American Institute for Bioprogressive Education

CONSUMMATE OCCLUSION

by Dr. Robert M. Ricketts

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Robert Murray Ricketts, D.D.S., M.S.

Director, American Institute for Bioprogressive Education
Professor of Orthodontics, Loma Linda University
Professor, Department of Occlusion, U.S.C.
Visiting Professor of Orthodontics,
Padmashree Dr. D.Y.Patal Dental College,
Bombay, India

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CONSUMMATE OCCLUSION

CHAPTER ONE
THEORETICAL ASPECTS OF OCCLUSION

I. Introduction

Occlusion is a medium of dentistry. It brings all the different branches into a common cause, whether it be orthodontics, prosthetics, pediatrics, surgery, or other divisions of dentistry, or even branches of medicine or other allied disciplines.

The term "occlusion" means many things to many people. The context in the mind of most clinicians limits it to the final fit of the teeth to each other. In principle, the word means to "fill up" or "stop up". It would be surmised that scholars developed the idea of the teeth filling the space between the jaws or the notion that the teeth "close up" the space as the jaws come together. Almost all usual definitions embody the teeth and jaws and some include functional parameters.

Angle wrote about the science of occlusion. He described occlusion as the relations of the inclined planes when the jaws are closed. Brodie refered to the occlusion as a part of the digestive system for the preparation of nutriment. Many clinicians identify occlusion by those relationships which are revealed by the articulator.

In order to amplify the subject, as envisaged by current scholars, the definition of health -- as formulated for the World Health Organization -- is considered as follows: "Health is not the absence of a disease or an infirmity, but it is a state of complete physical, mental and social well being." Taking from that definition, please ponder the following: **"Occlusology is the study of the contribution the teeth and the jaws make to the complete physical, mental and social well-being of the patient."** That definition extends the consideration of the teeth to the jaws, to

the skull, to the body and to the complete patient.

II. Complete Occlusion

A consideration in the light of the totality of contributions of the gnathologic apparatus involves four main divisions. These are basic vegetative systems, three joint components, dynamic mediums, and socio-biologic parameters.

Basic Vegetative Systems

The systems of oxygen procurement and nutriment procurement have not been separated since the beginning of vertebrate animals. The branchial arch system has been involved with respiration and mastication since the fish (Fig. 1). The crossing of the airway with the foodway was one of the most unique accomplishments in all of evolutionary theory. The mandible suspends the pharynx and trachea through the hyoid apparatus and the maxilla surrounds the nasal cavity. The subject of occlusion becomes involved in head posture as a component of the respiratory system. No seasoned orthodontist questions the effects of chronic absence of nasal breathing. Much can be learned from pylogenetics as the development of the jaws occurs from fish to man. The primitive hinge joint is retained as the ossicles of the ear. The joint of the mammal is a secondary addition developed in association with suckling.

Three Articulations

Bone is a calcified system of struts, and joints provide breaks in struss systems so that locomotion of the parts is possible. Three different types of joints are involved in the respiratory-masticatory apparatus in the human (Fig. 2). The tooth articulation is the first focus and the temporomandibular joint is a mechanism to provide jaw motion. A third articulation actually is a system of joints in the vertebral apparatus. The head needs stabilization but also the upper jaw is moved in a wide variety of functions that involve the oral cavity. It becomes obvious that the subject of consummate occlusion cannot be limited to the teeth.

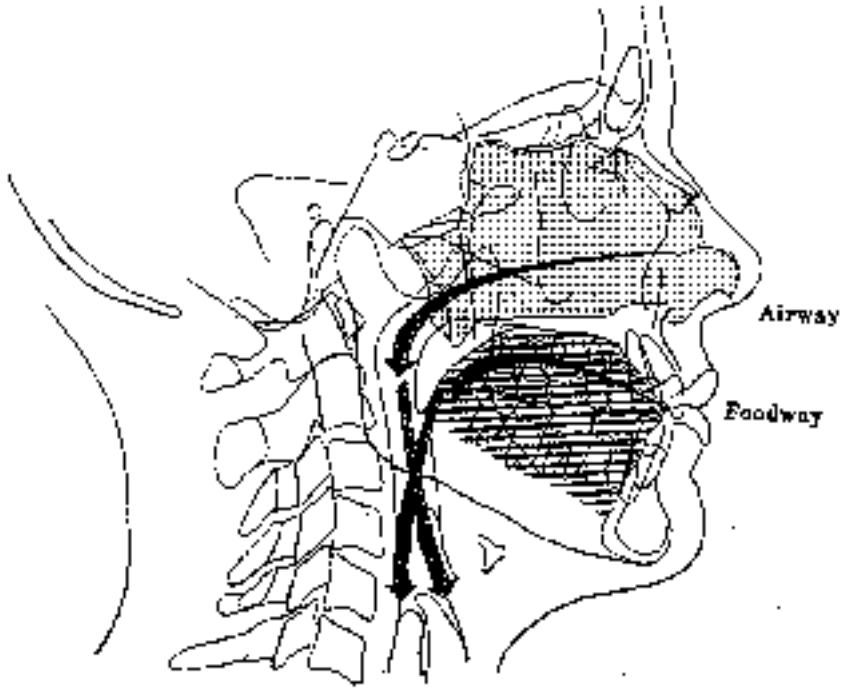


Fig. 1

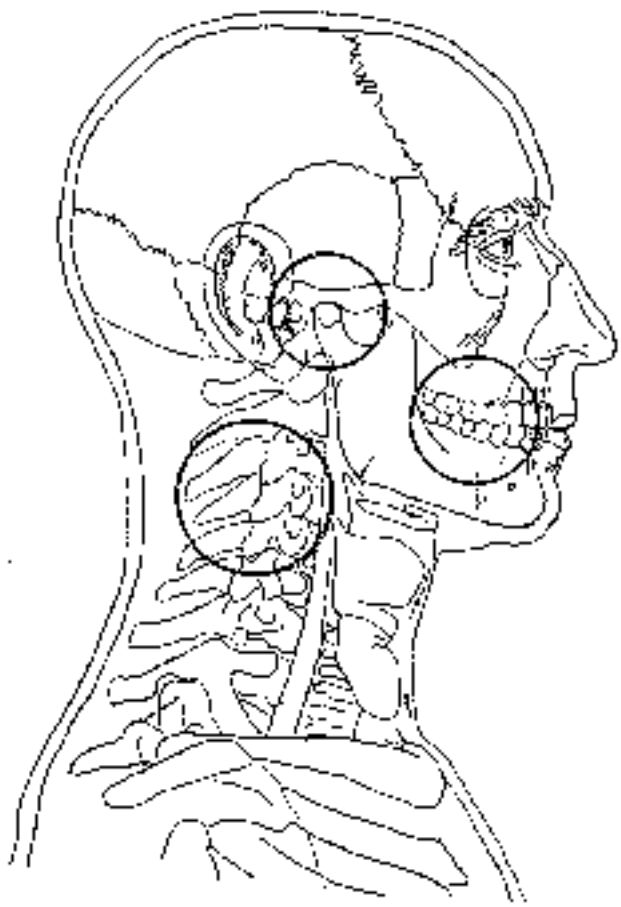


Fig. 2

Kinematics and Dynamics

Functional occlusion is a subject unto itself. But a broader perspective of occlusion, in the abstract, will uncover some less apparent factors. The teeth are employed for cutting, holding, and grinding food (Fig. 3). The teeth are also employed for the enunciation of sounds in articulate speech. One profound use occurs in deglutition as the teeth are closed for bracing of the mandible. Certain vocational uses may characterize the use of occlusion.

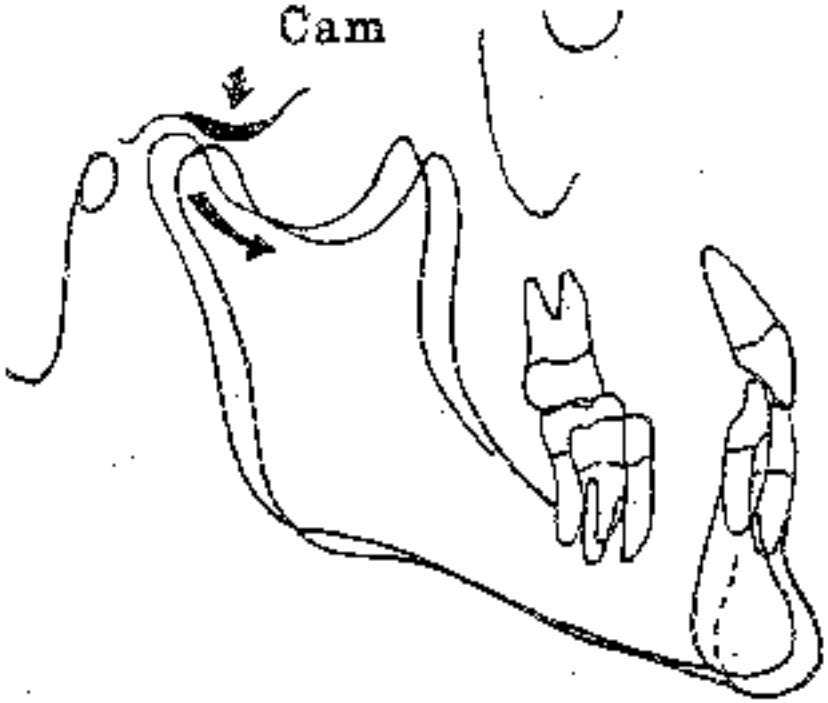
One function, however, that is not appreciated to its fullest is the role of the teeth in stabilization of the circumferential kinetic chain of the whole head, and even influences on body posture (Fig. 4). Absence of posterior teeth in particular are vital to the integrity of the whole apparatus.

