular plane angle and vertical height of the face are inherent in the individual and the growth direction of the dento alveolar structures of the labial segments and buccal segments has been influenced and controlled by soft tissue patterning.

With this average picture in mind it is possible with the lateral radiograph of any case of malocclusion to assess for clinical purposes the antero posterior relationship of the dental bases. The diagram demonstrates the method; it is the tracing of an Angle's Class 11, Division 1 occlusal abnormality associated with incompetent musculature and a tongue thrust. For the assessment of dental base relationship the upper incisor outline has been rotated keeping the apex on the dental base so that it has a correct axial inclination to the Frankfort plane. Similarly the lower incisor outline has been rotated again keeping the apex within the dental base so that its axial inclination is correct to the mandibular plane. A Frankfort mandibular plane angle varying inverse must be 10' below the mean value i.e. 80'. The overjet on these repositioned outlines gives us, for clinical purposes, a very good idea of the antero posterior abnormality of dental base relationship.

As it is assumed that this dental base relationship cannot be changed to order, then this degree of abnormality will obviously affect the prognosis of the cases and the ultimate incisor relationships will have to be something similar.

When on this assessment the mandibular dental base is posterior to the maxillary dental base the case is called a Skeletal 11; when normal a Skeletal 1 and when the mandibular dental base is anterior to the maxillary dental base a Skeletal 111. A dental base abnormality does not necessarily produce a marked abnormality of incisor relationship if the soft tissue behaviour patterns are normal and direct the vertical growth of the dento alveolar structures to the optimum position.

Discussion. In this method we use a standard as reference which must be assessed for each ethnic group. Using a standard we can tell whether B and G points are not displaced forward from standard but N and A are displaced backward, so giving a prenormal Class 111 relation.

This method presupposes that the apical bases of the teeth have not drifted from their developmental positions within the bone.

It does not take into consideration differences in facial height.

It may be that with further studies of normal and abnormal growth patterns it will be shown that in fact the dental base relationships do change in some cases favourabley in others unfavourably these changes being concurrent with or in spite of treatment. For clinical purposes however it is suggested that there is insufficient evidence at the moment to support the view that the skeletal pattern and therefore the dental base relationship can be changed by orthodontic treatment.

If this is so the prognosis in orthodontic abnormality depends partly on the accurate assessment of the dental base relationship at the time of diagnosis.

Conclusion.

The cephalometer is a scientific instrument which records facts. These facts are then analysed and a conclusion drawn.

The corollary is not true. One does not reach a conclusion then facts to support it.

The use of the cephalometer does not make a statement scientific.

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Development of the Dentition.

In the development of the dentition there is a regular rhythm of stages that merge and overlap from birth to death. Hellman described seven stages and used them as a physiologic time table to label skeletons

Stage l. early infancy before the completion of the deciduous dentition.

Stage ll. late infancy at the completion of the deciduous dentition.

Stage lll. childhood when the first permanent molars are erupting or have taken their place and there may be some of the permanent incisors present.

Stage lV. pubescence when the second permanent molars are erupting or have taken their places.

Stage V. adulthood when the third molars are erupting or have taken their places.

Stage Vl. old age when the occlusal surfaces are worn off.

Stage Vll. senility when half of the crown height has been lost or most or all of the teeth have been lost.(1)

Thus no stage is separate from another. Each is plastic. At any moment one stage is developing into another. Nothing is static, immobile or immutable until death overcomes the organism.

In the Dental Cosmos of March-April 1899, E.H.Angle presented his classification of malocclusion. In it he described the mechanical details of normal occlusion."In building the human denture nature has worked toward a definite end to produce the most efficient parts with the most efficient arrangement of these parts that they may in function be most efficient. And this type has been Nature's pattern for the human denture as long as man has been man and had need of teeth".

His classification as it appeared in the 1899 paper was as follows:

Class 1: relative position of the dental arches mesio distally normal with first molars usually in normal occlusion although one or more may be in lingual or buccal occlusion.

Class 11: relative mesio distal relations of the dental arches abnormal all the lower teeth occluding distal to normal producing very marked inharmony in the incisive region and in the facial lines.

Class 111: the relation of the is abnormal, all lower teeth occluding mesial to normal the width of one bicuspid or even more in extreme cases.

The loss of a tooth by extraction or otherwise is usually followed by such marked changes in the positions of the remaining teeth that both diagnosis and treatment are greatly complicated. Therefore great care and judgement should be exercised making allowance for the tipping of teeth and other changes which have taken place as a result of extraction.(2)

Angle has chosen one moment in the development of the occlusion and used that as a basis to assess normal. To that normal he has attributed qualities that neigher he nor any other orthodontist has confirmed in practice.

The civilised state in man is as momentary as the attainment of normal occlusion is in the dentition. Civilization, i.e. where teeth are not essential for survival, has occurred only in the last 10,000 years. Man, as we know him, has been developing over millions of years.

Hence the study of occlusion to be complete should show the dentition as a survival unit from birth to death.

Begg has done this by limiting his investigations to the study of Stone Age Man's dentition.(3) "correct occlusion is not a static conditio The relationships of inidividual teeth in the same arch, the relationship of the teeth of one arch to those of the opposite arch and the positional relationships of the teeth to the jaw bones, change continually throughout life. Therefore the only constant in correct occlusion is continual change"

Bjork confiirms this "the overjet generally changes with advancing age so that the front teeth of the lower arch show a forward displacement in relation to those of the uppper one..... generally the overbite decreases somewhat with advancing age"(4)

Sillman both in 1951 and 1953 states "there is continual change in the size and morphology with time of the dental arches....not only do arches change in size from birth to permanent dentition but also in morphology"(5),(6)

It may be said that for many animals and man must be included, anatomically correct occlusion is developed and maintained by several basic factors.

1. Tooth movement: continual mesial migration and continual vertical eruption botheof which compensate for tooth attrition.The resultant direction of eruption is oblique.

2. Anatomy of the teeth: the changing anatomy is dependent upon tooth attrition.

Unless there were excess of tooth substance relative to jaw bone size Stone Age Man would early in life have insufficient tooth substance to occupy fully the tooth bearing parts of his jaws because tooth attrition is so extensive. Overbite is reduced as attrition caused forward migration of both upper and lower arches. Incisal attrition starts as oblique attrition then as the patient grows older and the overbite is reduced, becomes horizontal.

Because of this early attritional reduction of the mesiodistal lengths of the first and second permanent molars in Stone Age Man, the undesirable overlapping, rotation and bimaxillary protrusion of the six anterior permanent upper and lower teeth which would have been inevitable in the absence of attrition is avoided. Because all the erupted teeth as they wear interproximally maintain proximal contact by mesial migration there is room for the third molars to erupt.

As the cusps are wearing away and the edge to edge incisor bite is becoming established all of the lower teeth are gradually moving forward relative to the upper teeth so that the molars, premolars and canines eventually assume typical Angle Class 111 occlusal relationships. This attritional occlusion is the only anatomically correct occlusion.

Strang(7) and Huckaba(8) refer to the forward migration of the teeth as if it were an abnormal and undesirable phenomenon that causes teeth to move bodily forward and to tip or lean obliquely forward thus producing malocclusions such as crowding and overlapping of the teeth especially the anterior teeth and also caused the condition known as bimaxillary protrusion. These writers consider that this forward migration of the teeth is due to abnormal and perverted muscular forces from the lips, cheeks, tongue and throat and also to perversion of axial stress of the teeth during mastication. Anterior component of forces is the name used in orthodontic literature to designate the force from whatever source it is considered to emanate that causes this undesirable mesial migration of the teeth.

Although mesial tooth migration does produce malocclusions when there is no tooth attrition and when the teeth a re very much too large for the jaws, it is, as has already been explained a normal physiological phenomenon vitally necessary for the development and maintenance of anatomically correct attritional occlusion. If this horizontal part of tooth eruption were not to occur the teeth would have become spaced as they wore. This mesial migration of the teeth, that is the horizontal part of the process of tooth eruption, exerts such a powerful force that we sometimes observe in beautiful examples of textbook occlusion the slow collapse in adulthood of this normal occlusion to produce progressive crowding and overlapping of the upper and lower anterior teeth. Perhaps anterior tooth crowding is due partly to the retention of the incisor overbite of adolescence.

From the foregoing it will be seen that the necessary conditions for the development of anatomically correct occlusion are slight hereditary quantitative preponderance of total tooth size over jaw size and living on a Stone Age Man's diet so that the teeth will wear whereas with this same preponderance of tooth substance man develops tooth crowding when he lives on our refined diet.

We may conclude from this that normal textbook occlusion develops and is maintained only in those civilized individuals who have too small an amount of tooth substance if assessment by Stone Age Man's requirements which after all are evolutionarily the correct quantitive relationships of tooth to bone. This accounts for there being so relatively few civilized people with the full complement of teeth in text book normal occlusion.

Broadbent's(9) investigations into the development of the occlusion have resulted in similar findings but his interpretation of those findings are opposed.

"If an individual has had the good fortune to have enjoyed normal developmental health then and only then will the bony skeleton of the supporting structure have achieved its destined size and form for its developmental age. Unfortunately there are numerous subclinical handicaps however slight that may prevent the expansion of the facial parts to a sufficient degree so that when the much larger permanent teeth begin their eruption they are forced into malocclusion. Thus malocclusions appearing in the early mixed dentition are largely symptomatic of past developmental growth defects in the face. If the cause is removed many of those defects tend to be overcome unleashing the normal forces of development and permitting the individuals to regain much of the lost ground.

Again if this process of normal articulation of the crowns of these eruptingpermanent teeth succeeds in spite of dwarfed facial bones it creates in the individual the appearance that the teeth and dental arches are too far forward in relation to the cranial base. This condition is commonly referred to as bimaxillary protrusion. It may be bimaxillary protrusion in the empirical sense but from the standpoint of these studies of normal developmental growth of the face it is largely the result of physical handicaps that leave a lasting and permanently dwarfed skeletal structure. In other words the condition and appearance is due more to the retarded facial skeleton than to the dentition being too far forward in relation to the base.

Any buckling of the lower dental arch and failure of the wisdom teeth to erupt is due to failures of the facial skeleton to attain its complete size and proportions. They are co-sufferers."

Broadbent does not define a "subclinical handicap" but if we analysed it under nutritional, endocrinal and functional deficiencies, we should cover it.

1. Nutritional: It is a paradox that malocclusion is more widespread in civilized communities than primitive communities. Yet the more advanced the community the better nourished it is. This follows. A hunter spends all his time locating and despatching his next meal. For a community to give its time to non edible pursuits such as basket making or weaving there must be surplus food available. Our own community is probably the best nourished in the world yet its orthodontic rate pro rata, is as high as anywhere.

2. Functional: It has been shown from the well formed jaws in Sir Norman Bennett's collection of congenitally edentuleus jaws(10) and the work of Sarnat and Gans(11) that a minimal amount of function seems to be required to stimulate the jaws to grow to their full hereditary sizes.

3. Endocrinal: Endocrine disturbances result in widespread effects

and if the facial complex were affected to a noticeable degree then othere functions would also be affected.

Thus it is probable that tooth crowding is very often due not to dwarfed facial bones but to largeness of the teeth.

In Stone Age Man Class 1 malocclusion whether it be the tooth crowding commonly present in the anterior teeth or bimaxillary protrusion or bucco lingual cross bite of the posterior teeth, seems to have been an almost negligible handicap to him because the teeth soon wore away so much that the cusps were eliminated and the flat tooth surfaces that were then left did not restrict mandibular masticatory excursion.

Even in the most pronounced cases of upper incisor protrusion in Class 11, Division 1 cases the upper and lower incisors were very markedly worn incisally. This indicates that the wide lateral and protrusive mandibular excursions permitted the upper and lower incisors to engage each other in masticatory function. There was no evidence of pyorrhea or dental caries being caused by Class 1 or Class 11, Division 1 malocclusions.

It therefore seeems that these two types of malocclusion are more harmful to civilised man than to his Stone Age ancestors.

This faces us with the need to review what we mean by malocclusion.

Although the occlusal relation of the teeth in Stone Age Man are anatomically correct when they are crowded, overlapping and rotated and when a Class 11 Divisionll occlusion is present, nevertheless the teeth are not in malocclusion. The teeth in these cases being worn flat occlusally are in far less malocclusion than in a case of ideal textbook normal occlusion. in civilized man when there is no appreciable tooth wear.

On the other hand Class 11 Division 2, and Class 111 malocclusions were far more serious afflictions functionally for Stone Age Man than for civilized man. In Stone Age Man the incisor overbite in Class 11 Division 2 occlusion resulted in extensive attrition of the labial surfaces of the lower incisor and of the lingual surfaces of the upper incisor so that some times, even in adolescence the pulps of these teeth became exposed. Also in some Class 111 cases the labial surfaces of the upper incisors wore away so much as to cause pulp exposure. Lateral masticatory movement in Stone Age Man was also restricted to very narrow limits in Class 11 Division 2 and Class 111 occlusions. From the evolutionary standpoint the low incidence of these occlusions in Stone Age Man is due to their low survival value. But Class 1 and Class 11 Division 1 occlusions being relatively harmless are quite common.

In about 800 cases examined 12% showed Class11 Division11, 3% showed Class 111, and 1% showed Class 11, Division 2.

The many environmental influences usually enumerated do not appear to have been responsible for the crowding nor for the antero posterior malrelationships in these skulls. Not one example of premature loss of deciduous teeth was observed in the very young skulls and those with mixed dentitions.

Generally speaking text book ideal occlusion has been implicitly endowed with attributes in excess of reality.

Discussion and Assessment; If the bypothesis submitted by Begg viz:

(a) excess tooth tissue in the deciduous and permanent dentition is essential in Stone Age man.

(b) continual eruption is necessary to provide contact interproximally and occlusally.

(c) the developmentally ideal occlusion is one that allows maximum contact of dental arches with free lateral and protrusive mandibular excursions.

is accepted, it answers a host of apparently unrelated yet fundamental problems.

(i) First generation offspring of primitive peoples such as the Eskimo and the Australian aborigine are afflicted with an increase in malocclusion, pyorrhea, dental caries and a higher percentage of impacted wisdom teeth.

(ii) Every science and art requires a standard. Some use the metric others the British. Orthodontics uses Angle's Normal Occlusion. Angle dogmatically endowed it with advantages of funtion, esthetics, stability and longevity which because it is our only standard, no one dared challenge.

G.P. or specialist knows that once normal occlusion is reached, orthodontically or developmentally, there is no increase in these factors for that reason.

(iii) Lundstrom(12),Breakspear(13),Siepel(14) in separate investigations in different countries and at different times are agreed that early loss of deciduous teeth has no general influence on the development of the dentition. Space maintenance therefore, has no definite advantage apart from preventing drift of certain teeth.

(iv) Clinicians universally accept the necessity for extraction in some cases. Tweed(15) claims it is due to faulty facial pattern; Howes (16), Nance(17) and Carey(18) claim there is disproportion between dental base and tooth size; Broadbent(9) attempts to show why but although his observations are sound his interpretations are suspect.