Socio-Biologic Mediation

A mediator is an intermediate agent between or among opposing factors, or the medium for bringing about a result. The teeth, jaws, and face have at least ten socio-biologic mediating functions between people (Fig. 5).

The teeth contribute to beauty, which is a **social attractor**. The smile serves to relieve anxiety between people, and is a **social releasor** of social barriers. The teeth serve in speech, which is an assist as a **social communicator**. People are brought together during eating dinner, which makes the teeth act as a **social uniter**. Humans use the oral cavity as a prelude to love-making and the teeth and jaws are therefore a **social expressor**. A good comfortable occlusion aids in promoting **psychologic security**.

In threatening circumstances people may employ the teeth as a **social protector**. Children bite! People with soundness in the gnathologic system have a better **social confidence** and less anxiety. People with adequate occlusion have a better sense **of wholeness** in their beings -- physically, mentally, and socially. It is well known that the human expresses emotion through clenching and bruxism, and



Disarticulation Function

Fig. 3

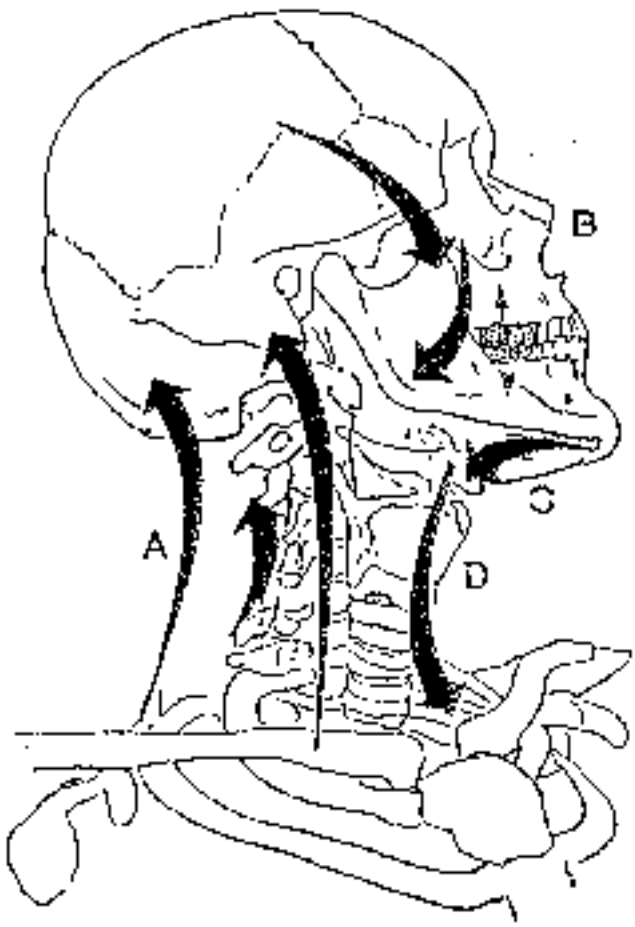
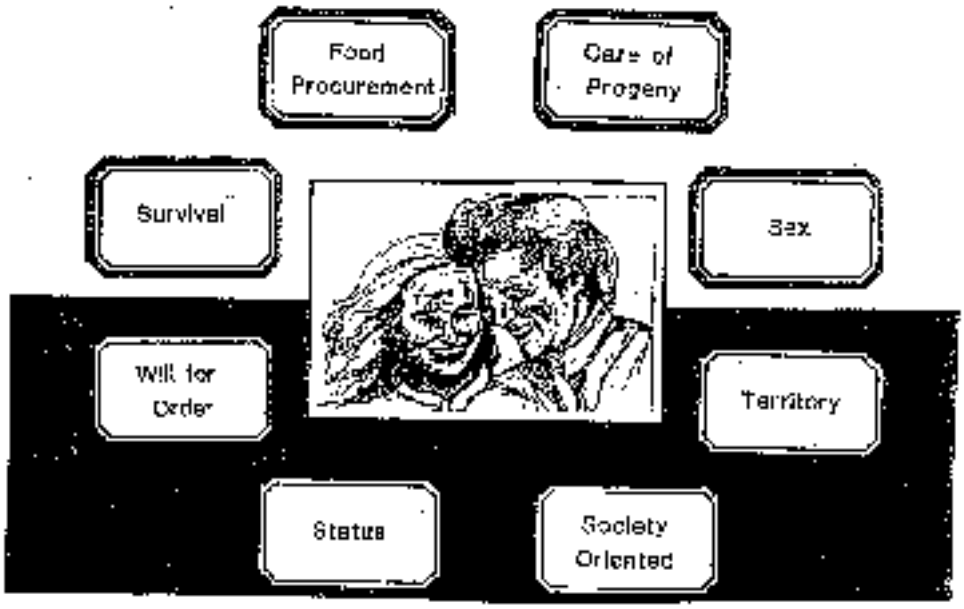


Fig. 4



OCCLUSION

TEN SOCIO BIOLOGIC MEDIATORS

BEAUTY OF THE FACE - SOCIAL ATTRACTOR
SMILE - SOCIAL RELEASOR
SPEECH - COMMUNICATOR
EATING - SOCIAL UNITOR
SEXUAL - SOCIAL EXPRESSOR
FIGHTING - SOCIAL PROTECTOR
HEALTH - SENSE OF WHOLENESS
COMFORT - SENSE OF WELL BEING
FIXATION - PSYCHOLOGIC SECURITY
CLENCHING - TENSION RELEASOR

Fig. 5

therefore the occlusion serves for **tension relief.**

The dental profession through the complete idea of occlusion has within its grasp a profound source to aid humanity beyond the elements of a single repair of a tooth.

III. Normal and the Ideal Concept

One of the problems in societies as they lose their sense of direction is the loss of appreciation of ideals. Without ideals there is no order. A model of perfection or an ideal in all things serves to establish order. An ideal is a standard of perfection (Fig. 6). Since everything in nature is subject to the curve of distribution, the question arises regarding how far a given situation can deviate before becoming undesirable.

Nature has an architectural plan in all species. The human occlusion is unique and majestic. The details of the anatomy of human teeth are fascinating. A marvelous purpose for each cusp and each ridge seems to exist (Fig. 7). **Human teeth are inherited in sets as *if* directed by a single gene.** It's a rare case indeed where the teeth cannot be fitted ideally.

Phylogenetics and Comparative Anatomy

Phylogenetics deals with the theory of evolution which to the scientist is difficult not to notice because each step is duplicated in the embryo. It is obvious that man, so far at least, has developed into an end product as an upright animal, shortened snout and biped locomotion with all its advantages. Of all animals, mankind has the only completely intact-contact occlusion.

From comparative anatomy we learn that all the teeth do not function at one time in mastication in any animal. Man with his omnivorous occlusion also has survival advantages. We learn also that animals in their natural environment cannot survive with deficient tooth structure. Even in Pre-Colombian Indians of Chile their

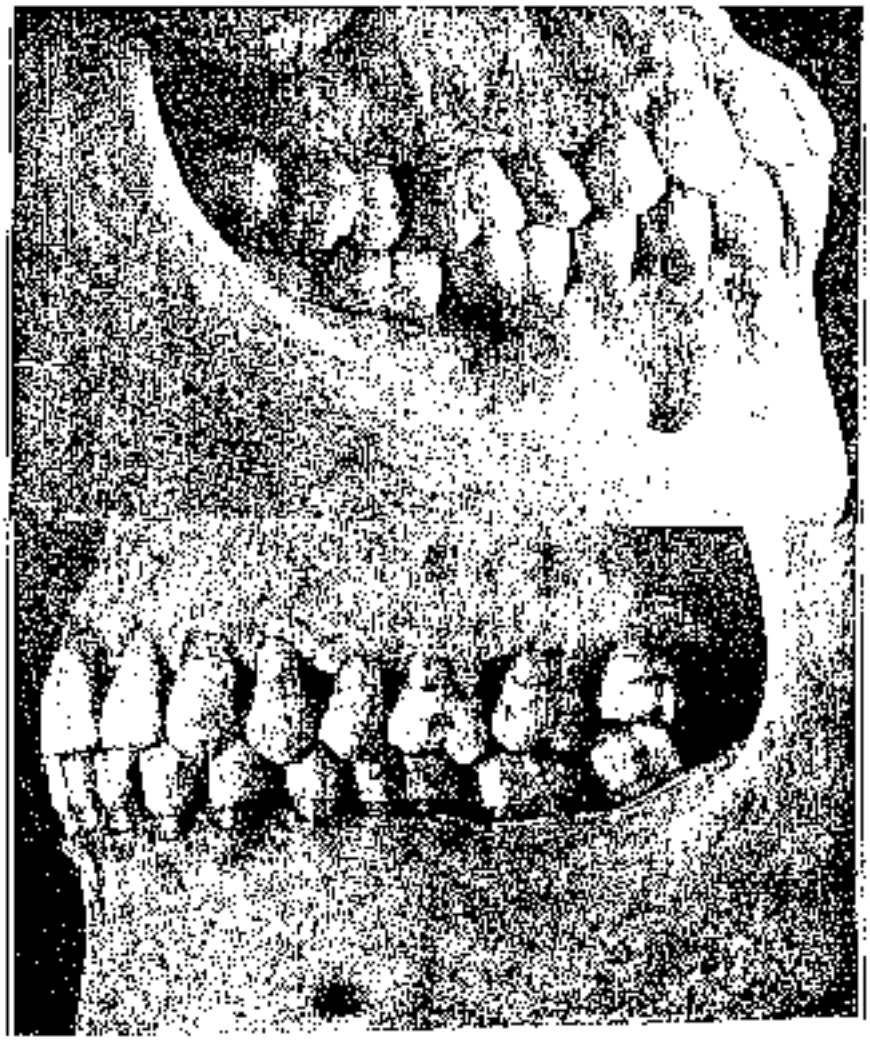


Fig. 6

Fig. 7

life span seemed to match the life of a functional occlusion, terminating at about age 40 years.

IV. The Controversies of Occlusal Arrangements

Despite a unity in diversity among the races, and individuals within races, there is an order. However, perhaps due to the nature of variation itself, there are differences of thinking and practices among various schools of belief within the profession regarding the manner in which the teeth are to be fitted and the exact nature of ideal function.

It would be expected that the most ideal fit of the teeth, (or at least the most in keeping with long-term stability) would have been thrashed out and agreed upon early in the specialty of orthodontics. Description of the normal was taken up about 100 years ago with E. H. Angle's classification. Modifications of Angle's original ideas in tooth relationship were presented by Steiner and others in the 1930s but with limited attention.

Currently, with commercial enterprises and a diverse choice of bracket and tube prescription, together with theories from a variety of articulator advocates, the agreements are scarce. Choices vary with different practices, and laboratory "setups" for positioners too often reflect the classic "prosthetic" ideas. Nature must certainly be kind to witness such differences with yet apparent clinical successes. This may be explained from our study of 1972 following a recall of hundreds of patients ten to fifteen years after treatment. Analysis of headfilms and models proved that teeth seldom stayed where they had been placed or retained. Growth, function and adaptation finally triumphed.

Equally alarming were the findings of Little et al, as well as many others who bothered to study long-term results, that a majority of patients even with premolar extractions, for what was expected to achieve the most secure lower alignment, had

experienced failure. This prompted a reinvestigation and reconsideration of extraction theory, and stimulated a review of objectives in orthodontic philosophy. A search was made yet again for the best assurance for stability through interlocking with the natural teeth. Dr. Ronald Roth and his coworkers observed that prosthetically constructed occlusions seemed to have remarkable permanence when compared to the results achieved in patients with natural tooth anatomy. This has further provoked a more in-depth study of the details of natural occlusal fit.

Ricketts and his co-workers described ideal occlusal "contact stops" and numbered them for scientific communication. This ideal seemed to offer stability to rival the prosthetic reconstruction.

V. The Five Theories

Theory One: The Prosthetic Setup

Before the turn of the last century a mechanical "balanced occlusion" was proposed. Dentistry was preoccupied with construction of full artificial dentures during the first half of the twentieth century. The author was told in dental school in 1943 that one-half the population would be edentulous by age 50 years. The occlusal plane, cusp height, overbite and overjet were planned according to the path of movement of the condyle on the slope of the eminence. Three-point balance was sought in all excursions for procuring the best relation for prevention of dislodgement of the artificial denture during function (Fig. 8).

Unfortunately, despite the teachings of Angle, and other naturalists, those "Laws of Articulation" were carried over into general dentistry for the natural teeth. During the 1950s and 1960s courses were conducted by clinicians with emotional fervor to the idea of balancing treated orthodontic patients by reduction of "cuspid interference".

In the setup of the classic "gnathologic prosthetic occlusion", molars tended to

Fig. 8

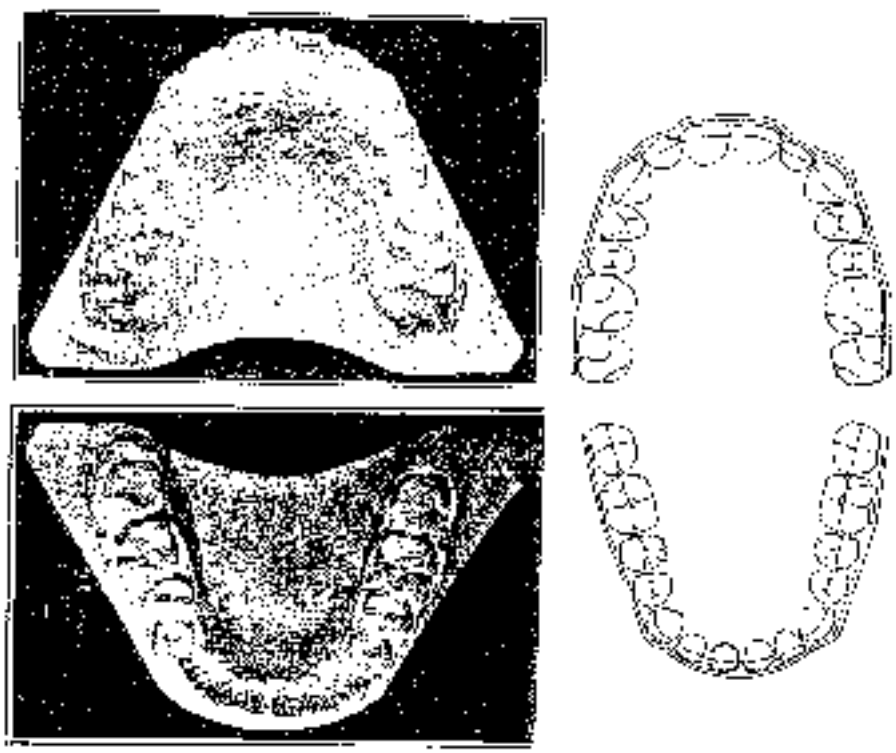


Fig. 9

be almost end-to-end, lower canines were canted mesially, and overjet was to be maintained free of centric contact. Arches also often tended to be too square in form.

At retention, full-scale equilibration was advised even in young natural occlusions. A series of grinding patterns were to be transferred from articulators in equilibration technique.

Theory Two: The Traditional Full-Banded Orthodontic Arrangement

With the advent of the Edgewise bracket and full tooth engagement with the "Ideal Arch" there came to be a classic arrangement for orthodontic finishes. This was carried over into current "Straight Wire" philosophy (Fig. 9).

(1) It was discovered that lower molars typically lacked sufficient distal rotation and as a guide for the upper, which in turn lacked enough distal rotation.

(2) The lower second molar was placed in a straight line with the premolar buccal segment.

(3) Roots of canines were often too buccal in torque compared to ideal normal conditions.

(4) Upper buccal segments came to be "rolled inward" with therapy in order to produce cuspal locking in the interspaces of the lower.

(5) Orthodontists came to concentrate on the buccal fit, forgetting to observe from the lingual.

(6) Often interincisal angles were too vertical and overbites were too deep as compared to normal controls.

(7) The upper second molars, instead of being placed on a natural curve, were torqued buccally at their roots with the idea of preventing interference of lingual cusps in excursions.

(8) Orthodontics would fall into a trap of producing their personalized arch form routinely, which became their standard.

In addition, four conditions resulting from orthodontic treatment techniques were also discovered which tended to tip the occlusal plane upward posteriorly. First, standard intermaxillary elastic traction (without buccal cortical anchorage) extruded lower molars. Some still growing children treated before the second molar fully erupted sometimes exhibited upper second molars to be occlusal to the first molar (a reverse curve). The upward tipping of the occlusal plane inclined the lower incisors forward as much as the plane itself was changed (see B in Fig. 10). These events happened also in Class I extraction cases as elastics were required to retract and torque the upper anterior segment.

As a second treatment situation during the 1960s, and up to the present, many clinicians also had come to abuse the use of cervical traction and were convinced of the merits of "high pull" extraoral traction to prevent the so-called "wedge effect". This approach intruded the upper molars and invited the lower molars to supraerupt. It further tipped the occlusal plane upward posteriorly (Fig. 11). Strong advocates of this technique consequently recommended **lingual crown torque on lower incisor** brackets to prevent "dumping" with the ideal arch wire. Of even worse consequence from the high pull procedure was the statistically significant finding that **vertical ramal growth was inhibited** with deficient posterior support and undergrowth of the mandible when compared to controls.

The third clinical situation was with activator-type modalities. The differential in eruption was held to account for some of the Class II correction. Upper molars were inhibited in their downward and forward path of development. This procedure allowed the lower molars and buccal segments to erupt more upward and forward. It also tended to elevate the occlusal plane posteriorly.

The fourth clinical situation occurred with the use of fixed Herbst (or fixed bite jumping type of appliances). A prop from the upper molar area down to the lower first premolar area pushed the upper molar upward and backward.