Begg says tooth extraction as an aid to orthodontic treatment is scientifically correct because:-

1. It simulates the natural loss of tooth substance by attrition which in Stone age Man very often made possible the development of anatomically correct occlusion.

11. The inherited amount of tooth substance is sometimes too much even with marked attrition.

111. Antero posterior jaw malrelationships sometimes are so pronounced that a stable and good occlusion is unattainable without tooth extraction even in such cases where is quantitative harmony of tooth substance with jaw size.

Begg's hypothesis explains many of the phenomena associated with malocclusion, and offers a consistent explanation for the success of apparently differing case analyses, diagnoses and treatment procedures.

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Soft Tissues and their Behaviour Patterns.

The maxillary and mandibular arches are suspended by, and surrounded with muscle masses. They provide the motivation for the purposes of deglutition, mastication, speech, posture and respiration, and as such are in direct and intimate contact with the teeth and their bony supports.

The dental arch is a narrow island that is in balance with the muscle force of cheek and lips buccally, and with the tongue lingually, and whose vertical development is determined by the muscles of mastication.

These muscle masses have been examined under the separate headings of:

1. The Muscles of Mastication
   and Rest Position.

2. The Muscles of Facial Expression
   and the Tongue.

3. Deglutition and its Effects
   on Occlusion.

The Muscles of Mastication.

Rest Position.

The stability of the rest position was first mentioned by Brodie in his "On the growth pattern of the human head from the third month to the eighth year",1940. This was further examined by Thompson and Brodie in 1942, and the subject exhaustively studied by Thompson from 1946 on.(1),(2),(3).

Definition. The rest position of the mandible is dependent entirely upon the musculature. All functional movements of the mandible begin and end in the rest position because the musculature is then in equilibrium. When the mandible is at the rest position, an interocclusal clearance or freeway space of 2-3mm or more with individual variation exists between the maxillary and mandibular teeth. It must be thought to exist not only in the vertical but in all planes of space viz. antero posterior, lateral and oblique. In other words there is a spatial relationship of the mandible not just a tooth relationship.

The rest position is established before the teeth have erupted. It is not altered by the eruption of the teeth and a high degree of stabilit exists to a resting position after the teeth have been lost. It cannot be altered permanently by any restorative dental procedure. The musculature then is an important part of the masticating mechanism in that it established the resting or postural position as well as motivating functional movements of the mandible.

Variations. There are variables in the rest position that must be recognised to exist and since a broader concept of mandibular position has been established these can be better understood. They are related to variations in the tonicity of the musculature such as;

1. hypotonicity as seen in fatigue, disease and generally diminished muscular tone,

2. hypertonicity, which in the extreme is muscle trismus.

These may completely supplant or alter the normal rest position.

Functional movements of the mandible. In all our radiographic studies on the closing movement of the mandible from rest position to occlusion of the teeth made on young adults and adults with excellent occlusions the lower portion of the joint functions primarily.

The normal movement of the mandible from rest to occlusal position is almost a hinge movement with the axis located in the vicinity of the condyle or lower portion of the joint. The mandibular incisors and the chin point swing up and forward. The molars move on a similar but smaller arc since they are near to the axis. It is important to note that there may be slight bodily movement of the condyle. This slight movement should still be considered to be within the normal range. The apparent bodily movement indicated on the x-rays may actually still be a hinge movement if the axis is slightly below the centre of the condyle.

In our radiographic studies on the closing movement from rest to occlusion in children with excellent mixed dentition considerable variation is observed. This is apparently the normal or usual situation for this age range. As the individual approaches maturity the pattern of closure described above becomes the rule in the normal functioning masticating system.

Centric position. It is a fact that when the teeth are occluded they determine the mandibular position. This may be said to be the occlusal position and of the mandible and it should be identical with the centric position of the mandible. Centric position not only is that maxillo mandibular relation where the teeth should occlude in the normal or good functional situation but also where the condyle of the mandible is in a balanced and unstrained position in the glenoid fossa. This balanced position exists when the condyle is in its natural retruded position in contact with the fibrous tissue forming the anterior wall of the articular fossa and when the antero superior surface of the condyle is in close approximation to the postero inferior surface of the articular eminence.

From the functional viewpoint it can be said that if the path of closure from the rest position to occlusion is an approximate hinge movement through an acceptable interocclusal clearance the occlusal position and centric position will be identical.

It has been shown however that in many individuals the path of closure is not normal. The mandible is shifted bodily on an upward, upward and backward, forward or lateral path whatever the case may be in order to occlude the teeth.In these instances the occlusal position and centric positions are different and an abnormal functional situation exists.

On closure from an open mouth position or during mastication the mandible closes directly into the position of displacement without being directed by dental interference. On closure from rest position however, the mandible is seen to close, contact the interference then continue to close but now on an abnormal path and into an abnormal occlusal position.(4)

Discussion and Assessment.

Sleighter in an examination of 71 skulls, 33 patients and 40 laminagraphs concluded:-

1. centric occlusion is closely related to a central location of the mandibular condyle in the glenoid fossa. Ricketts confirms this when he says the least variable condition proved to be the position of the condyle in the fossa when the teeth were clenched. Here the condyle was generally found in the fossa in the position usually portrayed as typical.

2. there is normally insufficient space between the posterior parts of the tempero mandibular joint for significant distal movement of the mandible from a position in which the teeth are in centric occlusion. This space in the bodies examined was invariably less than one half the width of a premolar.

3. the anterior movement of the mandible from a centric occlusion the width of a premolar places the head of the condyle out of the normal position in its fossa and well up on the slope of the articular eminence.

4. the possibility of forcing the mandible dorsally from a normal condylar relation a distance equivalent to the width of a premolar is exceptional if not the result of a morphologic abnormality.

In 1952 Ricketts examined 50 treated Class 11 cases, 1000normals and 17 untreated Class 11 cases for controls. The only striking differecne noted between the joints of the controls and those of the Class 11 sample was in their respective resting positions. The controls tended to exhibit the typical relation whereas two thirds of the condyles of the Class 11 group were found down and forward on the eminence when in the relaxed position.

Our belief based on the work of Thompson and Brodie, and Thompson had been that there was little variation in the resting position of the condyle in either typical joints or those associated with Class 11 malocclusions.

Translatory movements of the mandible from the resting to the clenched position as determined by the behaviour of selected points on the mandible were therefore assumed to be accompanied by an upward and backward thrusting of the condyle beyond the typical position. A technique that permitted scrutiny of the total condylar fossa relation indicated that such translatory motion during closure more frequently started from a down and forward point and ended at the typical position or relation.

These findings would seem to call for a slight modification of our concept of the stability of the resting position of the mandible. Although we are still firmly of the opinioh that the resting position represents an equilibrium of various forces muscular and gravitational, and is extrememly reliable under stable conditions, we can no longer accept it as unchangeable.

The least variable condition proved to be the position of the condyle in the fossa when the teeth were clenched. Here the condyle was generally found in the fossa in the position usually portrayed as typical. This is understandable when it is realised that most techniques previously employed have required full occlusion of the teeth.

The maintenance of the position of the mandible is a function of the proprioceptive system serving posture, occlusion , speech, deglutition and respiration to mention only a few of the demands made upon it. So long as these functions and the parts that serve them remain relatively unchanged the resting position of the mandible will remain unchanged. But with a marked change in any of these factors one can logically postulate changes in the state of equilibrium for followed by change leading to a new stable position.

Two possibilities existed to explain the changes that were seen at the end of treatment;

1. backward and upward growth of the condyle,
2. a positional shift of the mandible.

The first indications that changes were due to reposition were given by the control group which, although growing at the same rate as the treated cases, showed none of the changes in relation we saw from our sample.

Thus the normal condyle in occlusion is well seated and well centred in the glenoid fossa, and this position represents the most constant position when all related structures are in harmony and balance.

The electro myographic analyses of Moyers in 1949 confirmed the rest position as an expression of the functioning length of all the muscles of the tempero mandibular joint articulation. If Thompson and Brodie visualised a fixed mandibular position not normally altered with age they were probably correct.

With orthodontics however, some cases adopted new neuromuscular patterns with a resultant change in rest position.

The observations of Thompson and Ricketts are very similar yet their conclusions are directly opposed. The radiographic techniques differ in that Thompson required a full occlusion of the teeth. It was not till Ricketts developed his laminagraphy of the joint that the relations of condyle to fossa could be studied at rest and in occlusion and the observations of Thompson placed in their true perspective.

Moyers(4) studies with the electro myograph were the first scientific shadows to cut across Thompson's hypothesis. Ricketts'(5),(6) laminagraphy rattled at the foundations of his analysis and the coup de grace was administered by the down to earth observations of Sleighter(7).

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The Muscles of Facial Expression.

The Buccinator.

This muscle arises posteriorly from the pterygo mandibular raphe which runs between the tip of the hamular process on the medial pterygoid plate and the posterior end of the mylohyoid line on the lingual surface of the mandible. The raphe lies therefore, to the lingual of both upper and lower arches. From this origin it must cross the alveolar processes to take the rest of its origin on the buccal aspect of the maxilla and mandible opposite the molars. The muscle therefore follows a curved course backward around the tuberosity and the infratemporal surface of the maxilla.

The buccinator lies just under the oral mucous membrane and constitutes the deepest layer of the labial and buccal musculature. It is thus in most intimate relation to the teeth. The muscle decussates when it reaches the lips forming the orbicularis oris with other muscle masses. The most superior and most inferior groups run to their respective lips. The two remaining or middle groups cross each other as they go into the lips, the upper going to the lower lip and the lower going to the upper lip.

If one were to stretch a wide rubber band around the denture in a manner simulating the buccinator and if there were a horizontal slit in it in the incisal region like the lip line, it can readily be seen that the tension of the band running over a convex surface would cause the slip to open. This tendency explains a decussation of the fibres is necessary at the corners of the lips if the lips are to be held closed.

Brodie (1) has said the lip line may vary from the level of the incisal edges of the upper teeth to well above their gingival margins and it thus becomes apparent that it is the lower lip that controls the upper teeth. This means that the lower lip rests against the incisal tip of the maxillary teeth and is their chief restraining factor to the tendency for them to drift labially.

There is therefore, a relation between the lip line and the level of the incisor teeth and this is governed by the inherent morphology of the lips and the occlusal level of the incisor teeth.

Teeth erupt till they find an equal and opposite force. In the case of the upper incisors the lower lip. They come under the control of a greater depth of the lower lip. By the anatomical shape of the inner surface of the lower lip alone these incisors tend to be tilted lingually That is without any increase in muscular activity and without any change in posture of the lower lip.(2),(3),(4).

The buccinator lies in intimate contact with the teeth throughout the entire extent of the arch, and being constantly in a state of tonus exerts a gentle constricting force. This force is exercised almost exclusively on the maxillary teeth since this arch overhangs the lower. It operates indirectly on the lower through the inclined planes of the teeth.

The Caninus and Triangularis.

These two relatively powerful muscles constitute the middle layer of the lip musculature. The caninus arises from the canine fossa just

Full Face: While swallowing.

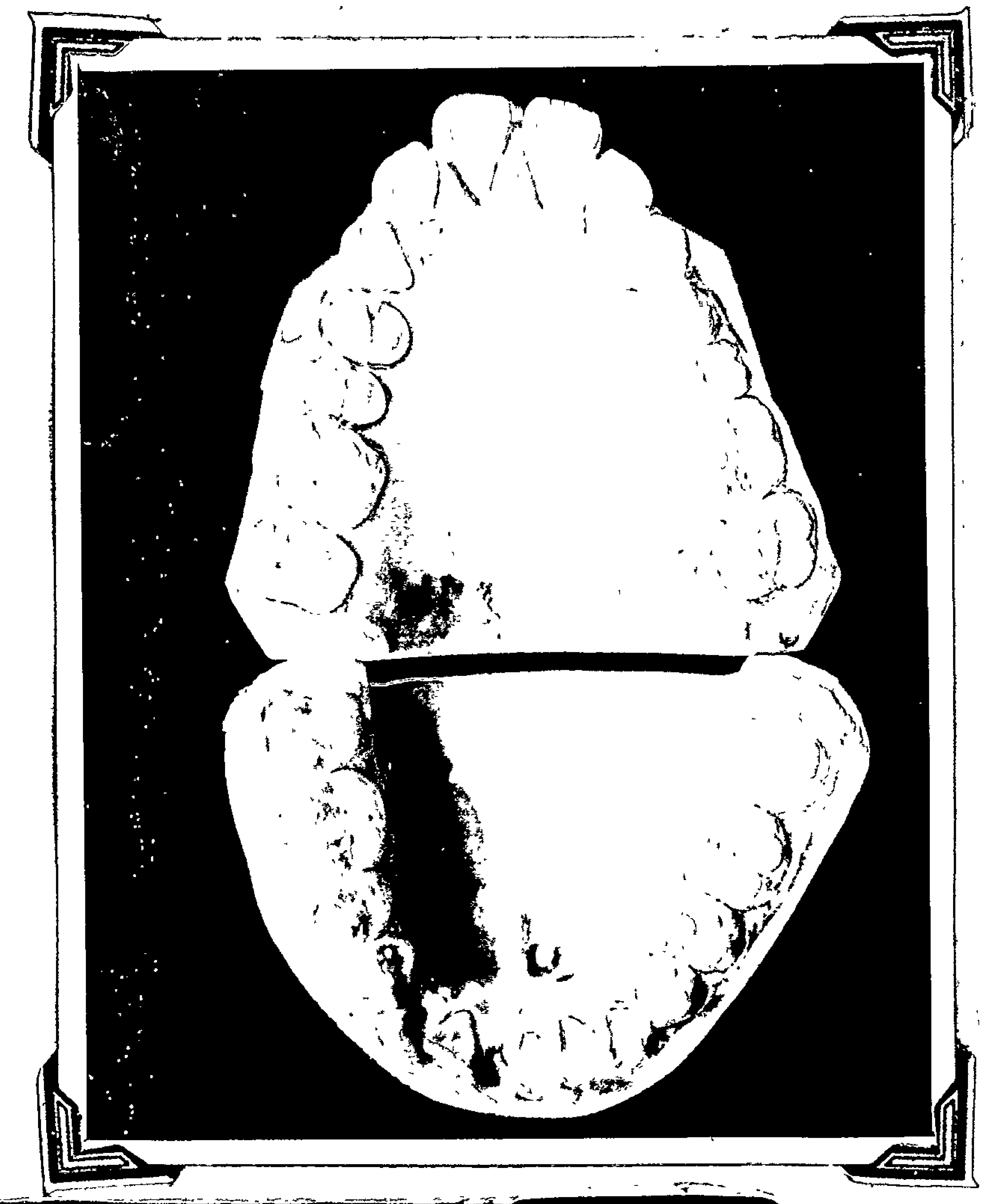
Analysis: 1. Skeletal 1, Angle's Class 11, Division 1 occlusion.