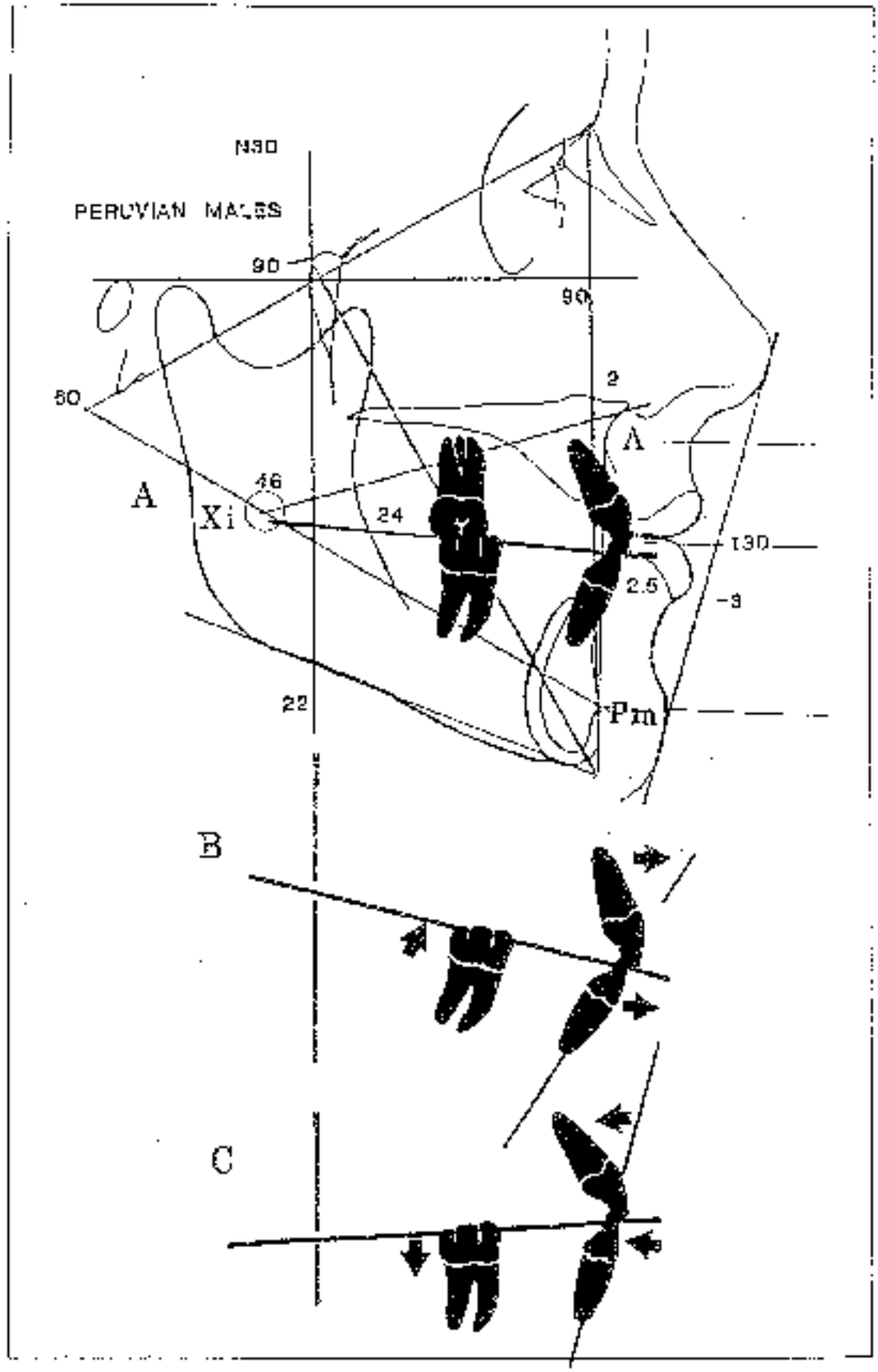


Fig. 10

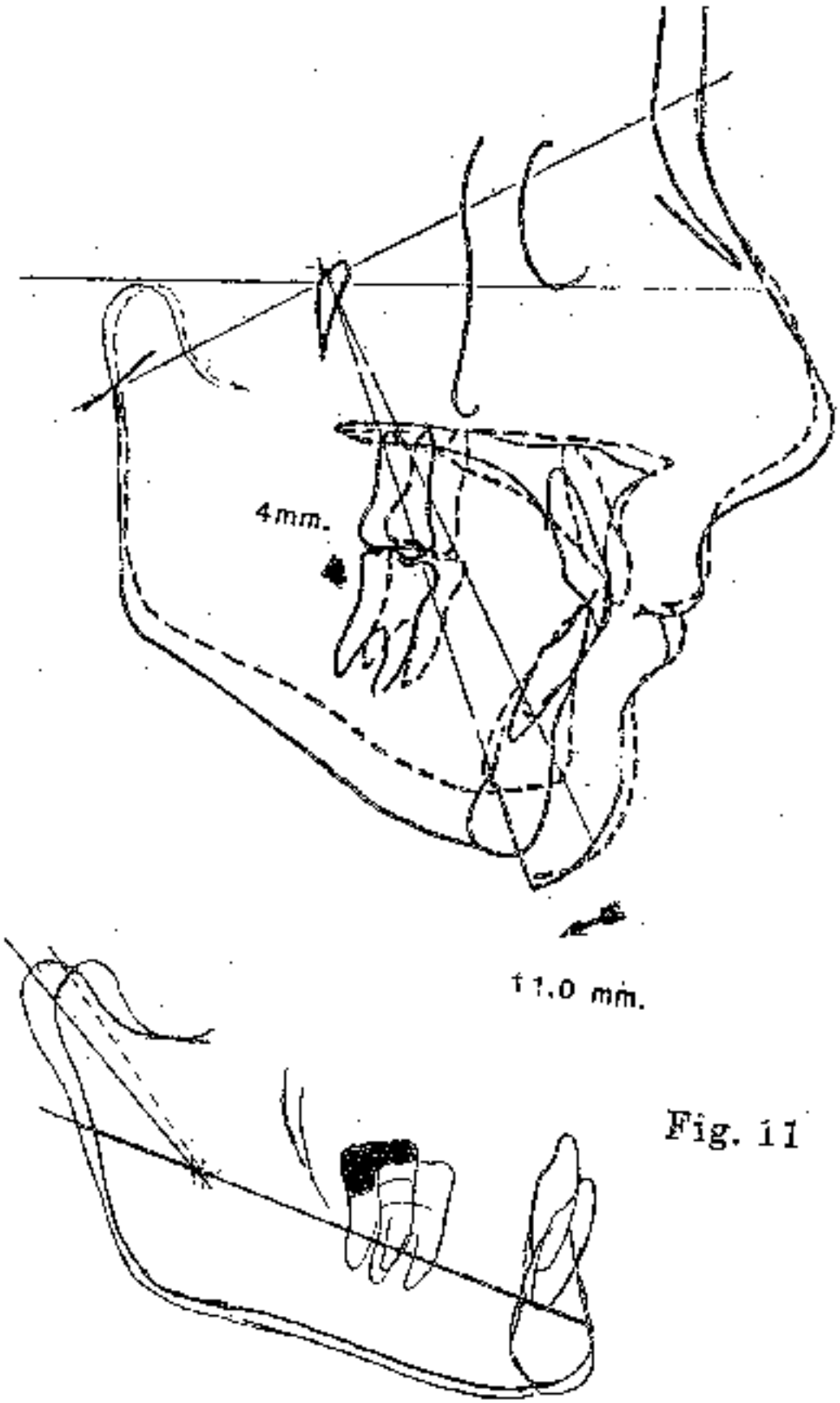


Fig. 11

A sort of compromise came to be made by orthodontists to satisfy the gnathologic schools. The condyle was to be "fully seated in the fossa" which allegedly would yield the best "disclusion" component. Orthodontic clinicians following the charges of their referring dentists were obliged to achieve a common "centric relation" and "centric occlusion" if possible.

Luckily, the findings of D'Amico from natural occlusion studies put a stop to the mutilation of canines from the previous prosthetic idea

All the foregoing techniques were factors tending to alter the occlusal plane. Some patients accommodated to the treatment, while others did not. In order to assist in occlusal plane control, some techniques were advocated to intrude the upper anterior teeth with hooks off the arch and high-pull headgear anteriorly employed during the course of correction. This was an advantage, but sometimes elevated the whole occlusal plane upward which would help with gummy smiles, but also tended to inhibit mid facial vertical development of the palatal plane.

Theory Three: The Prosthetic Therapeutic Ideal (Gnathological)

The wave of interest in employing casts of natural teeth for articulator study was probably started primarily by Dr. B. B. McCollom. "Terminal hinge" position was sought. It became obvious that conditions for derangement in the joint were actually invited by this philosophy. Further, with the advent of high-speed technology full mouth rehabilitation became a theory widely practiced. This gave rise to a variety of sophisticated articulators in which all movements of the condyle were explored and analyzed.

With the articulator approach, for waxing of the teeth for construction, a "cusp-fossa" theory was developed and taught by Dr. Peter Thomas and Dr. Charles Stewart and others (Fig. 12). A hinge position of the condyle was sought by many and emphasized by Dr. Eugene Dyer and many other "gnathologists". With often a

mandible moved slightly distally, the occlusion constructed was closer to an end-to-end relation. Slight overjet came to be recommended.

Orthodontists were expected to finish cases in this arrangement, but it was a highly unstable state. Such a condition would require essentially permanent retention without a tongue habit to hold the bite open. The buccal segments were sometimes curved upward posteriorly in the normal natural manner. Canine guidance and group function were by now accepted as objectives, but upper second and third molar interferences were difficult to manage when flat planes were produced. The result was that orthodontists felt obliged to band all second molars and torque their roots buccally. Treatment in young patients was delayed until second molars were available. This meant bypassing precious growth years.

This theory led to controversy and confusion on a scientific basis.