2. Incompetent anterior oral musculature.

3. Abnormal swallow with anterior tongue thrust.

4. Occlusion. There is flattening, retroclination and imbrication of the lower incisors due largely to the firm contraction of the mentalis muscle resisting the thrus of the tongue.(see photograph)

Strong contraction of the orbicularis oris in the region of the modiolus is evident and this results in a narrowing of the upper arch in the premolar-canine region.



below the infra orbital foramen and runs downward across the canine tooth into the lower lip where it reaches the midline and anastomoses with its fellow of the opposite side. The triangularis along a considerable extent of the external oblique line of the mandible beginning well lateral to the midline. Its fibres converge as they go upward giving it a triangular form and it too crossed the canine eminence decussates with the caninus and enters the upper lip where it anastomoses with its fellow at the midline. These two muscles are probably the chief registers to the mesio labial tendency of the canine.

These two muscles at rest are held somewhat laterally so that they lie in a pair of curves but upon contracting they tend to assume straight courses from origin to insertion. This brings their points of decussation (the corner of the lips - the modiolus) medially and bunches up the mass of the lips over the teeth throwing the lips into a pout or pucker. This is their normal function.

The contraction of the caninus and triangularis brings a considerable increase in pressure to bear on the canine area of the arch. If this is not carried beyond the point of normal usage it has no effect , but occasionally, as in abnormal swallowing habits, the tension is applied too often and the arch is narrowed in this region.

The Superficial Group of Labial Muscles.

These muscles the quadratus labii superioris, the zygomaticus and the quadratus labii inferioris comprise the outermost layer and like the preceding pair are restricted to the lips proper.

The quadratus superior arises by three heads viz., the angular from the frontal process of the maxilla medial to the eye, the infra-orbital a rectangular shaped portion which takes its origin just below most of the infraorbital margin and the zygomatic which arised from the zygoma just lateral to the zygomatico maxillary suture. The three heads converge as they run downward to make a continuous insertion from the midline to the corner of the upper lip.

The quadratus inferior arises just above the oblique line on the mandible well lateral to the midline and the two muscles left and right converge as they run up to the lower lip to take insertion throughout its entire length.

Being the most superficial these two quadratus muscles tend to curl the lips or when working in conjunction with the caninus and triangularis, to increase the pouting or puckering acts.

Muscles running from the facial surface of the zygomas must take a medial and forward course to reach the corners of the mouth. This is exactly what the zygomaticus proper and the zygomatic head of the quadratus superior do. Thus they tend to disturb the even tensions of the buccinator by relieving it at these points. They are truly relief muscles, and their traction at the corners of the mouth not only permit the canine to assume its more prominent position but they likewise tend to flatten the incisal segment of the arch.

<u>The Mentalis</u>.

It arises in the incisal fossa of the mandible and runs down and outward to the integuement of the chin. Thus its functional contracion would elevate the soft tissue of the chin raising the lower lip. If the upper lip is made stiff the lower lip is caused to curl forward and protrude, and acting with caninus, triangularis and the quadratus muscles it increases the degree of protrusion and puckering of the lip.

This muscle is interesting however, mainly in its malfunctioning aspects and the effect it will have depends on several factors viz.,

1. the level of the lip line.
2. the relation of the upper and lower incisor teeth to each other
3. the habitual position of the jaw.

Due to the band like structure of the labio buccal musculature, the elevating and balling up of the mentalis causes a very significant increase in pressure over a very limited area.

In those cases where the relation of the dental arches is abnormal the normal behaviour of the surrounding muscles may cause abnormalities of the occlusion.

In a Skeletal 11 relation where the lip line is not high the effects of the mentalis a re likewise an aggravation. In those cases the elevation of the lower lip by the mentalis brings it up behind the upper incisors. Having not only lost the restraining force of the lip on the labial side these teeth are now actually pushed from behind by the lower lip and they quickly tip labially to a marked degree.

In all cases of a hyperactive mentalis muscle the integument of the chin instead of being smooth presents a rounded elevation above the chin point and this elevation is dimpled and hard to the touch. When dimpling of the mentalis is necessary to close the lips when the jaws are at rest the lip condition is called Incompetent. (see later).

Similarly the Skeletal 11 dental base relation breaks the union of the lips and the upper of which curls up over the roots of the maxillary teeth. Increased strain from the external oblique line through the triangularis muscle to the upper lip crushed the canines lingually and the muscle balance is completely altered though the muscles and their action may be completely normal. Reduction to a Skeletal 1 if this is possible brings about a spontanious correction of the muscle balance in many cases.

In a Class 11 Division 2 type occlusion the level of the lip line coupled with the fact that the lips do not part (5) results in increased pressure on the upper incisor region with the result that it buckles in a lingual direction. This is again merely the result of a malrelation of the skeletal parts which give origin to the muscles of the lips.

The Skeletal 11 picture is completely reversed. The maxillary skeletal structure is relatively smaller and more posterior than the mandibular. In these cases the maxilla ry teeth have a strong tendency to flare out and the mandibular teeth to lean in, and both quite accurately reflect the course of the buccinator muscle from its superior attachment to its inferior attachment.

This is an oversimplification of the problem but it does show despite the normal muscle functioning a faulty relation of the skeletal scaffolding can result in a deforming force for that reason with subsequent malocclusion of the teeth.

The Tongue.

In order to understand the contribution made by the tongue to the maintenance of the balance of the denture one must remember -

1. Its relative size at different ages.
2. The manner in which it is positioned by its extrinsic muscles.
3. Its ability to create localised pressures by changes in its form.
4. Its relations to the dental arches.

Relative Size at Different Ages.

There are no teeth erupted and very little alveolar process present at birth. The masticatory function develops considerably later. Suckling and deglutition, on the other hand, are functions that are present at birth. It is not surprising therefore, to find the tongue advanced in development and larger in size than the rest of the denture. In fact second to the brain and the eyeball, the tongue is the most advanced organ in the human head at birth.

If a head plate x-ray is taken of a resting new born infant it is found that is jaws are wide apart and that its tongue not only occupies the entire mouth within the arch, but flows out over the alveolar ridges and supports the back of the closed lips. Indeed if the effort is made to close the jaws further until the gum pads meet, the infant will struggle, choke and cry because its tongue is being pushed back into the pharynx.

As growth continues and the teeth of the deciduous dentition erupt a gradual change takes place but it should not be assumed that the tongue is abruptly enclosed by the teeth. Serial x-rays taken of the same child reveal that the interdental freeway space is decreased slowly and that the teeth are caused to enclose the tongue gradually by the growth of the jaws. This is accomplished by the interplay of three factors:-

1. the growth of the jaws.

2. the diminishing rate of growth of the tongue compared to that of the jaws.

3. the cranial suspension of the tongue.

Extrinsic Suspension of the Tongue.

The tongue is suspended above and in back of the styloid process a cranial origin which lies in back of all of the growth sites of the face. In addition it is attached above to the palatal process of the palatine bone and maintains a constant anatomical and functional relationship to that bone. Below and in front it is attached to the superior genial tubercles of the mandible and directly below to the hyoid, a floating bone.

The growth of the maxilla which lead to changes in position of this bone are located at the posterior surface of the tuberosity and on the maxillary side of the transverse palatal suture. The pyramidal process of the palatine caught between the tuberosity and the pterygoid process acts like an anchor to the palatine thus preventing its sharing the forward movement of the maxilla with growth. In this manner the palatine maintains the stability of position necessary for deglutition and the tongue being attached to it and to the cranium is prevented from going forward at the same rate as the jaw. Being attached to the symphisis of the mandible it does go forward but only at half the speed of this bone.

Like all other parts ofthe body the tongue shos great variation in its size, its development at birth and in the rate at which it is enclosed by the teeth. Because of its connection with the lymphoid rings, so prominent in the infant it is in many cases apparently too large at birth. In some it may protrude from the mouth. The condition generally corrects itself spontaneously but occasionally radium or x-ray therapy is prescribed to reduce the size of the organ. Very rarely is there actual muscle fibre hypertrophy.

The fact that the tongue is relatively oversized in the infant stage makes it a potent agent in the control of the deciduous dentition. Each tooth as it erupts is acted upon and brought to a position determined by the periphery of this organ. It is not surprising therefore that most deciduous dentition exhibit teeth that are well aligned in an arch form. However if the tongue is too large it may have deleterious effects. There may be a generalized spacing of all teeth and particularly of the uppers and this arch may be expanded to the point where the mandibular arch telescopes up completely inside it. By this is meant that the buccal surfaces of the lower meet the lingual surfaces of the upper.

Failure of the tongue to take up its position within the tooth arch may lead to other conditions of a localised nature. If the tongue constantly is held between the upper and lower anterior teeth these never fully erupt and a condition of open bite results usually from cuspid to cuspid. Persisting into the permanent dentition this habit gives rise to the same condition with the upper and lower incisors evenly aligned but with an opening one eighth inch or more separating upper and lower teeth. This even alignement of the incisal edges is a diagnostic sign of a passive tongue resting habit. In cases of macroglossia, regardless of the cause the teeth will exhibit generalised spacing.(6)

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Deglutition and its Effects on Occlusion.

Research work in England has concentrated on muscle function and the effects it has on occlusion. Ballard believes that "some of the abnormal postures and behaviour patterns of the muscles of expression, chewing and swallowing........ are associated with and probably frequently the sole cause of dental anomalies". (1).

Their investigations have brought a new language to the orthodontic field and it is necessary to define their terms before we can appreciate their work.

Incompetent Lip Musculature.

This occurs when with the mandible in the physiologic rest position and the muscles of the face in physiological rest the lips do not meet. In this type of case the individual can never close the lips without contraction of the mentalis and orbicularis oris in particular and that applies throughout life.(2)

Ballard goes on to say "I am not certain in my own mind that incompetent musculature on its own is associated with an abnormality of labial segment position when the dental base relation is within the normal."

Normal Swallow.

After preliminary clearing of the buccal vestibules begins with the mandible being raised to light occlusion. Thebtongue is lifted into the roof of the mouth and a peristaltic wave spreads along it. This peristaltic wave commences as an elevation of the tip against the mucosa immediately behind the upper incisors. In the normal act of swallowing there is no contraction of the lips. They remain at rest.

Examples of incompetent anterior oral musculature.

Abnormal Swallow.

Type I. 1. depression of the mandible.

2. tongue moves forward and narrows.

3. drawing in of lower lip against ventral surface of tongue.

4. margins of upper and lower lips are kept in contact by an eversion of the margin of the lower lip i.e. the upper lip is pursed rather than drawn tightly back across the surface of the upper incisors.

5. the lower lip is tensed. The mentalis is tight as well as the orbicularis oris.

6. while still being held forward the tongue presses up against the palate in the region of the oncoming incisors over the lower incisors.

7. the thrust is accompanied by a tenseing of the myloh oids and elevation of the mandible from the depressed position assumed in the preparatory stage.

8. the teeth are not in occlusion.

9. the lower lip is drawn back still more agaist the ventral surface of the tongue forming a resistant wall to aid the thrust of the anterior part of the tongue against the palate in the region of the incisors.

Thus the tongue thrusts over the lower incisors against the upper incisors proclinating them and the orbicularis oris of the lower lip and mentalis muscle contract against the lower incisors and the tip of the tongue. There is no lingual pressure from the tongue against the lower incisors. Again the action of the orbicularis and the mentalis muscles tends to produce some retroclination of the lower incisors whereas if there were no abnormal muscle action the lower incisors would be stable

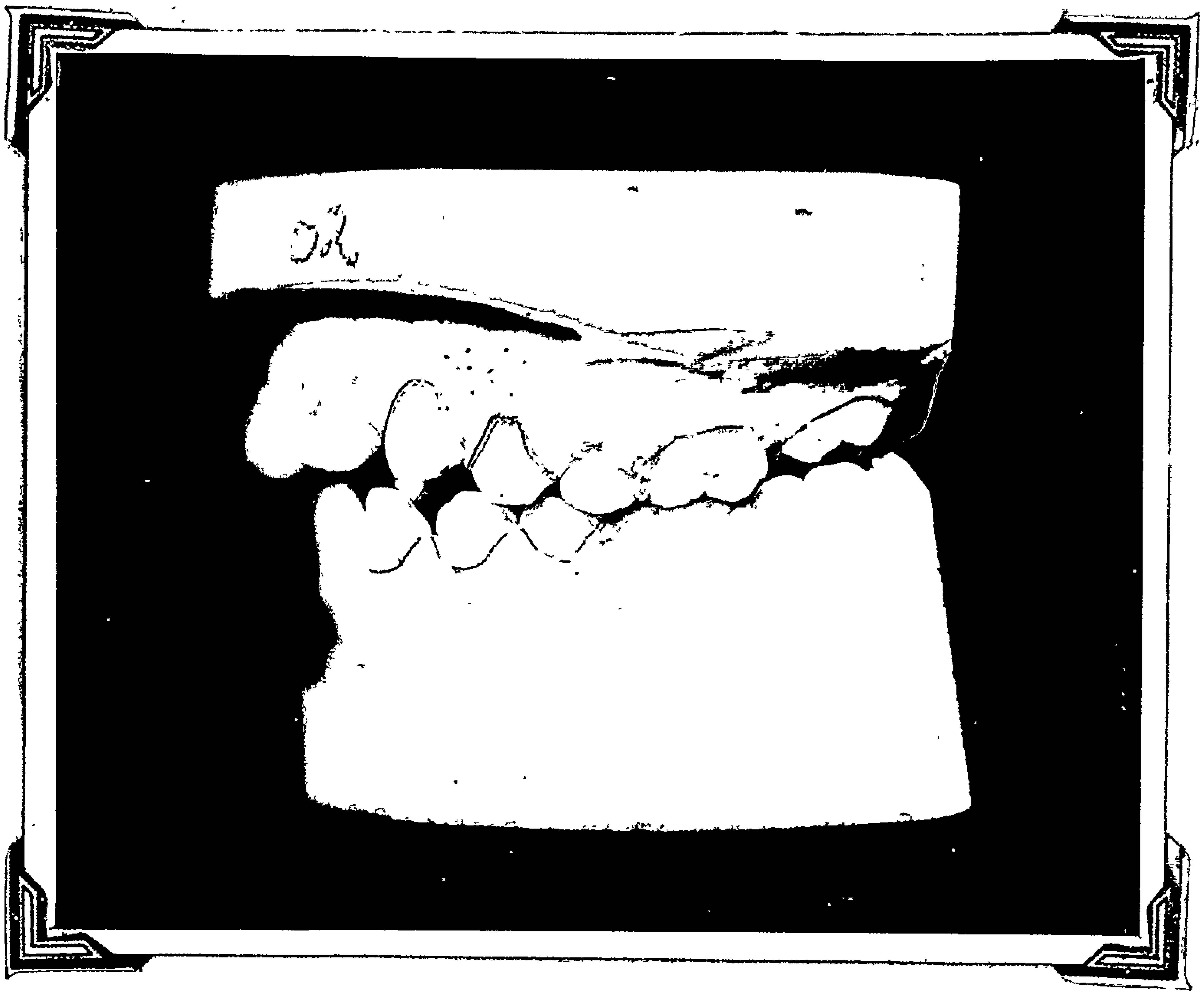
<u>Full Face</u>: At rest.