Theory Four: The Orthodontic Therapeutic Arrangement

An arrangement of teeth for the best simulation of Nature's architectural pattern was promulgated mainly by Ricketts and was in general agreement with Slavicek.

The concept was derived from several sources. It involved the recall of hundreds of orthodontically treated patients and also a study of many patients treated for temporomandibular joint disorders. Comparative anatomy and neurophysiology also were a part of this theory.

The issue was to find an arrangement that would offer the best insurance for the best health and long-term stability together with superb esthetics in an orthodontic practice (Fig. 13). It was aimed at producing an arrangement resistant to the forces that commonly produce relapse.

Eighteen different studies of the detail of natural fit of the teeth were conducted. The concept was three-dimensional in terms of arrangement for each

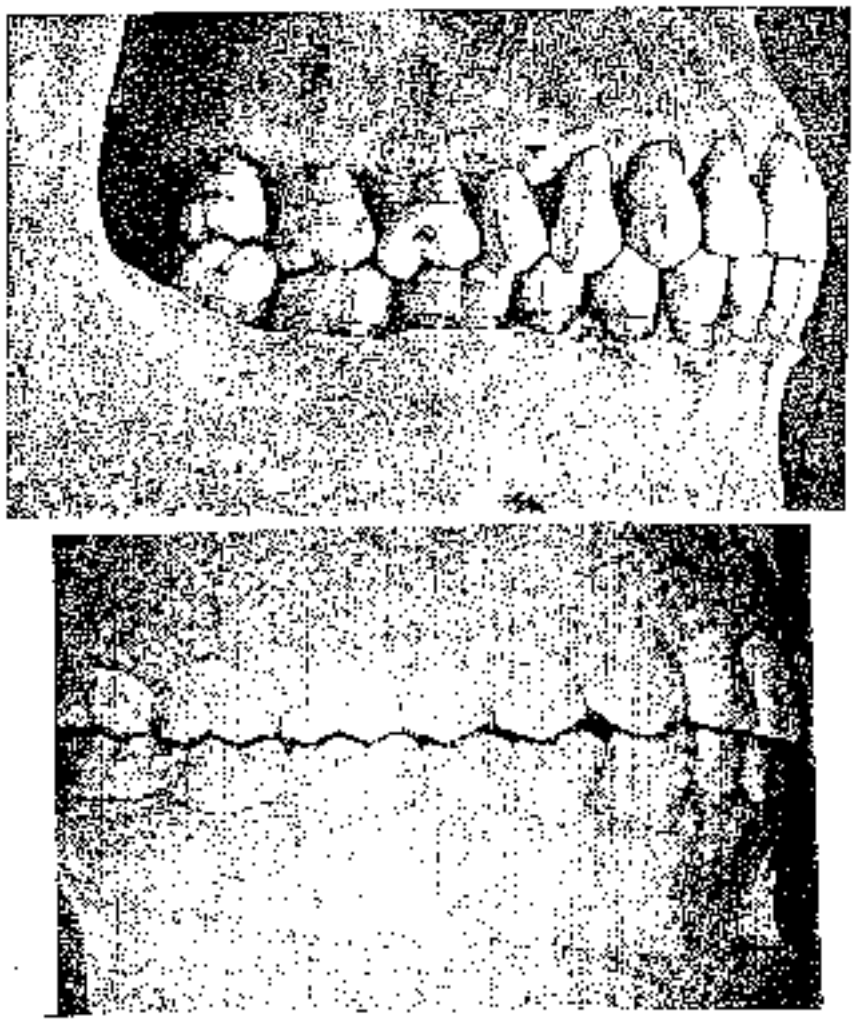


Fig. 12

Fig. 13

tooth related to its counterparts. After having determined the most desirable relationships and building them into routine technique it was found that Dr. Cecil Steiner had drawn some similar conclusions in 1934. It was wondered, therefore, why these ideas had not come to be a more common practice in the specialty

Features

The therapeutic ideal has slightly different proximal contact objectives than traditional objectives discussed previously.

Lower Arch

The buccal line of the lower exhibits the premolar and first molar on the line; the canine and second molar are inward (Fig. 14). The lower first molar distal contact is more centered on the second molar than toward the buccal. The lower second is rotated 6° and the first is rotated 12° as a "standard". The second premolar is centered on the mesial surface of the first molar The lower first premolar is upright bucco-lingually, and is placed so that the canine contacts near the center of the mesial surface. The lower canine is by no means in line with the buccal cusps of the premolars in the normal occlusions studied.

The canine is "tucked in". This means, as stated before, it is inward relative to the first premolar. But more importantly, the lower lateral distal contact is decidedly labial to the mesial contact of the lower canine. This overlap, often ever so slight, produces a better stability because **the first sign of relapse, as studied, was the movement of the lower lateral lingually** when retainers were discontinued. This overlap arrangement of the lateral became the insurance! Placement of the lower canines inward also permitted them to drift inward or outward as natural to the occlusion without the breaking of lower incisor alignment. The lower canines were also found to be generally upright mesio-distally.

Upper Arch

In the upper arch the molars are likewise arranged in a segment of their own

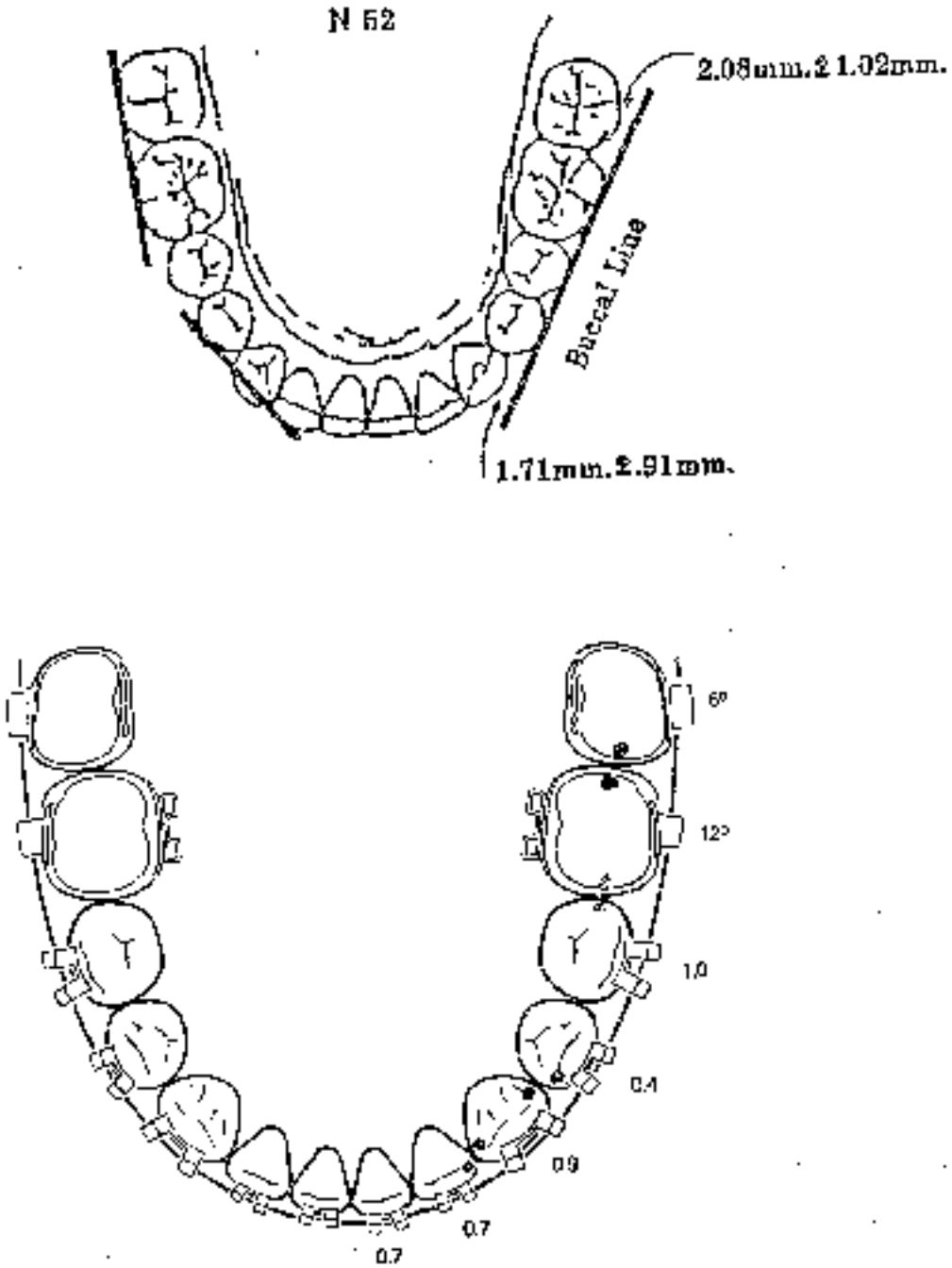


Fig. 14

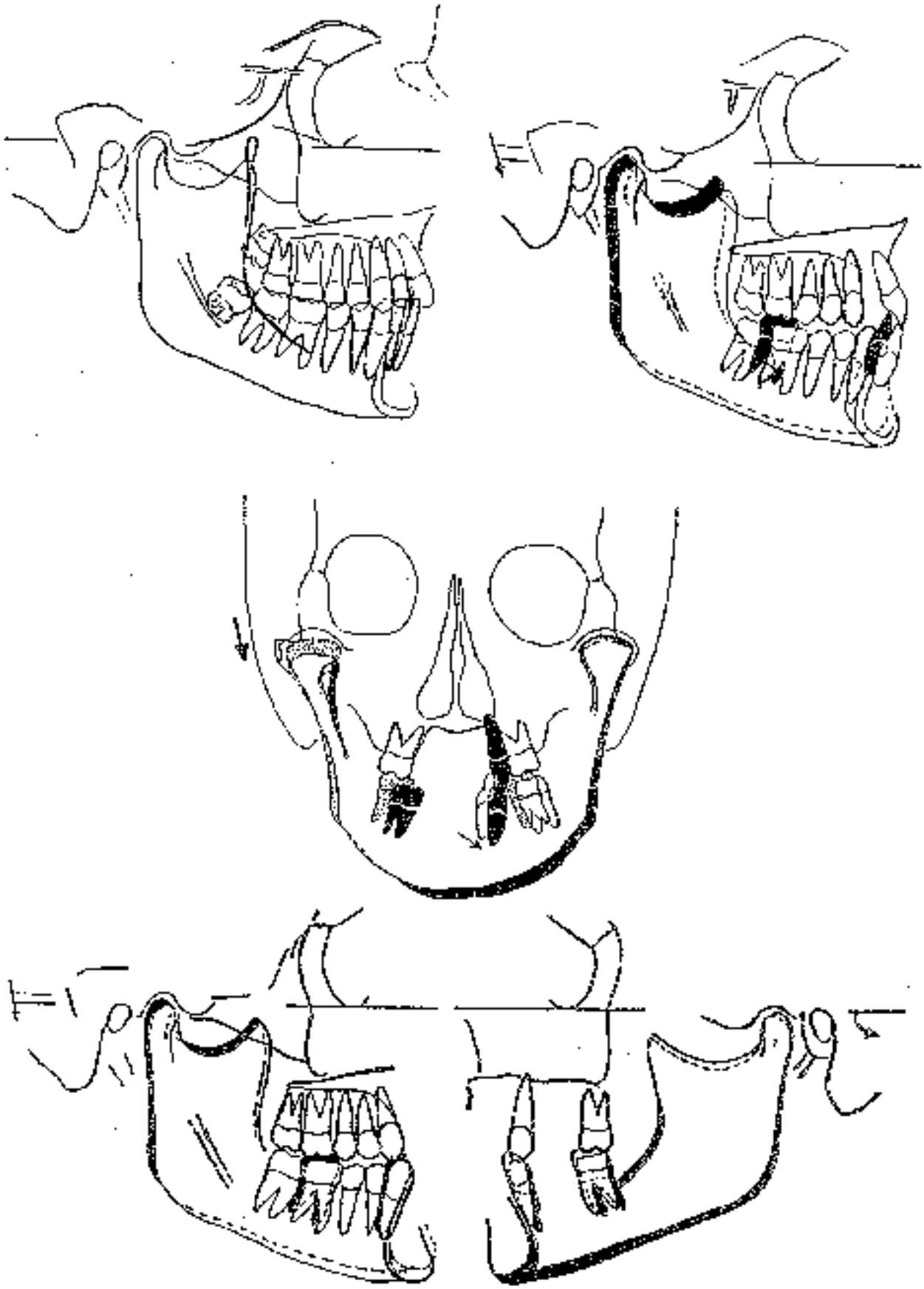


Fig. 7

Thus, biting and chewing are dominant aspects of function, but that is only one aspect of the function of teeth. The other factors perhaps fall into the category of "parafunction".

Parafunctions

"Para" means "around", and it is supposed that parafunction pertains to functions other than chewing or mastication. First to come to mind is the action of closing the teeth together commonly associated with empty mouth swallowing. The maxilla is essentially fixed by sutures, but it is moved by neck muscles as the head is moved. **The mandible needs to be stabilized for the hyoid and pharyngeal muscles to be provided a firm base.** In closing this stabilization is performed by locking of the teeth. The lower jaw is set in the double mortar and pestle arrangement of the teeth so that stability is offered vertically, horizontally, and transversely.

Habit patterns are also attributed to parafunction. The patterns of bruxism are for the most part not consistent with the same pattern of mastication. The violent action of nocturnal bruxism is often almost seizure-like in that its degree is difficult to provoke in a normal awakened state. Patients have been noted to kill the nerves in the teeth in this action.

Clenching, while more subtle, can be a more damaging factor when it becomes chronic. Prolonged clenching can intrude teeth, while bruxism tends to produce attrition.

Habit patterns can also be initiated for performance of speech. Accommodation for esthetics surrounding malocclusions also are included here.

Role of the Joint to Occlusion

Five functions have been attributed to the unique temporomandibular joint (Fig. 8). These are: (1) a provision to protect the airway during wide mouth opening (and a mechanism for suckling in the infant); (2) a part of a servo-control mechanism

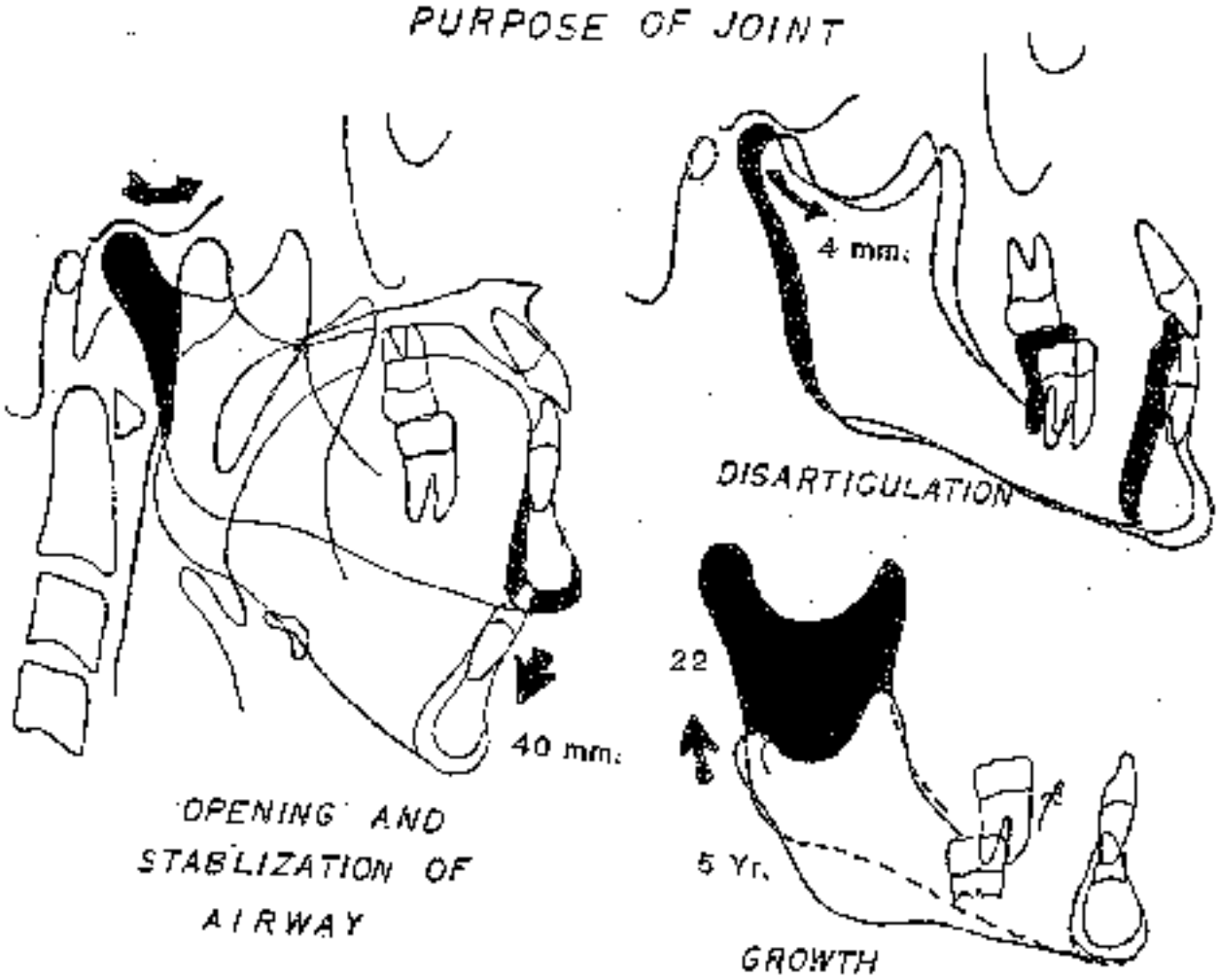

PURPOSE OF JOINT
4 mm.
DISARTICULATION
40 mm.
OPENING AND
STABLIZATION OF
AIRWAY
22
5 Yr.
GROWTH

Fig. 8

for making a unity of joint and occlusal function; (3) a component of a force couple for mandibular control. (4) a site of growth of the mandible; and (5) a "torque action" for disarticulation of the teeth during functional operations. While canine and incisal guided protection is referred to, actually the occlusion is also joint protected in that it is a disarticulator for the teeth. When the joint is disturbed all five of these functions can be affected.

Role of Occlusion to the Joint

The temporomandibular joints form at 14 weeks in utero and the face continues to grow in patients with complete anadontia. It could be wondered, therefore, what the influence of the teeth could be on the joint. The answer comes in two factors. First is the activity needed for adaptation of function to malocclusions. A case in point is the inordinate translation required to protrude the mandible for biting and speaking in the Class II, Division 1 (Fig. 9). Avoidance patterns patterns were mentioned before, and crossbites in certain instances cause interferences and provoke abnormal muscle conditions. Another instance is interferences or factors that produce abnormal withdrawal of the mandible through the temporalis muscle and give rise to distal mandibular displacement.