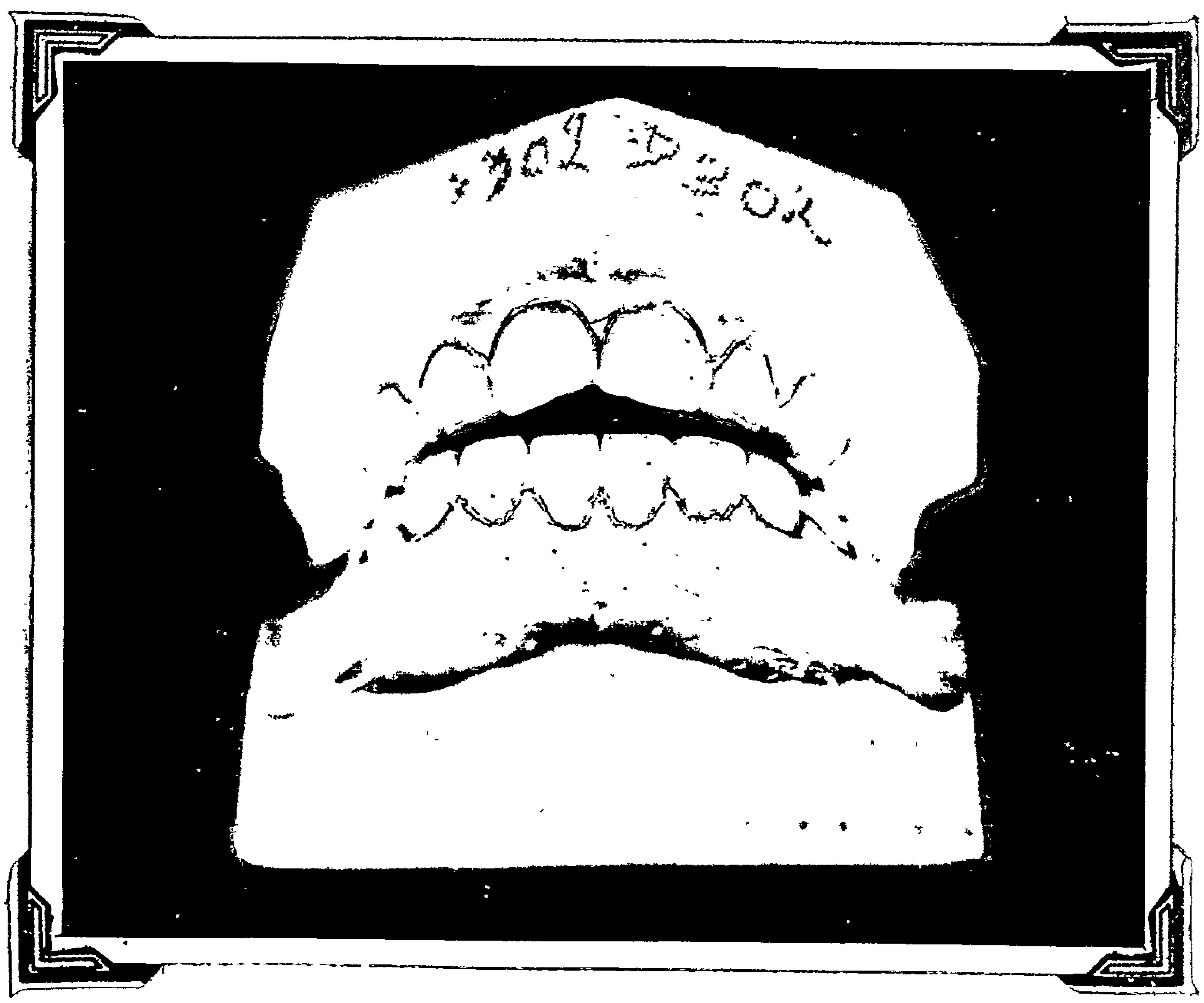
<u>Analysis</u>: 1. Skeletal 1-111, Angle's Class 1 occlusion.

2. Incompetent anterior oral musculature with a passive lip-to-tongue resting posture.

3. Normal swallow with interdental sigmatism (lisp).

4. <u>Occlusion</u>. Normal occlusion with anterior open bite due to the lip-to-tongue resting posture.





in a more proclined position. This increases the overjet.

Anterior Open Bite.

Failure of the tongue to take up its position within the tooth arch may lead to other conditions of a localized nature. If the tongue is held constantly between the upper and lower anterior teeth these never fully erupt and a condition of open bite results usually from cuspid to cuspid. Persisting into the permanent dentition this habit gives rise to the same condition with upper and lower incisors evenly aligned but with an opening of one eighth inch or more separating upper and lower teeth. This even aligning of the incisal edges is a diagnostic sign of a passive lip to tongue resting posture. This is often lost but the loss is gradual.(3)

The upper lip does not always continue to contribute to an anterior seal during swallowing. Part of the upper incisors remain visible during swallowing the everted margin of the lower lip makes a seal with the upper incisal edges and with the ventral surface of the front of the tongue. A tongue pressed against the back of the anterior teeth and supported by a taut lower lip makes a perfectly efficient seal for the purpose of swallowing. This latent inability of the upper lip to remain normally covering the upper incisors can thus be secondary. There is a discrepancy in upper and lower incisor relations but not because of a primary failure of the upper lip. The upper lip in these cases has merely become physiologically redundant. Thus lip incompetence as Ballard calls it, is not in itself primarily responsible for malocclusion.

Type 2. This may be called the "blunt tongue" swallow.

Children with retroclined incisors usually have good radial relations with excessive incisor overlap. The lower lip does not lie against the ventral surface of the protruded tongue nor does one see resting contact between the tongue and lower lip that we see associated with open bites. There is obvious tension of the sealed lips taking them back towards the withdrawn tongue which oozes laterally during the act of swallowing. The teeth are not in occlusion. As the permanent upper incisors move down they are subjected to the extra pressure of the tense upper lip. Due to the lateral ooze of the tongue there is no normal lingual pressure on the lower anteriors. The result is a Class 11 Division 2 type occlusion with retroclination of the incisors.

The fundamental difference between normal and abnormal swallowing patterns "is the contraction of lips and/or cheeks to resist the thrust of the tongue.(4)

Alveolar dental deformity can be caused by lip or tongue. Take the case of the anterior tongue thrust. The tip of the tongue thrusts against the lingual surfaces of the incisor teeth. These are gradually forced to tip labially until the arches become peaked. This may continue until an open bite is established but it will not resemble the open bite caused by the lip to tongue resting posture. Whereas the axes and alignment of the teeth will be good in the first case in the thrusting pattern the teeth are tipped outward giving the lips a prominent appearance. Another difference may usually be noted in the form of the arch. In the resting posture it will frequently be normal in width and form whereas in the latter i.e. the tongue thrust the arch will be narrowed through the canine-premolar area. In a forward thrusting the tongue becomes longer and narrower. This permits the buccal muscles and particularly those which decussate over the canine to crush these areas in.

Gwynne Evans(5),(6) and Rix(7),(8) describe a similarity between the infantile suckling pattern and the abnormal swallow. At first they believed that in time there would be a maturation of this pattern as there often is in open bite cases caused by a lip to tongue resting posture.

Tulley(9),(10) and Ballard(see references) challenge this and believe that though there may be some change particularly in those cases where the force is less positive and there is no dental sigmatism, the fundamental pattern remains unchanged.

Discussion.

A tongue thrust during swallowing can produce anything from an anterior open bite to a typical Class 11, Division 1 type occlusion and the degree of overjet or overbite is, to a great extent, determined by the dental base relation.

Thus on a normal dental base relation this leads to an open bite and on a Skeletal 11 dental base relation to a Class111, Division 1. In mild degrees of abnormal swallow it is possible that as a result of treatment the tongue thrust is completely eliminated. When the abnormal swallow is associated with a Skeletal 11 pattern on plans one's treatment as though it were going to be eliminated and as though the mandibular dentition can be brought forward against the contraction of the lower lip which resist the tongue thrust during swallowing. As one closes up the overjet a degree of open bite tends to develop if the tongue thrust is uncontrollable. In the majority of cases the relapse is not complete, there is a reduction of the proclination of the labial segment and there is some reduction of overbite with the tip of the tongue resting between the teeth and thrusting during swallowing. The greater the incompetence the less the lower labial segment can be proclinated and the poorer the prognosis.

Assessment of Soft Tissue Behaviour.

That teeth move when force is applied them is indisputable.

The muscle masses of mastication and facial expression are in direct and intimate contact with the teeth. The force exerted in an abnormal swallowing pattern with tongue thrust, the resisting mentalis and the orbicularis oris muscles particularly in the region of the modiolus, is obvious and considerable.

Q.E.D. Muscle force moves teeth.

Rix confirms this in his analysis of nearly 100 children between the ages of 7 and 11¾ years. He found that 71% swallowed in one basic way and 29% in another. The interesting point which emerged was that it was among the 29% that a high concentration of defects of the dental arches were found. In fact defects of the position of teeth were more than twice as common in this group than in the 71%.(9)

There should be no dogmas in orthodontics.

We have seen that the relationship of the dental bases may alter with or without treatment; that rest position is a conditioned posture which best satisfies the needs or respiration, mastication, speech, deglutition and posture, and is altered therefore, according to those changing needs.

Similarly with the soft tissue masses surrounding the dentition. That they initiate a malocclusion is possible;that they perpetuate an already existing deformity is probable. But to claim as Ballard does "(muscle abnormalities) are probably frequently the sole cause of dental anomalies" is as naive as the alchemist's belief in the touch-stone. Both are gross oversimplification of complex problems.

Since the first clinical observations of the abnormal swallow and its associated dental abnormalities by Rix in 1946, the beautiful clarity of the problem has been obscured by the jargon and philosophical discussions that raged round it.

No attempt has been made for example, to analyse the types and degrees of abnormal swallow; to assess their incidence in the non orthodontic population; to relate the type of swallow to the type of occlusion; to assess the effect of treatment on an abnormal swallow. These are only a few of the problems that are crying for clinical, statistical and scientific assessment. Answers to these problems would drastically alter our treatment planning and prognosis.

Orthodontics is essentially a practical subject and its problems require essentially practical answers.

Hypotheses must be tested by facts which can be recorded, tabulated analysed and then duplicated before they become accepted.

Constant repetition of an hypothesis does not make it a fact.

Until orthodontists scientifically confirm their hypotheses, these must remain ingenious thoughts on as yet, unsolved problems.

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Assessments of Some Treatment Plans with reference to Principles of Treatment.

With a sound knowledge of the fundamental sciences we are in position to apply principles of treatment to each case thus establishing a uniformity of thought and practice no matter what appliance therapy we use. We can then assess trends as they sweep the profession and challenge or explain the empirical rules of treatment which have guided clinicians.

Orthodontics is an applied science where, up till now, experience has been the greatest teacher. Many of its practitioners have evolved treatment procedures which are successful in their hands and which they have attempted to systematise. Very often they have substituted rules for principles, oversimplifications for clear thinking.

Take the separate but similar cases of Howes(1), Nance(2) and Carey (3). Each is an eminently successful clinician who, by means of table or computer, relates tooth size to basal arch size or finds a direct relation between the arch lengths of deciduous and permanent teeth. By following certain mathematical equations one decides which teeth should be extracted, if any.

Yet the specimens described by Sarnat and Gans(4), and those in the collection of Sir Norman Bennett(5) show that despite complete anodontia the jaws grow to a normal size. Thus there is no relation whatsoever between basal bone and the teeth. Begg in his studies on Stone Age Man(6) has shown there is a drastic reduction in the mesio distal diameter of the deciduous dentition from eruption to eventual loss. Thus the final result bears no direct linear relation to its permanent successor.

Now it is not that extraction therapy is in itself, wrong. Far from it. Nor is that their results are poor. On the contrary they are excellent. Yet the basic principles are obviously true.

Thus the neat formulae, the oversimplified rules of thumb that fly in the face of a basic principle are the greatest stumbling blocks to understanding and clear thinking; to uniformity of though and practice.

The finest clinical orthodontist of our time, Charles Tweed (6,7, 8), is guilty of the same error and though we may admire his results his explanation of how he achieves those results is a gross understatement of his achievements.

Wylie (9) in an exhaustive analysis examines some of Tweeds results "Tweed has jelled his ideas and developed a more precise position of the lower incisor.Now a single measurement of the lower incisor to the Frankfort horizontal from the lateral head film determines case analysis treatment planning and apparently prognosis.(see cephalometrics)

Tweed not only preaches the reduction of the profile about the lips but he achieves those changes to a marked degree in his own cases.

He undeniably moves teeth back in relation to the bony base, not only just by tipping but often by moving them bodily as well.

His own material shows however, that the good facial changes can not be ascribed to tooth movement entirely, for in young patients the improvement gained is largely related to the amount of mandibular growth which has occurred establishing a new and better position for the chin. Further the lingual movement of anterior teeth is not always accompanied by proportionate lip change.Several cases were found where there was lingual bodily movement of anterior teeth, yet where the soft tissue outline of the lips superimposed exactly upon the original soft tissue position.

Growth undoubtedly has an important role in the successful outcome of his cases. To a remarkable degree he capitalizes most effectively upon natural processes of growth.

Now if the uprighting of the lower incisors a specific number of degrees is so virally necessary in the process of straightening the profile, then we should frequently find associated with the cases in which there has been the greatest amount of net change in the lower incisor a correspondingly large amount of improvement in the facial profile.But this is not so.

With the upper incisor the greatest amount of facial improvement was found where the greatest amount of lingual tipping had occurred. In a similar fashion the least amount of change in which the soft tissue angle became greater was found in a case where the upper incisor was moved forward.We should not say that this is the only significant thing in improving the facial profile nor are we entitled to say that the angulation of the lower incisor is never important in the improvement of the facial profile.We can say that so far as the inclination of teeth is concerned that we should expect improvement of the facial profile if we can retract the upper incisors.If it is necessary to retract the lower incisors to do so obviously we cannot look for much improvement in the face until we upright both teeth.

He relies on the cephalometer to tell him where he has been rather than where he is going.But if we are to use it for the latter, then tailor the lower to fit the inclination of the upper anteriors.

Discussion. In our examination of the value of cephalometrics we found that the validity of a single measurement, line or angle as a diagnostic criterion is inaccurate and unreliable. Yet this is precisely what Tweed uses.

Tweed is more successful in achieving his orthodontic success than in explaining it. If facial change were simply a matter of tooth movement then he should have equally successful results in adults and in the young patient. Yet this is obviously not so.

What does he do that singles him from the other successful orthodontists?

1. He carries maxillary incisors posteriorly in a bodily fashion so that at the end of treatment they do not have a lingual inclination.

2. He effects profound changes in tooth position without changing to a great degree the occlusal plane and the Frankfort - mandibular plane angle.

3. He gets sizable amounts of growth in the mandible with relatively little maxillary growth. This results in a drastic alteration of the skeletal bases and is independently confirmed by Holdaway (10), Stoner et alia (11).

4. He moves anterior teeth substantial distances and does so bodily but with a minimal forward displacement of posterior teeth.

In his 95 cases of pleasing facial type Tweed claims the angle FMIA is the one factor they have in common and is therefore the only factor responsible for the best in facial esthetics. Every one of these cases shows a well developed mandible, and generally the mandibular incisors tend to be more upright in individuals with more mandibular development. This is a symptom rather than an essential facial feature. Wylie concludes "where Tweed emphasises incisor angulation in his selection, I see strong mandibular form; in his treated cases he emphasises alteration of incisor angulation while I see mandibular growth.

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Classifications of Malocclusion.

E. H. Angle Classification.

This classification as it is used today, appeared in the 7th Edition of Angle's "Malocclusion of the Teeth",1907.

Class 1 Arches in normal mesio-distal relations.

Class 11 Lower arch distal to normal in its relationship to the upper arch.

Division 1. Bilaterally distal, protruding upper incisors. Primarily, at least associated with mouth-breathing.

Sub-division. Unilaterally distal, protruding upper incisors. Primarily, at least, associated with mouth-breathing.

Division 2 Bilaterally distal, retruding upper incisors. Normal breathers.

Sub-division. Unilaterally distal, retruding upper incisors.

Normal breathers.

Class 111 Lower arch mesial to normal in its relation to upper arch.

Division Bilaterally mesial.

Sub-division. Unilateral mesial.

Before classifying a mutilated case the molars should be visualized in the position they had occupied before any drifting took place.

Discussion. The relationship of dental base to dental base is determined by the North-Western or Eastman assessment techniques.

Angle's classification is used as a description of the occlusal picture.

Paul Simon's System of Diagnosis of Dental Anomalies.

In 1922, Paul Simon of Berlin published his work, " A System of Diagnosis of Dental Anomalies". Following translation of the work into English in 1926, Simon went to the U.S.A. on a lecture tour and many of the antagonists of Angle, Struck by Simon's apparently scientific approach, became his followers. Briefly stated Simon's thesis was as follows:-

The Angle Classification of malocclusion was an empirical concept since it was based on the premise that the maxillary first permanent molar was a fixed point.(Angle never claimed this). Simon pointed out that since variation was the first law of nature, it was a mistake to take any tooth as a fixed point, since it would only be logical to expect to find it forward or backward of a "normal" position in many cases.He asked how its position in the head had been arrived at because , he claimed, since the teeth were housed in and a part of the head, they must have certain relations with other parts. These relations had never been subjected to a critical study and this his system was intended to do. For the purpose he used methods borrowed from the physical anthropologist, who had been subjecting the skull to just such measurements for many years.

The physical anthropologist has employed planes which are established by landmarks within the head and these are taken to represent the zero of his measurements.

The Mid Sagittal Plane.

Since the body is more or less symmetrically divided into a right and left side, and since there are many midline points which may be used for reference, the universal base plane of all biological systems of measurement is the mid sagittal plane. Obviously this plane is perpendicular and orientated in an antero-posterior direction. Giving the plane a value of zero, measurements are made to the right or left.

The Frankfort Horizontal Plane.

It can readily be realized that a head could be rotated in the vertical direction 360 degrees without affecting its relation to the mid sagittal plane. It is therefore necessary to establish another plane at which such a rotation must be stopped

To establish a plane it is necessary to have three points and the three points selected for the establishment of the Frankfort plane are

1. the most superior points on the bony external auditory meati, left and right and

2. the most inferior point of the lower border of the left orbit.

The first is known as porion and the second as orbitale. Thus, there are two ear points and one orbital point.The plane is established at right angles to the midsagittal plane and the three points enumerated above are placed on this plane. The resulting position represents the average posture of the head when standing erect. Since this plane is horizontal and runs through the head, its use as a zero point results in measurements which are stated as "above Frankfort or below Frankfort".

The Orbital Plane.

The only remaining measurements are the antero posterior, which gives us length or depth. For this purpose one could erect a plane at right angles to the other two at any point one desired. Simon elected to employ the left orbitale, one of the points used in establishing the Frankfort horizontal. Such a plane would intersect the dental arches which he desired to do.

<u>The Canine-Orbital Law</u>.

Simon claimed that he had measured large numbers of German children with normal occlusion and that in an overwhelming majority the orbital plane passed through the tip of the maxillary canine tooth. He claimed further, that age did not affect this relationship. On the basis of this relationship Simon classified cases as forward or backward of the orbital plane. But this would relate the teeth to the face and cranium only in an antero posterior position and Simon desired a three dimensional diagnosis.

<u>Gnathostatics</u>.

The technique of relating the teeth and arches to the head for purposes of detailed diagnosis and measurement Simon called gnathostatics. It is carried out on principles similar to those employed in dental prothesis when the face bow is employed.

The base of the model becomes a representation of the Frankfort horizontal plane and the teeth are in the same relation to it as they were in the living. By means of a perpendicular graving device, the orbital plane, which has already been recorded on the patient by means of a pointer, is marked completely round the model. In a similar manner the medial raphe or midsagittal plane is marked and the case now can be described in relation to the three plane system.

Simon's method was seized upon quite enthusiastically by large number of men in the U.S.A. although it apparently never enjoyed much favour in Europe. In this country the Canine Orbital Law was immediately checked by several investigators, notably Connelly of Georgetown and Broadbent of Western Reserve. These men, working independently, both subjected groups of skulls possessing normal occlusion, to exact craniometric analysis. Neither could find skulls in which a perpendicular to Frankfort dropped from orbitale went through the tip of the maxilla ry canine. The greates incidence occurred through the distal half of the first and mesial half of the second bicuspid, although Broadbent found one skull where the line dropped far enough back to go through the first permanent molar.

Value of the Simon Method of Diagnosis.

In spite of the fallacy that is inherent in the canin orbital law the method of making models does undoubtedly yield information greater than that from the usual orthodontic model where the bases are trimmed approximately parallel to the occlusal plane.

The use of the mid sagittal plane gives information about the symmetry (or lack of it) in the dental arches and palate and the pouring of a base to represent the Frankfort Horizontal orients the denture to this plane and to the face. Through these aids the localization of the deformity is more readily accomplished. (1).

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Method of Examination.

General observation of face and body posture. Note particularly unusual asymmetries. As a matter of interest, note usual asymmetries.

A correct assessment of the incisor relationship is the next essential. Each of the four buccal segments should then be related individually to their respective labial segments, to their dental bases, and finally, left lower to left upper, and right lower to right upper.

Assessment of labial segments should be carried out in the following way:

1. From the lateral aspect decide whether the general axial inclination of upper incisors is correct aesthetically, or either proclinated or retroclinated.
2. Ditto for the lower incisors.
3. Now note the occlusal relationship of upper and lower labial segments:

a. Overjet: Normal.
Increased.
Reduced - edge-to-edge bite,
- Class 111 incisor relationship (mandibular overjet).

b. Overbite: Normal.
Increased - excessive overbite.
Reduced - edge-to-edge,
- open bite.

It should be remembered that the labial segments grow vertically until this growth is balanced by occlusion. If, therefore, the lower incisors do not contact lightly either the upper incisors or gum the cause for this must be found during the examination, eg. abnormal soft tissue behaviour pattern or abnormal skeletal pattern, or a combination of these factors.

<u>Skeletal Pattern</u> (Clinical Assessment without lateral Radiograph).

From the axial inclination of the upper and lower labial segments and the degree of abnormality of their relationship it should be possible by a mental correction of the abnormal axial inclination to decide roughly whether the dental bases are in normal or abnormal relationship; eg., if after mentally correcting a proclination or retroclination of the upper incisors, and a proclination or retroclination of the lower incisors, there is a possible abnormality in their antero posterior relationship, then this is the result of an abnormal dental base relationship.

If a normal incisor relationship would result from this mental correction of incisor axial inclination, then the labial segment dental bases are in correct antero posterior relationship.

<u>Classification - Skeletal 1</u>.

If the mandibular labial segment would be lingual to the maxillary then the mandibular dental base is postnormal.

<u>Classification - Skeletal 11</u>.

If the mandibular labial segment would be labial to the maxillary then the mandibular dental base is prenormal.

<u>Classification - Skeletal 111</u>.

N.B. This classification is entirely one of antero posterior dental base relationship and not of maxilla and mandible to profile.

Soft Tissue Behaviour Patterns.

Mandibular Position.

Ricketts has shown that the only stable position of the condyle is centric position: this is the most retruded unstrained position of the condyle in the glenoid fossa, from which lateral excursions of the mandible can be made. (1, 2).

Thus any examination of occlusal relations or mandibular position must be made from this position.

Habitual Posture of the Lips.

a. Normal

Lips closed without effort.

Muscles in resting tonus.

b. Abnormal.

Lips habitually open.

Incompetent anterior oral musculature.

Test for oral and nasal respiration - cold metal tongue spatula.

c. Lips closed, but with effort.

That is, with contraction of orbicularis oris and mentalis muscles incompetent anterior oral musculature.

d. In examination for a. to c. it will have been noticed whether the tongue is between the teeth and against the lips.That is habitual lip-to-tongue resting posture.

Swallowing.

__Normal__ is with the teeth in light occlusion and no activity of facial muscles. In b and c above, there will inevitably be contraction of the lower lip.

__Abnormal__ swallow occurs when the tongue is -

i. thrust forward between labial segments against contracted lips. This may occur in cases in which there is normal resting posture of lips.

ii. Less commonly, the tongue squeezes laterally between parted cheek teeth against contracted facial muscles.

__Articulation__.

Any speech abnormality might be noticed in the course of general conversation. To test for interdental sigmatism ask the patient to recite a nursery rhyme which has two or three S's in the first few lines.

__Sucking Habits__.

Either ask the patient, if old enough, or the parent. It is always wise to ask such questions of the parent out of hearing of the patient.

From the examination so far the cause of an abnormal incisor relationship should be determined.

Check the position of upper and lower centres. These have probably been observed in examination of the centric position of the mandible. Are labial segments spaced?

Determine the relationship of buccal segments to labial segments to basal bone, and to one another, by the following observations:

1. Relate axial inclination of canines to basal bone and to the axial inclination of labial segments.

2. Are buccal segments in contact with labial segments?

3. Have buccal segments been mutilated - in particular, have the first permanent molars drifted as a result ?

Each buccal segment may be -

i. in normal contact with labial segment;

ii. forward of labial segment, producing -

a. labial displacement of canines;

b. crowding of labial segment;

iii. forward in contact with proclined labial segment. Canines mesially inclined in relation to basal plane or occlusal plane.

iv. spaced from labial segment because of -

a. tooth size - arch size discrepancy;

b. proclined labial segment, buccal segments not having drifted mesially to maintain contact.

Having thus determined the position of each buccal segment, and knowing the dental base relationship from skeletal pattern assessment the cause of any abnormal relationship of upper to lower buccal segments is known.

Clinical Records.

After a full examination of the patient has been completed, we may then commence an equally exhaustive examination of the lateral radiograph and models.

1. Lateral radiographs should be analysed for -

a. dimensions and dental base relationships antero posteriorly and laterally.

b. abnormalities due to pathology.

c. asymmetries.

d. condyle position.

2. Models should be examined for -

a. upper and lower arch forms.

b. relationship of labial and buccal segments to basal bone. With the labial segments this is best expressed in terms of axial inclination of the teeth. Inclinations of individual teeth must be noted if different from others in their segment.

c. relationship of buccal segments to labial segments. The best guide is axial inclination of canines related to axial inclination of labial segments, whether the latter are normal or abnormal.

d. relationship between size of dentition and size of the arch.

e. irregularities within the dento-alveolar structure -

i. absent teeth.

ii. supernumeraries.

iii. teeth of abnormal form.

iv. fraenum and interpremaxillary suture.

v. impactions.

vi. premature loss of deciduous and permanent teeth and the result on the arch and position of the other teeth.

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Overcrowding.

Only that overcrowding which is not associated with abnormalities of muscle action or skeletal pattern and early loss of deciduous teeth will be dealt with.

Crowding is due to the dentition being too large for the dental arch (1). The shape and dimensions of the dental arch are determined by (1) soft tissue behaviour; and (2) size of dental base.

It is important to remember that the arch form and size is the result of muscle balance and no change of shape or size will be stable unless there is a change in the position of muscle balance. Achange of the position of muscle balance can only be expected if it is seen to be abnormal and it is thought that conscious effort on the part of the patient will achieve the change. The size of the arch laterally is only indirectly related to dental base width, and the latter should not be taken as a guide to the possibility of expansion as a method of treatment. Similarly, the length of the arches is the result of soft tissue behaviour controlling labial segment position anteriorly and posteriorly the developmental relationship (genetically determined) of the molars to the tuberosity in the maxilla and the ascending ramus in the mandible. There is never much hope of materially increasing arch length.

Crowding in Labial Segments.

As judged from the axial inclination of the teeth (the canines in particular) this more often the result of antero posterior shortness of the arch, the buccal segments encroaching on the labial segments. Rarely is it due to a soft tissue pattern plus a very narrow dental base in the incisor and canine region - canine apices mesially placed in relation to crowns.

Crowding in Buccal Segments.

This, as a rule, only manifests itself at either end of the segments; anteriorly, as above, when the canine has been pushed mesially and is crowding the labial segment; posteriorly in the mandible by delayed eruption of the last tooth, impaction, etc.; in the maxilla by impaction of the first permanent molar, and by the buccal eruption with distal tilt of each successive erupting molar. Crowding within the buccal segments usually only results from early loss of deciduous molars and canines.

Many irregularities of upper and lower incisors must be regarded as within the normal in the stage of development from about six to ten years of age. Broadbent calls this the "ugly duckling" stage of development.(2)

It should always be remembered that, fortunately from the point of view of treatment, the majority of incisor crowding requiring treatment is due to forward position of buccal segments. This requires the removal of a unit and distal movement of teeth before alignment of incisors is proceeded with.

Overcrowding is more common in the maxilla than the mandible, and in any case should receive more attention than that in the mandible because of

(i) aesthetics;

(ii) the fact that the mandibular arch is frequently best left slightly crowded to support the aligned upper arch and to avoid an excessive overbite.

Ideal Treatment.

Step 1. age 7-8 extract $\underline{c/c}$ as $\underline{2/2}$ eerupt. But if there is little or no overbite, which is relatively rare, extract $\underline{c/c}$ and $\overline{c/c}$, or $\overline{c/c}$ may be extracted later than $\underline{c/c}$.

Step 11. age 9-10 extract $\underline{4/4}$ on eruption (but not if $\underline{5/5}$ are in the palate, or if $\underline{6/6}$ and $\overline{6/6}$ are too carious to save).

Step 111. age 10-11 extract $\overline{5/5}$ as or before the $\underline{3/3}$ erupt.