The second factor is the loss of posterior teeth or the absence of ramal support for the mandible (Fig. 10). Normally forces of chewing, clenching, or bruxing are transmitted through the jugal process, through the zygoma and up to the frontal and parietal elements. In the absence of posterior support there is evidence of condyle compression and traumatic arthritis.

VI. Physical Homeostasis of the Mechanisms

A state of health is referred to as one of balance, equilibrium or -- as W.B. Cannon (1922) described it -- homeostasis is "the coordinated physiological processes which maintain most of the steady states in the organism". Taking from Cannon and

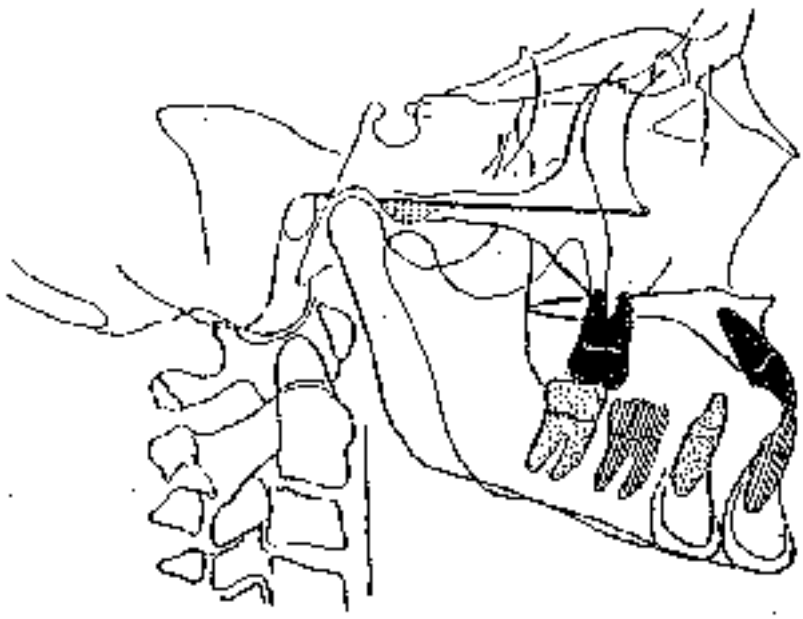
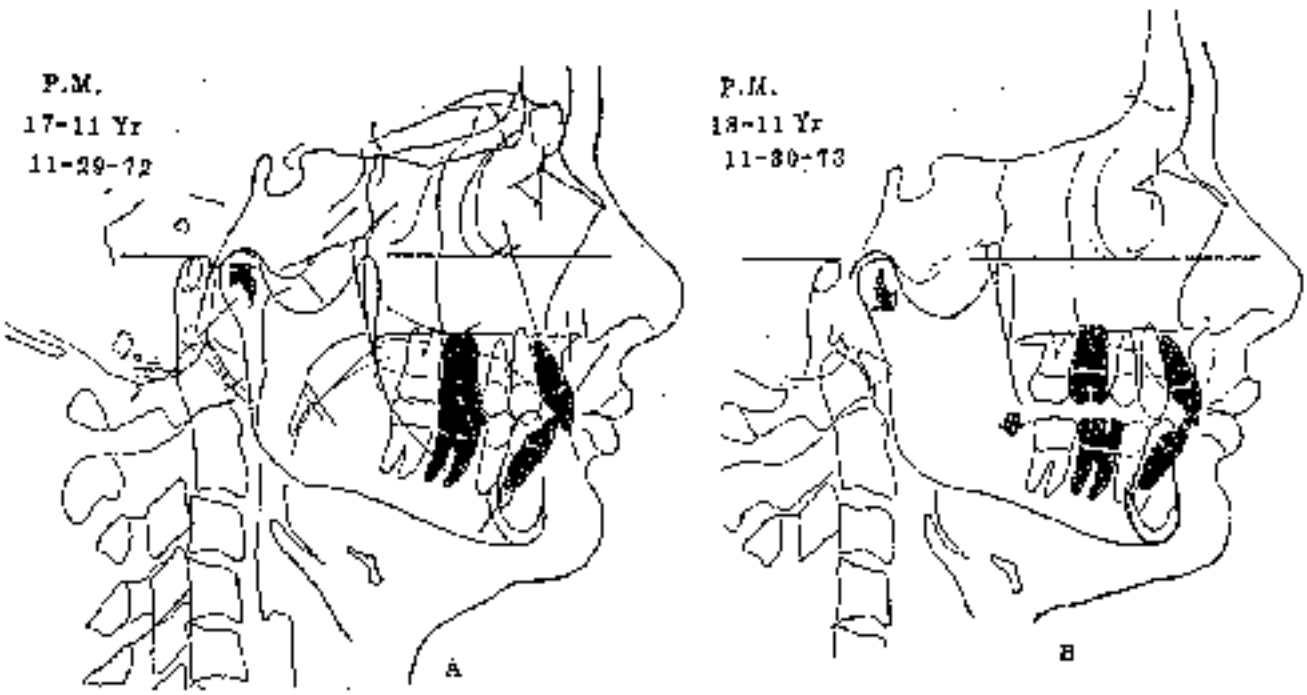


Fig. 9



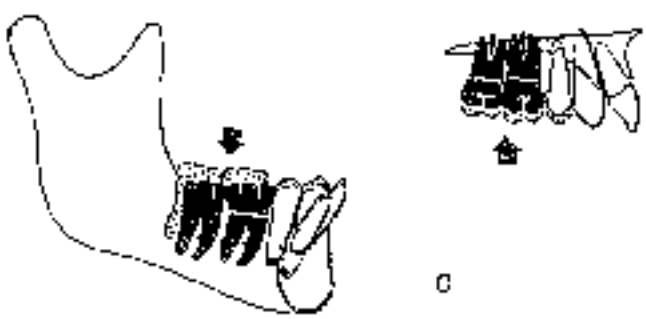


Fig. 10

Steindler's concepts of kinesiology, we transformed the idea of joint equilibrium and denture equilibrium into the concept of "physical homeostasis". This included the physical factors and invoked the neuromuscular apparatus. Thus, occlusal homeostasis or stability came to be related to a totality of systems even to the psychologic (Fig. 11).

VII. Stress and Occlusion

Many publications in the past decade have made reference to stress as a factor in health, and particularly have attributed anxiety factors to joint disorder conditions. Stated previously was the problem of clenching. We would perhaps divide the whole field of temporomandibular-occlusal connection into two separate entities with overlapping of both. The first type is simple derangement with anxious clicking and often associated with occlusal developmental problems. These are quite commonly associated with "occlusal derangements" (Fig. 12).

The second type are those with psychologic problems, compulsive disorders, and general health inadequacy of some kind. Patients in this category either overload the tissues involved, or -- alternatively -- the deficient state of resistance to normal loads leads to breakdown. The important issue is that stress (or distress) is an underlying factor. In order to diagnose these conditions common sense and experience will help. The stress rating scale composed by Holmes and Raye can aid in making the determination of social stresses. Ricketts further devised an assessment scale with characteristics to help identify the depth of "the systemic factor".

VIII. Temporomandibular Joint Diagnosis

There is a tendency to take it for granted that a normal joint exists. There has also been a movement to indemnify any problem in occlusion with joint involvement. However, as stated previously, the joint and occlusion are related in influence -- one