Discussion. If the lower deciduous canines are extracted where there is overbite in the deciduous dentition then there is greatly increased overbite.

Extraction of the lower fives before the eruption of the lower sevens there is less lean of the lower sixes than a later extraction.

In a Class 1 Angle malocclusion with an incisal overbite, if both upper and lower premolars (first) are extracted particularly early there is a tendency to increased overbite and over-jet.

These are general rules only, to which there is a wide variety of exceptions.(3),(4),(5),(6).

Points to Remember.

1. This treatment does not apply to those cases of lateral narrowness of the anterior part of the arch when canine apices are mesially placed.
2. Ideally, both lower premolars should only be extracted if-

(a) the dental base relationship is Class 1 or 111;

(b) both upper premolars are also being extracted.

3. If the case is a Class 11 dental base relationship, Angle's Class 1 occlusion, then either the mandible should be left crowded or an incisor or one premolar only extracted to balance two extractions in the maxilla.(7).

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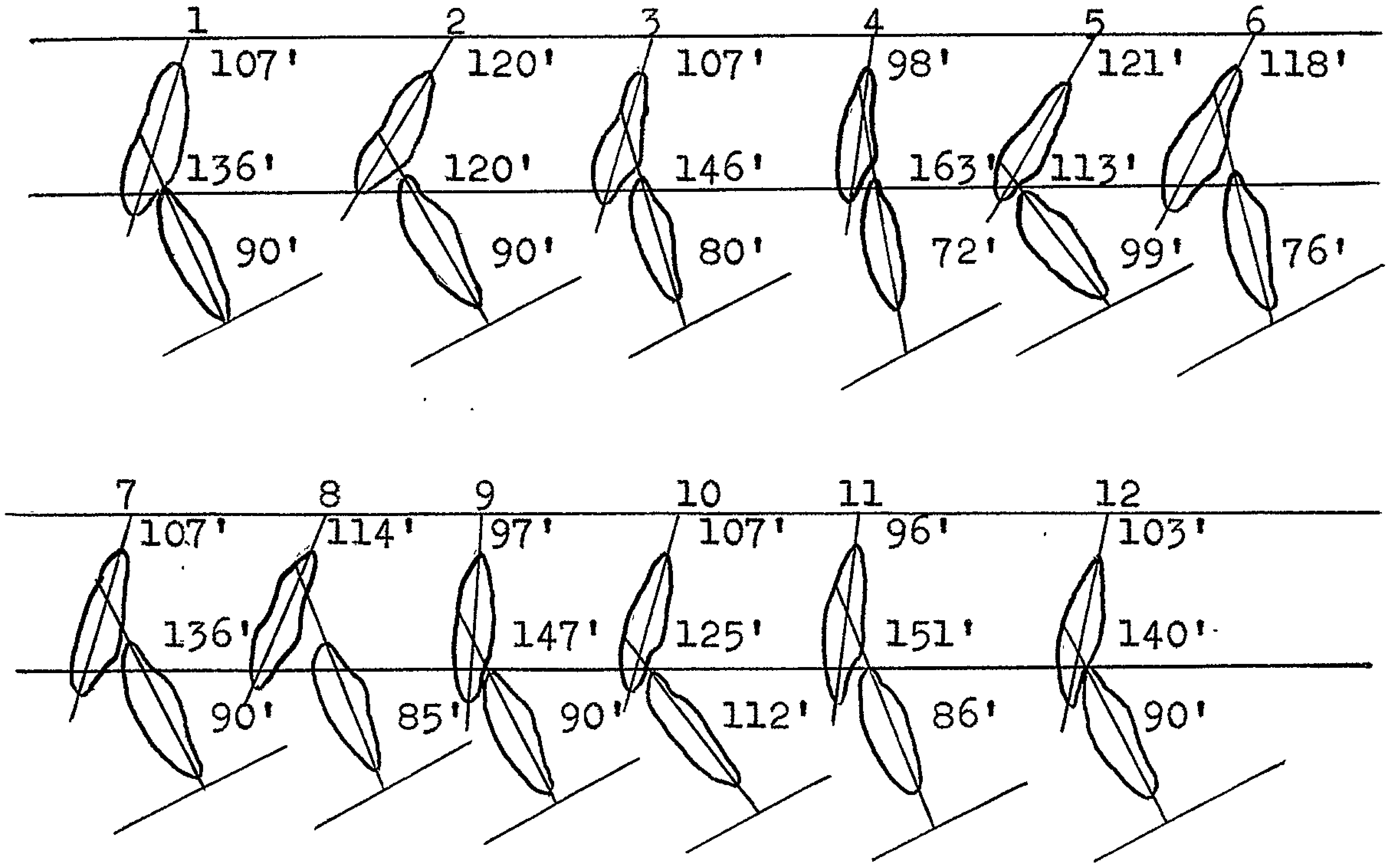
Variations of Incisor Overbite and Overjet.



Figs. 1 - 6 show variations in incisor relationship due to variation 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 11 dental base relationship.

Variations of Incisor Overbite and Overjet.

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 due due to 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 overclosure on cheek teeth occlusion.

4. shows the incisor relationship of an Angle's Classll, 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 11, 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 post normal. The cause of suchaa relationship is usually an abnormality 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 11 Division 1 incisor relationship as the result of a Skeletal 11 pattern, 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 an abnormal swallow, or finger sucking on a Class 11 dental base relationship.

9. and 10. show possible optimum incisor relationships with normal soft tissue behaviour patterns on a Class 11 dental base relationship. In 9. soft tissue balance has resulted in a retroclined 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 11 Division 2 type on a Class 11 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 untreatabl orthodontically.

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Close Bite and/or Closed Bite.

1. Excessive Incisor Overbite - Normal Interocclusal Clearance

2. Overclosure - Increased Interocclusal Clearance (Excessive Freeway Space). Or Closed Bite.

1. Excessive Incisor Overbite.

This is always the result of abnormal incisor relationship and not the result of overclosure (Figs. 2, 3, 4, 6, 7, 8, 9, 12).Normal incisor relationship is an occlusion which does not permit of excessive incisor overbite (Fig. 1).

The abnormality may be produced by -

A. Abnormal axial inclination of either upper or lower incisors, or both, on a normal dental base relationship (Figs. 2,5, 4, and 6).

B. Abnormal dental base relationship, particularly Skeletal 11, which may be associated with a further abnormality of axial inclination of incisors with incompetent lip action and perhaps an abnormal swallowing behaviour with anterior tongue thrust (Figs. 7,8,9,11,and12).

Some types of Skeletal dental base relationship also result in excessive incisor overbite.Incisor relationship as in Fig. 4, but pivoted to a Skeletal 111 dental base relationship.

Treatment and Prognosis depends in (A) on the cause of the abnormal axial inclination.If due to early loss of lower deciduous cheek teeth, then labial movement of lower incisors is probably all that is required. If due to soft tissue behaviour, then it depends on what changes in posture and behaviour can be achieved to permit a change of axial inclination of the labial segment. In (B) the prognosis is not good, as the skeletal pattern cannot be changed.Correct axial inclination as far as possible, and recognise the limitations imposed by the abnormal dental base relationship.

2. <u>Overclosure - Increased Interocclusal Clearance or Excessive Freeway Space. This is often called Closed Bite</u>.

Clinically there appears to be an overeruption of the incisors with a corresponding undereruption of the posterior segment.

Brodie (1) confirms this "it has been shown that beginning as much as a year before the eruption of the permanent central incisors and before the decidous teeth are lost, the crest of the alveolar process which is attached may be cut off in the form of a sequestra. This loss can amount to as much as 7mm.When the permanent teeth erupt they must completely rebuild the crest of the alveolar process to this extent and of course beyond if additional height is required.The same study has shown that this rebuilding requires a period of three to four years before the previous height of the alveolar process is regained.The increments added to the free margin of the alveolar process are apparently not as great as has been universally taught.And here again is variation.

The major point of growth for increased height is found in the incisor region and this would seem to explain another condition in the deciduous dentition, extreme overbite.If the incisors erupt to what might be considered average or normal height, but at the same time the eruption of the molar does not keep pace with them, the denture is left with a wide freeway space which upon mouth closure permits a marked overriding of the two incisal segments.We say the patient has a deep overbite.

At the present time we are completely in the dark as to what causes this lagging in molar eruption.But another piece of work indicates that if the jaws are kept from complete closure by the insertion of a bite plate there is invariably some eruption of the posterior teeth.This would seem to indicate the wisdom of intercepting this type of developing malocclusion at a rather early age.

The cephalometric analyses of Sleighter (2), Belger (3), Bahador and Higley (4) with the use of bite plates show a consistency in their findings which supports the more academic results of Brodie.

The majority of cases either had no change or some slight increase in the height of the lower incisors and most of the vertical increases were in the posterior region.

Sleighter concludes "the permanency of the results may well depend on early treatment, patient co-operation, the resultant incisal occlusion, adaptability of the interocclusal space and the length of retention.

References:

1. Brodie, A.G.: The fourth dimension in orthodontia. Angle Orthodontia 24:1:15-30, 1954.

2. Sleighter, C.G.: Effects of maxillary bite plane therapy. A.J.O. 850-870, 1954.

3. Belger, I.: Cephalometric growth and analysis in subjects using the bite plane. Angle Orthodontia, 26;1;42-49, 1956.

4. Bahador, M.A. and Higley, J.C.: Bite opening; a cephalometric analysis. J.A.D.A., March, 1944.

Open Bite

Usually in the incisor region and perhaps extending distally.

Causes: A. Abnormal soft tissue behaviour patterns.

B. Abnormal skeletal pattern.

C. Failure of vertical development of dento-alveolar structures with normal soft tissue behaviour and skeletal pattern. This is rare.

A. Abnormal Soft Tissue Behaviour Patterns.

Vertical development of the dento-alveolar structures has been prevented from closing the intermaxiallary space because of the persistent presence of tongue or thumb or fingers, i.e. thumb and finger sucking and abnormal swallowing action with a habitual posture of tongue between the teeth. It should be remembered that harmful finger or thumb sucking is almost invariably associated with an abnormal swallow and resting position of tongue between teeth. Cessation of the so-called habit with thumb or fingers does not therefore result in the closing of the open bite and/or overjet.

It should also be remembered that there are many minor defects of tongue control which tend to delay the full eruption of the upper incisors in particular, so that there is an open bite perhaps up to nine years of age.

If the tongue thrust is also associated with an interdental sigmatism (lisp), then prognosis is less good, and the patient should have speech therapy.

B. Abnormal Skeletal Pattern.

Vertical development of the dento-alveolar structures has reached the maximum without closing the intermaxillary space.

The intermaxillary space is excessive vertically because of a high gonial angle (i.e. high Frankfort-mandibular plane angle). These cases are often Skeletal 111 dental base relationship and associated with the abnormal mandible there is antero-posterior under development of the maxilla.

This type of anterior open bite is untreatable. Alveolar bone growth has reached its maximum. Grinding posterior teeth or even extracting them is contra-indicated in any type of anterior open bite.

C. <u>Failure of Development of Dento-Alveolar Structures</u>.

This is sometimes associated with other bony dysplasias but frequently occurs as the only abnormality. There may be a family history indicating inheritance.

References:

Ballard, C.F.: Post-graduate notes, 4th. Edition.

Angle's Class 11, Division 1 Occlusal Abnormality.

(The figures referred to are those attached to notes on Incisor overbite).

The typical incisor abnormality of the class may be due to -

1. Incompetent lip behaviour resulting in a proclined maxillary labial segment and forward position of buccal segments maintaining continuity of the arch (Fig. 2). No skeletal abnormality, e.g. a Class 11 dental base relationship. The lower labial segment may be relatively lingually inclined as a result of the contraction of the lower lip in its effort to overcome the incompetence.

2. Abnormal swallowing behaviour with anterior tongue thrust. This results in a proclined maxillary labial segment with forward shift of buccal segments as in (1), and a relatively retroclined mandibular labial segment with the buccal segments in contact and relatively dist-ally placed (Figs. 2, 6). No skeletal abnormality.

3. A resting posture of the lips and behaviour during swallowing and speech which does not produce the same labio lingual position of upper and lower labial segments. A characteristic one is that in which the lower lip is posterior to the upper lip and contracts firmly against a very lingually placed labial segment during smiling and speech (Fig. 6).

4. Class 11 dental base relationship. If this abnormality of the skeletal pattern is associated with an Angle's Class 11 Division 1 occlusionthen it must also be associated with an abnormality in the postural position of the soft tissues (Figs. 7, 8). The maxillary labial segment at rest is between the lips, but there is no incompetence (Figs. 9, 10).It is possible to have a relatively normal occlusion on a Class

Full Face: At rest.

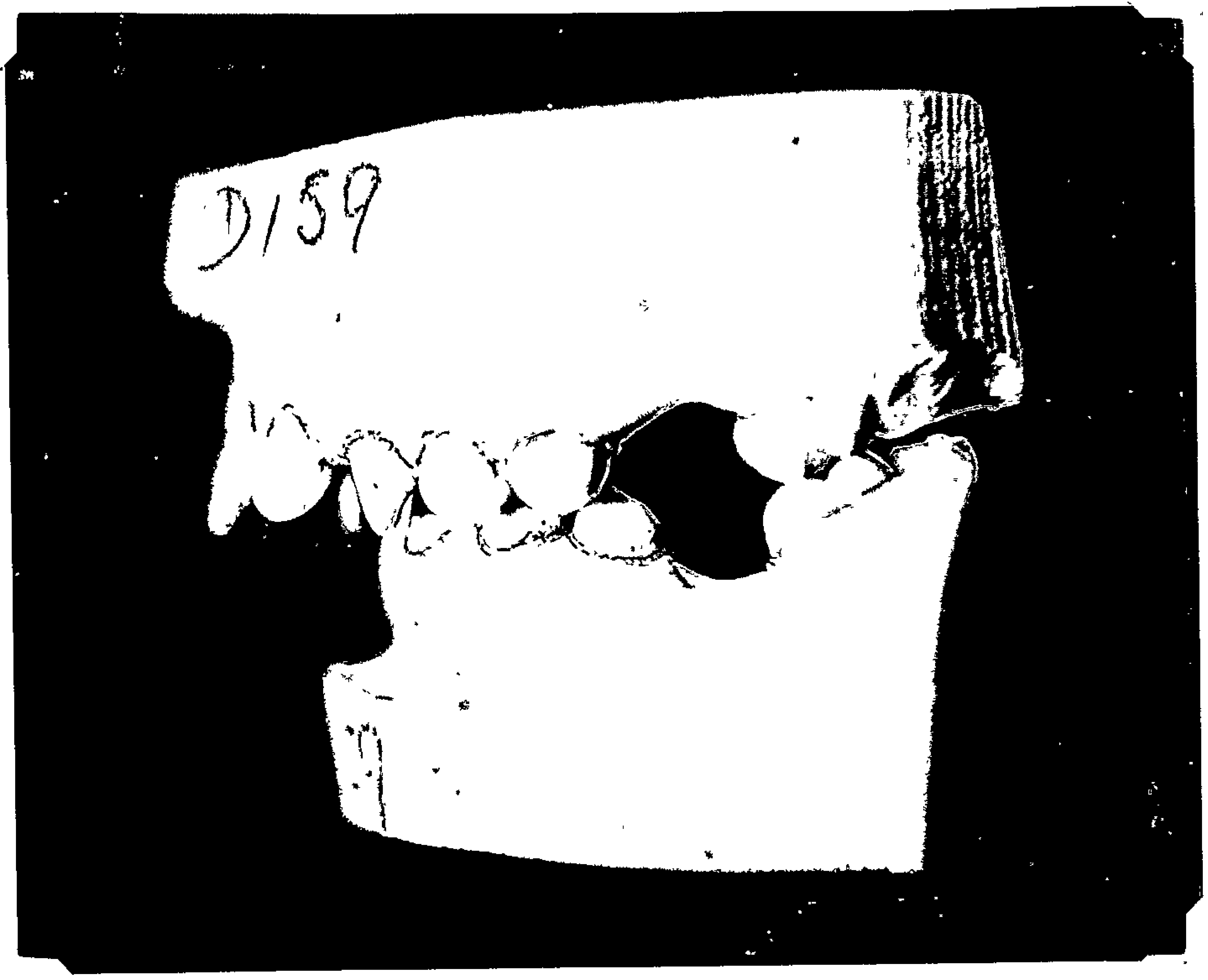
Analysis: 1. Skeletal 11, Angle's Class 11, Division 1 occlusion.

2. Competent anterior oral musculature however the lower lip is posterior to the upper lip and contracts firmly against a very lingually placed labial segment during smiling and speech.

3. Abnormal swallow with an anterior tongue thrust.

4. Occlusion. The lower anteriors are retroclined and flattened due to the soft tissue pattern described in 2. and to the fact that the mentalis contracts firmly against them during swallowing.

The upper anteriors are proclined and narrowed from the canine forward due to the abnormal tension in the orbicularis oris particularly in the region of the modiolus.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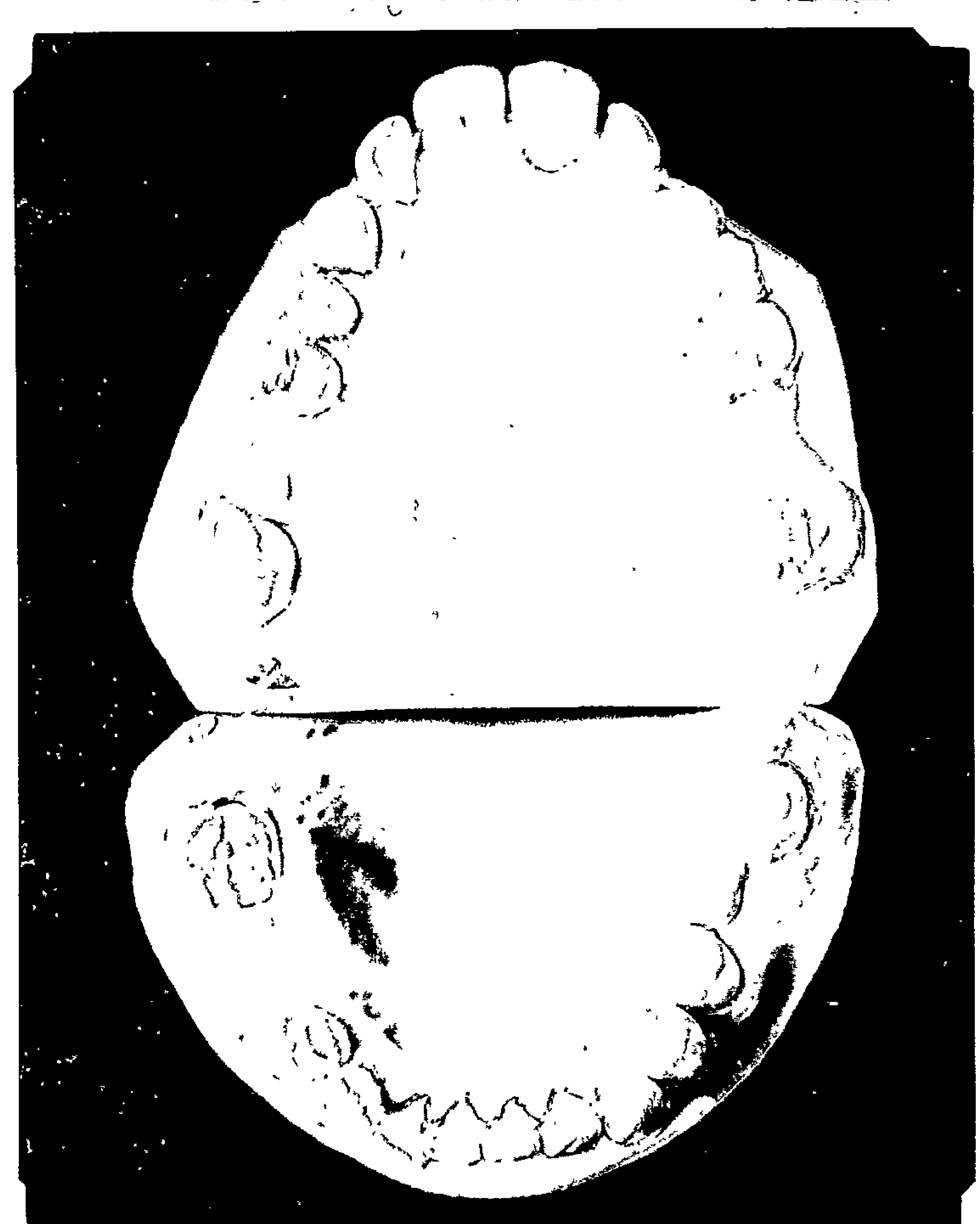

11 dental base relaionship if the soft tissue behaviour produces a r relatively proclined mandibular labial segment, or a retroclined maxillary labial segment ,or both combined.

5. A Class 11 dental base relationship associated with (1) or (2) or both (Figs. 7 and 8).

Prognosis.

The dental base relationship cannot be changed to order, therefore a stable and satisfactory end result depends entirely on what can be achieved in improving labial segment relationship in relation soft tissue behaviour. A stable end result must be visualised before treatment can be planned. Probably the best way to do this is first to assess the stable position of the lower labial segment. The movement of the upper labial segment to occlude with the new position of the lower labial segment is then obvious, and the degree of antero posterior movement of cheek teeth, with or without extractions, required to maintain contact with the Labial segments is also easy to assess.

1. Incompetent Lips. Unless the lips are so incompetent that the lips closed posture cannot be maintained habitually, then during treat -ment the individual has to learn, mainly by conscious effort, to keep the lips closed as a habitual posture by means of contraction of the orbicularis oris and mentalis muscles. This contraction contra indicates any forward movement of the crowns of the lower labial segment during treatment, and therefore any forward movement of the lower arch. The upper labial segment has to be tilted lingually until it occludes with the lower labial segment inside the closed lips. This movement of the labial segment usually necessitates the removal of first premolars or

the distal movement of the buccal segments with removal of 7/7.

2. <u>Abnormal Swallowing Behaviour (Anterior Tongue Thrust)</u>. Unfortunately, our clinical experience has shown that complete elimination of an anterior tongue thrust cannot be expected, and therefore the prognosis is always a little uncertain. As a rule, if the tongue thrust is associated with an interdental sigmatism, which is still present at the age of about 12 years, the chances of much improvement in the incisor relationship are small. It is usual to proceed with treatment which is aimed to bring forward the mandibular arch, proclining the labial segment a little and taking back the upper arch, retroclining the upper labial segment to an aesthetically satisfactory position. Subsequently there may be some relapse, but as a rule it is not sufficient to disturb the patient. If the abnormal swallowing behaviour is associated with incompetent lips, then the degree of improvement that will remain stable depends more on whether the individual will be able to maintain a lips closed posture as a habit, or whether this will be impossible.

3. <u>A Resting Posture of the Lips and Behaviour During Swallowing and Speech which does not produce the same labio lingual position of upper and lower labial segments</u>. The behaviour of the lips described under this heading above has been shown by clinical experience to contra indicate any attempt to bring forward the lower arch and procline the lower labial segment. As a rule, it is possible to reduce the proclination of the upper labial segment a few degrees, but any attempt to make the upper labial segment occlude with the lower labial segment is aesthetically unsatisfactory and probably unstable.

4. <u>Class 11 Dental Base Relationship</u>. When a Class 11, Division 1 occlusion on a Class 11 dental base relationship is not associated with an abnormal swallowing behaviour (anterior tongue thrust) or incompetent lips, then the lower lip permits the lower labial segment to be proclined many degrees, frequently a sufficient amount to compensate completely for the dental base discrepancy, the incisor end result in such cases being as in Fig. 10. Alternatively, if sufficient labial movement of the crowns of the lower labial segment is not possible, the result might be a compromise, as in Fig. 9.

5. <u>Class 11, Division 1 Occlusion on a Class 11 Dental Base Relationship Associated with Incompetent Lip Posture</u>. When a Class 11, Division 1 occlusion on a Class 11 dental base relationship is associat -ed with incompetent lip posture, then the lower labial segment must not be moved labially at all, and the only stable compromise of labial segment relationship is as in Fig. 9 or 11. If treatment necessitates the use of the lower arch for anchorage then units should be removed.

6. <u>Class 11, Division 1 Occlusion on a Class 11 Dental Base Relationship Associated with Abnormal Swallowing Behaviour.</u> As has been previously mentioned, it is general clinical practice to ignore the abnormal swallowing behaviour in these cases, and proceed with the treat -ment plan as indicated by the other factors, expecting slight relapse.

<u>Summary of Methods of Treatment</u>.

Removal of a unit from the anterior part of the maxillary buccal segments, retraction of canines, followed by retraction of incisors. This line of treatment is indicated when the lower arch must not be brought forward, and therefore Class 11 traction cannot be used.

Intermaxillary traction with extractions - see below.

Removal of 7/7 and distal movement of buccal segments. This line of treatment could be used when (a) the lower arch cannot be used for anchorage because it must not be moved mesially, but extra oral anchorage is thought sufficient to take the upper buccal segments distall; (b) when the lower arch can be used for anchorage but most of the tooth movement required is distal in the maxilla; (c) when intermaxillary traction has been used, the lower arch is in a stable position but the uppper buccal segments still should go distally a fraction; at this stage 7/7 can be removed.

Graber (1) says the removal of 7/7 expedites the correction of a Class 11 Division 1 malocclusion provided that -

i. there is excessive labial inclination of maxillary incisors with no spacing;

ii. the overbite is minimal;

iii. the 8/8 are present in good position and shape.

Intermaxillary traction alone; it is only certain that this line of treatment will take the case to completion when all the tooth movement required is a proclining of the labial segments and a forward shift of buccal segments. Frequently some distal movement of buccal segments is achieved as reaction, but the amount can never be assessed beforehand. One must alwasy be prepared, therefore, to relieve the resistance to distal movement by extraction of 7/7 if and when required.

These notes are on Class 11, Division 1 cases uncomplicated by antero posterior crowding. Where there is antero posterior crowding in the maxilla or mandible then that must be taken into account, and more often, extractions in both upper and lower jaws are necessary in these cases. (2).

<u>References</u>:

1. Graber, T.M.: The role of the upper second molar extraction in orthodontic treatment. A.J.O., May, 1955.

2. Ballard, C.F.: Post-graduate notes, 4th. Edition.

Angle's Class 11 Division 2 Occlusal Abnormality.

(The figures referred to are those attached to notes on Incisor overbite).

There are three factors which contribute to the production of this typical incisor abnormality. These are -

1. A short maxillary arch and dental base in relation to the size of the dentition, the maxillary buccal segments being forward in relation to the labial segment. Canines are mesially inclined and laterals overlap centrals. The post normal occlusion (Angle) is due to the mesial position of the upper buccal segments. The central incisor relationship may be very nearly nearly normal (Fig. 1).

Normal dental base relationship.

2. Again, normal dental base relationship, but associated with the forward position of maxillary buccal segments as in (1) there is a soft tissue pattern which results in bimaxillary retroclined incisors (Fig 4) This is usually associated with competent lip musculature (1).

3. The factors in (1) and (2) above on a Skeletal 11 dental base relationship (Figs. 9 and 11).

<u>Prognosis</u>.

In all Class 11 Division 2 (Angle) cases it has to be realised that the position of balance between lips and tongue cannot be changed much. Whether or no a good incisor relationship can be attained and remain stable depends on the degree of retroclination in the original abnormality. For instance, if in Fig 2 the bimaxillary retroclination was such that the angles were: $\underline{1|1}$ to Frankfort plane 90', $\underline{1|1}$ to $\overline{1|1}$

163', and 1/1 to mandibular plane 80'; then if lip behaviour only permitted labial movement of the crowns an amount equivilent to 4' change of angel in upper and lower incisors, the end result would be as in Fig; 2. This relationship is still a bimaxillary retroclination with excessive incisor overbite.

Treatment.

In the first type described above prognosis is good because the incisor relationship does not require treatment. Extract 4/4 and retract 3/3. With cases in the second and third groups, most of what has been said in the first paragraph of prognosis in Angle's Class 11, Division 1, and summary of methods of treatment, apply with the following factors to be borne in mind:

(1) The antero posterior shortness of the maxilla ry arch and dental base produces a fanning of the teeth w ith the result that the first permanent molars usually have a distal inclination. This contra indicates extraction of 7/7 and distal movement of buccal segments.

(2) There is frequently some antero posterior crowding in the mandibular arch but extraction should be avoided if possible because of the risk of lingual movement of the incisor crowns.

References:

1. Walther, D.P.: Skeletal form and behaviour patterns of certain facial muscles. T.E.O.S., 55-71, 1954.

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Angle's Class 111 Occlusal Abnormality.

For purposes of analysis it is best to visualise the two extremes of morphological type which may produce a class 111 occlusal relationship, remembering that cases present with a morphology anywhere between the two.

Type 1. Long, tapering faced individuals with flat or even mildly concave profiles. Skeletally, the mandible is very obtusely angled (high Frankfort mandibular plane angle), the maxilla is small both antero posteriorly and laterally, with the palate narrow and high. Besides the typical Class 111 incisor and cheek teeth relationship, in the maxilla there is usually marked antero posterior crowding, possibly with 3/3 apices being mesially placed. Because with this typical skeletal pattern there is a deep intermaxillary space, in the incisor region the vertical development of the dento alveolar structure frequently fails to fill it, resulting in an open bite. Also related to this skeletal pattern there is usually a low tongue posture which results in a bilateral contraction of the maxillary arch. Neither of these abnormalities are very amenable to treatment.

Type 2. Short, broad faced individuals with low Frankfort mandibular plane angles and a mandibular prognathism. These cases frequently show the erroneously called pseudo Class 111 condition because they are likely to be able to bite incisor edge to edge, from which they swing forward. The maxilla is usually comparatively normal in size and shape.

Treatment.

Type 1. Extractions in the maxilla are almost invariably indicated because of the small size of the dental arch. Usually 4/4. Much labial movement of the incisors is contra indicated. If there is much of a reverse overjet then $\overline{321/123}$ should be retracted after extraction of $\overline{4/4}$. The decision to extract in the lower jaw may be influenced by other factors, but it must be remembered that because the mandible is well developed the labial segment may be spaced from the buccal segments. This should be closed up first. Also because the mandible is large $\overline{4/4}$ rarely close completely. Parents should be warned of this residual space.

Type 2. Extractions in the maxilla are not indicated as a rule. Extract $\overline{4/4}$ and Class 111 intermaxillary traction, or move $\underline{12/21}$ labially and move $\overline{21/12}$ lingually after extractions, and retraction of $\overline{3/3}$.

In all Class 111 cases it should be remembered that the Class 111 incisor relationship is in balance in muscle action, therefore treatment of the reverse overjet simply by pushing the maxillary incisors labially may produce a traumatic relationship with the lower incisors. The reason for this is that the lip at rest tens to push the incisors lingually, but the occlusion tends to push them labially. For this reason it is usually advisable to correct the reverse overjet by extraction in the lower so that the lower labial segment may be moved lingually perhaps even more than the upper labial segment is moved labially. (1).

References:

1. Ballard, C.F.: Post-graduate notes, 4th. Edition.

Additional reference:

McCallin, S.G.: Angle's Class 111 malocclusion. The Dental Practitioner, January, 1956.

Timing of Treatment.

Carey says "generally speaking, the ideal age for orthodontic treatment is, that age at which a malocclusion, if corrected, will create a more favourable occlusion, which in time will influence development in the derection of balance and harmony with the related structures, and provide a substantial contribution to the perfection of the adult or secondary dentition". (1)

The principles that guide our timing of treatment are these:-

1. When the most stable result can be obtained. This depends on the detrimental effects of the malocclusion on the development of the environmental forces of occlusion on the path of eruption of the remaining teeth and the growth of alveolar bone.
2. When it is possible to correct the malocclusion with the least amount of disturbance and destruction of tooth tissue and alveolar bone.
3. When it is possible to have the shortest time of treatment.
4. When it is possible to use the least amount of appliances.
5. What is the psychological effect of the malocclusion.(2)

Thus treatment should be started as soon as any inhibiting factors are present which will disturb the facial growth and development of the patient.

Habits. These are part of the individuals pattern of living and we must replace an objectionable habit with a desirable one.

Using a direct appeal to the child's intellect and with his permission we can place a reminder device such as an oral screen or an

Andresen appliance.If the child is willing to co operate in a voluntary habit such as thumb sucking, we often achieve a satisfactory result.But with an involuntary muscular pattern such as lip to tongue resting posture, or tongue thrust during swallowing, satisfactory results are less likely. The appliance may carry the anterior teeth back during the night in a Class 11 Division 1 type occlusion, but during the day the active tongue may procline them. Ballard believes that this jiggling of the teeth sometimes results in apical resorption.(3),(4), (5).

Early Loss. The hypothesis of Begg (6), that man is provided with excess tooth tissue to compensate for the considerable loss in arch length and occlusal height due to attrition is, to some extent, confirmed in the deciduous dentition. Thus the mesio distal widths of the deciduous molars are greater than the premolars that replace them. Deciduous arch length as found in the civilized child who does not have attrition, is in excess of what is required. Following this hypothesis to its conclusion since there is excess arch length in the deciduous dentition, early loss does not necessarily result in malocclusion.

Lundstrom (7) says early loss of deciduous teeth has no general influence on the development of the dentition.In spite of extensive and extremely early loss the end result may be normal. Breakspear (8) confirms this when he showed that with the eruption of the permanent teeth there was an average gain or regain of 3mm arch length on each side. Siepel (9) says there are no uniform results with the premature loss of deciduous teeth. He concluded that due to the lack of scientific foundation for this kind of therapy (i.e. space maintenance) there are no clear indications.

Overcrowding and Serial Extraction have been discussed elsewhere.

Treatment Planning for Angle-type Occlusal Abnormalities.

Our first consideration in case assessment , is what part of the face is in the best balance to the environmental forces of the face, and which teeth are in the best relation and position to supporting facial bones. We must be able to guide the malpositioned teeth in correct positional relationship and balance without disturbing those that are in good balance and position.

1. Class 11, Division 1 Type Occlusion. It is often advisable to retract the incisors out of harms way i.e. within the action of the lower lip if this is possible. If the lower arch is in a stable position then it may be left alone and treatment done with extra oral anchorage and upper molar bands.(10),(11),(12),(13),(14).

Secondary treatment may be necessary but primary treatment allows

i. Better development of the facial muscles.

ii. Better balance of environmental forces of occlusion.

iii. Better development of alveolar bone resulting in a more stable result.(16).

2. Class 11, Division 2 Type Occlusion. A bite plane often unlocks the occlusion and allows it to develop more easily.Proclinate the upper centrals and allow the lip force to mould the already proclinated lateral incisors.

3. Class 111 Type Occlusion. In a Class 111 type occlusion which results in anterior and/or posterior cross bite even in the deciduous dentition, treatment must be instituted immediately the patient has

reached the age of co operation since:-

i. they may act to destroy teeth and supporting structures.

ii. they may result in maldistribution of supporting alveolar bone.

iii. they may cause obvious and objectionable facial asymmetries.

As soon as the correct direction of growth is established active treatment should be discontinued.(16),(17).

Brodie has shown that different parts of the dento facial skeleton develop at different rates, that the soft tissues develop at different rates to each other and to the skeletal tissue, and each may be out of phase with the pattern of eruption. Hence there may not be synchronization in the developmental timing.

The period of replacement of the deciduous incisors and canines by those of the permanent dentition is probably the most critical stage through which the denture passes. All the neuro muscular reactions of the muscles are adapted to the size, shape and form of the deciduous dentition. If the growth is on a par with, or in front of the tooth eruption then there is even spacing and eruption. If it is behind then the teeth will be crowded.

There is another chain of circumstances which produces similar a clinical picture but is due to different causes. If there is deep over bite and the teeth are forced to erupt in an arc too small, benefit gained by growth is lost and a strictly environmental malocclusion is created. With a bite plane we may get self alignment.

The head cap treatment does not drive the molars distally but they are maintained in space while the rest of the jaw grows forward and the mandible proceeds down and forward in an uninhibited manner. Since it is during the period of the deciduous dentition that mandibular growth is at a maximum this should be the best time to treat.

In a class 11, division 1 type occlusion with crowding in either/or both upper and lower jaws this is carried out. When the jaw is given the chance for unhibited growth the alignment may automatically result.

<u>Objective</u>. The objective of early interference is not treatment but

1. the removal of factors which are slowing growth,

2. the prevention of the seemingly inevitable results of a lack of harmony between the eruption of the teeth a nd the growth of the jaws,

3. in Class 11 cases the adjustment by growth of parts that are out of harmony in their relations to each other.(18),(19).

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1. Carey, C.W.: Treatment in the deciduous dentition, Hahn, G.W. A.J.O. April, 1955.

2. Kloehn, S.J.: A new approach to the analysis and treatment in the mixed dentition. A.J.O. March, 1953.

3. Littlefield, W.H.: Thumbsucking and its relationship to malocclusion in children. A.J.O., April, 1952.

4. Lawes, A.G.H.: Psycho somatic study into the nature, prevention and treatment of thumb sucking and its relationship to dental deformity. D.J.A., April, 1950.

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7. Lundstrom, A.: The significance of early loss of deciduous teeth in the etiology of malocclusion. A.J.O. November, 1955.

8. Breakspear, E.K.: Sequelae of early loss of deciduous molars. B.S.S.O., 55-64, 1951.

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17. Jenkins, H.: Timing of treatment in orthodontics; a summary of our present knowledge. A.J.O. January, 1953.

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<u>Force and its Effect on Tooth Movement.</u>

In 1932 Schwartz classified orthodontic force:

1. <u>first degree of biologic reaction</u>: gentle force, or one of too short duration, so that no definite reaction is evident in the periodontal membrane.

2. <u>second degree of biologic reaction</u>: constant gentle pressure which does not exceed capillary blood pressure 20-25 gms/sq. cm. Such pressure produces orthodontic movement without tissue damage.

3. <u>third degree of biologic reaction</u>: pressure greater than capillary blood pressure and causes injury by strangulation of soft tissue and delay in bone resorption on the side of pressure. Damaged tissue must first be removed before tooth movement can occur. This is brought about by undermining resorption.

4. <u>fourth degree of biologic reaction</u>: crushed periodontal membrane; there is contact between bone and tooth. This may result in strangulation of the pulp, necrosis of periodontal membrane, root resorption and eventual ankylosis of the tooth and the alveolus. (1)

These figures were based on experiments he carried out in moving three premolar teeth in a dog with a calibrated spring. They were examined histologically.

It is difficult to estimate the exact force applied to one tooth when the pressure from a single spring is distributed over three. The teeth were moved by tipping which means that the pressure on the periodontal membrane would have varied from apex to the gingival margin. Thus the accuracy of his assessments may be challenged.

Though there is general agreement that too much force results in tooth or tissue trauma and subsequent undermining resorption, there has been no such consistency of opinion about how small a force could be used to move teeth,nor whether the force should be continuous or intermittent.

Story and Smith of Melbourne University,(2),(3),(4) have attempted to answer some these fundamental clinical principles.

They used cuspid retraction springs of different designs with light and heavy wire on eight patients. They compared the results.

They explain their results this way:

i. "The fact that cuspid teeth do not move appreciably when low forces upt to approximately 150 grams are applied, means that the tissues can support up to a certain pressure before active bone resorption takes place. If this is true it should be possible to obtain effective anchorage with little or no movement of the anchor teeth, without the use of distal tipping bends on the arch wire. This could be achieved by assuring that the forces used were such, that the pressure over the bone adjacent to the anchor teeth was less than the value above which active bone resorption occurs.

ii. The behaviour using heavy forces in the range from 400 to 600 grams conforms to that which would be expected according to the theory of undermining resorption. In the case of patients 7 and 8 where forces of above 250 grams were applied continuously, there is evidence for the validity of this view, because there was little or no movement of the cuspid teeth for three weeks in the case of patient 7, and 6 weeks in the case of patient 8 and then very rapid movement.

iii. "The maximum rate of tooth movement may be due to a surface or frontal resorption of bone, due to the force decreasing the blood supply to the bone on the pressure side. This could result in a stimulus to bring about an active resorption of bone at the interface between the bone a nd the periodontal membrane. It is worth noting that the rate of resorption when the optimum force was applied. This maximum rate was calculated to be approximately 0.1 mm per day."

They conclude:

i. "More efficient cuspid retraction springs can be designed if the forces to be applied are to be light and continuous.

ii. When the forces applied to move cuspid teeth distally apply the optimum pressure on the tooth bone interface, movement is produced rapidly with practically no movement of the anchor teeth or depression of the sécond bicuspid teeth. Also there is little inconvenience to the patient. This is different from the behaviour obtained when one of the common cuspid retraction springs is used which applies forces above the optimum range. In this case, initially the cuspid teeth act as the anchor units, and the anchor teeth are the teeth which are moved. Also the second bicuspid tooth is depressed."

In a later paper(4) Storey radiographically examines the bony changes associated with tooth movement and concludes "There is a significant difference in the behaviour of bone surrounding a tooth following the application of force of different degrees. With low forces within the limit of tolerance of the tissues, dense laminated bone is formed in tension areas with these low forces, bone is formed ahead of the area of resorptition on the pressure side, but on the other hand, with heavy forces, it is formed only after completion of movement or when the force has decreased. Observations in several cases demonstrated that when using relatively constant forces below 100 grams, a cyclic behaviour in regard to the rate of movement is to be seen and is most obvious in the female."

Discussion and Assessment.

These findings are revolutionary and if they can be substantiated on a large number of patients, each appliance will have to be assessed by a new yardstick, that of "the optimum pressure range".

Any appliance that operates beyond this range is pathologic and/or relatively inneffective, and no amount of theorising or bowing to idols can flout the simple figures.

However a great many questions such as;

i. Do the intermittent pressure appliances such as the Andresen or the extra oral have an optimum range of pressures?

ii. Is there any difference in the range if we tip teeth rather than move them bodily?

iii. Does the direction we move teeth alter the range of pressure? For example will a $\underline{6}$ move distally just as easily as it moves mesially, if pressure within the optimum range is applied it?

remain unanswered.

These investigations are a start in the dispersing of empiricism and emotionalism from orthodontic techniques.

If they could be duplicated and extended an era of precise clinical

Appliance Therapy.

Many of the appliances we now use have been designed by men who fanatically adhered to treatment philosophies. Treatment plan, case analysis, diagnosis and prognosis were associated with the exclusive use of a particular appliance in a particular way. Thus Tweed using the edgewise appliance has a rigid treatment planning associated with a clearly defined technique for each type of malocclusion. The technique is exacting but nothing beyond it is ever required. An operator following the Tweed philosophy need never have the faintest inkling of the twin wire arch, nor how to adjust an Andresen appliance. That another appliance may simplify this treatment plan is of no concern. This is a speciality within a speciality; another form of Isolationism.

An ideal appliance should be within the capacity of the operator to use, and the patient to wear. Any force that it applies which is not light, continuous and within the optimum range of pressures is a menace to the life of the dentition and to the available anchorage.

There is no appliance that is universal in its action; nor is there any appliance that is exclusive in its action. Thus the edgewise cannot offer stationary anchorage and Tweed uses the head cap introduced by Oppenheim to achieve this. Again the bodily movement of teeth can be achieved with a removable appliance, or with the edgewise mechanism; intermaxillary traction works successfully whether we use rubbers, coil springs or muscular pressure as in the Andresen appliance.

This does not mean that each appliance is equally efficient. Nor does it mean that the most efficient appliance for one problem will be equally efficient for another. For example I might prefer to mow the lawn with a pair of hand shear; you might prefer to use a motor mower. As long as the result is the same no one way is right. Nor should it be exclusive. I may want to use your mower on the long, sloping flats of the back lawn and you may want to use my shears on the untidy front edges Our aims are identical and by sharing techniques we take the drudgery from the work, and at the same time increase our efficiency.

It is more logical to know what we want to do then select the best appliance for those requirements, than to tailor each patient to fit the limits of our appliance.

There is no such thing as the universal appliance, only the universal operator.

Stability and Retention.

Our treatment plan is to arrange the teeth as close to Angle's normal occlusion as the natural limits of skeletal relation, soft tissue behaviour patterns, tooth size and form, will allow us.

If we go beyond these limits then no amount of retention will prevent a partial or complete relapse once the retaining device is removed.

A retaining device to prevent a rotated tooth springing back is permissible; a retaining device attempting to correct an error in diagnosis is an impertinence.