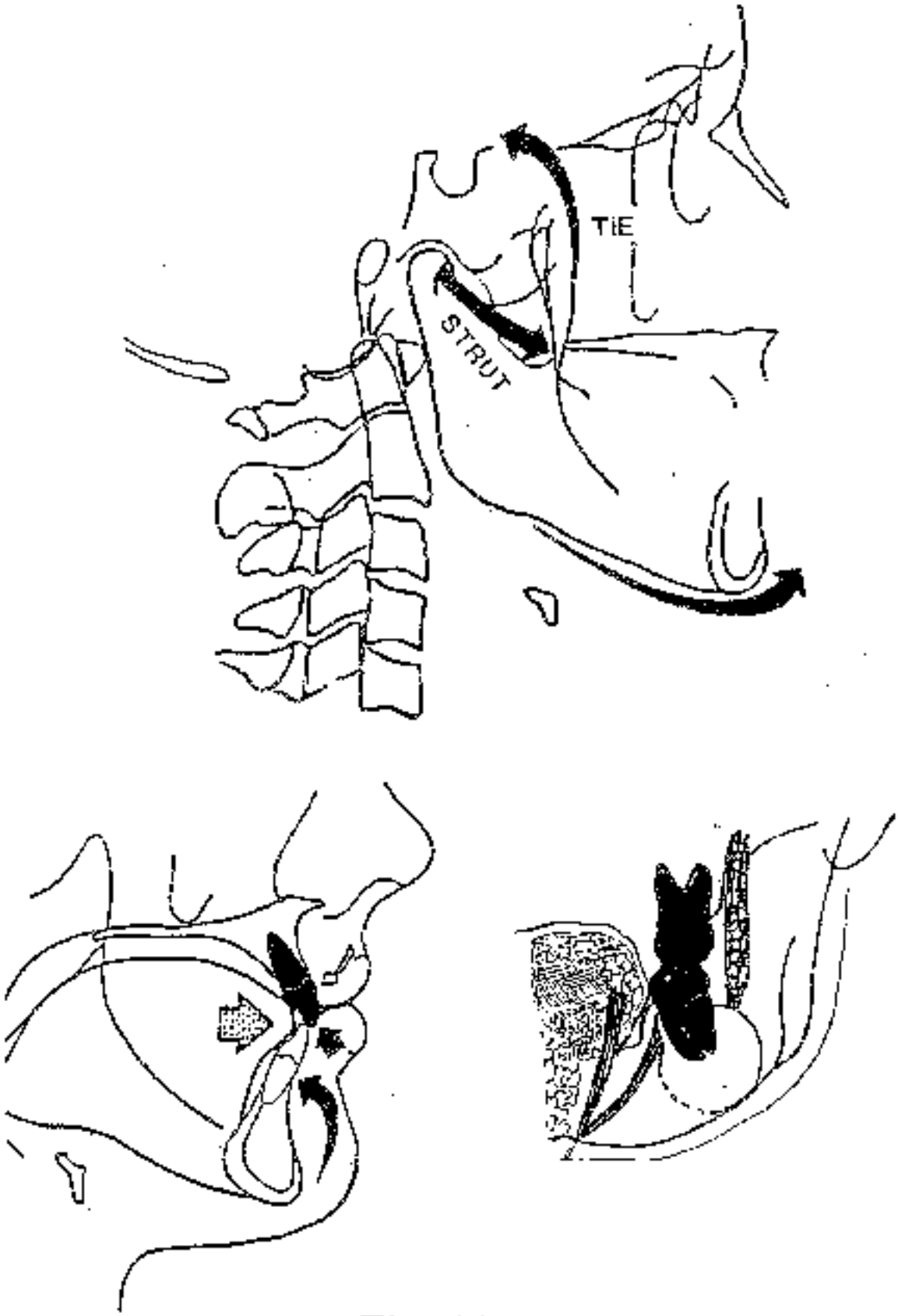
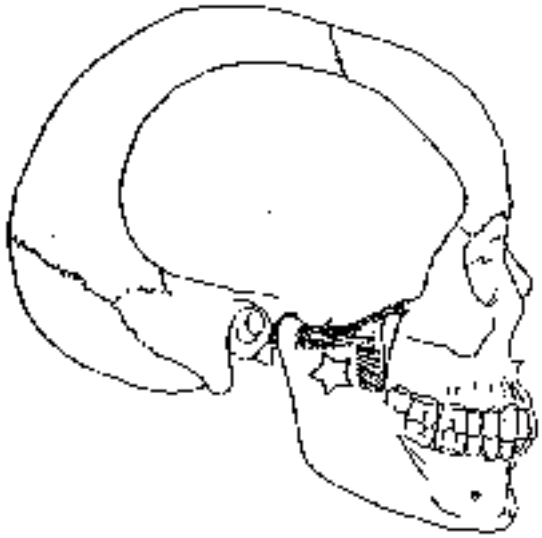
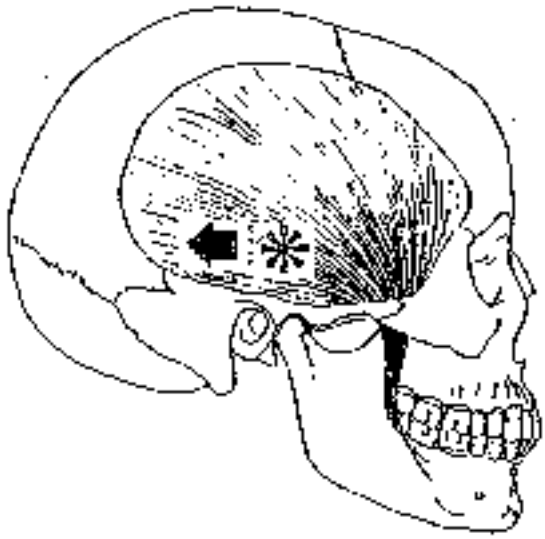


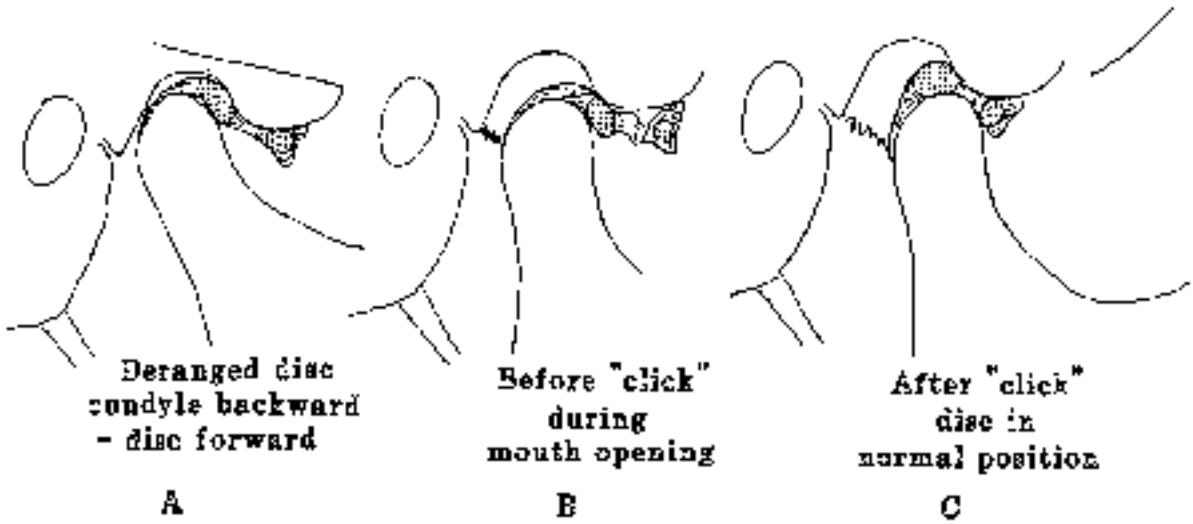
Fig. 11



A. Loss (at the star) of stabilization muscles



B. Over-contraction (at asterisk) of the muscles pulls the condyle backward



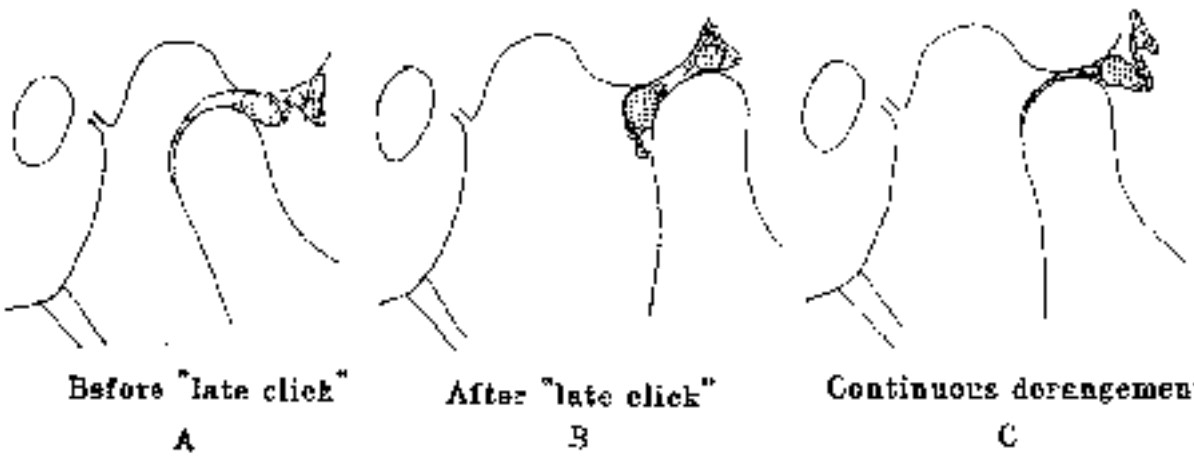


Fig. 12

affects the other.

One problem has been the arguments regarding the trustworthiness of X-rays and what kind of X-ray apparatus is used. Beginning in 1950, reports of a normal control sample of 50 patients and 100 joints was published (Fig. 13). The dearth of availability of the body section apparatus (Laminagraph, Tomograph, Sectograph) made it difficult for information to be passed along. However, **the advent of Magnetic Resonance Imaging has made the body section method far more appreciated.** Normal relations have been corroborated and abnormal conditions more clearly defined (Fig. 14).

Also, with techniques organized and verified, movement patterns and symptoms in clinical examination have proven to be trustworthy. There is no reason to ignore the joint in any occlusal problem, particularly when the joint and muscles are symptomatic.

IX. Articulator Applications

The question arises: is the articulator a diagnostic instrument, or is it a planning tool, or is it a treatment tool? Articulators have been argued over for more than a century. Some developers and users of articulators profess to be able to duplicate all physiologic movements and use it specifically for determining patterns for equilibration. Much reliance is often placed on the articulator, most often for prosthetic reconstruction of the occlusion. Many orthodontists consider articulator mounting to be the ultimate in sophistication.

The arguments "against" are not with the articulator but in the techniques or manner of registration. The starting and end point or positions of movements are not seen by mounting. "Terminal hinge" position has been discarded, and agreements have not yet developed or what is to take its place. It would appear that many clinicians now prefer the condyle to be in juxtaposition with the eminence through

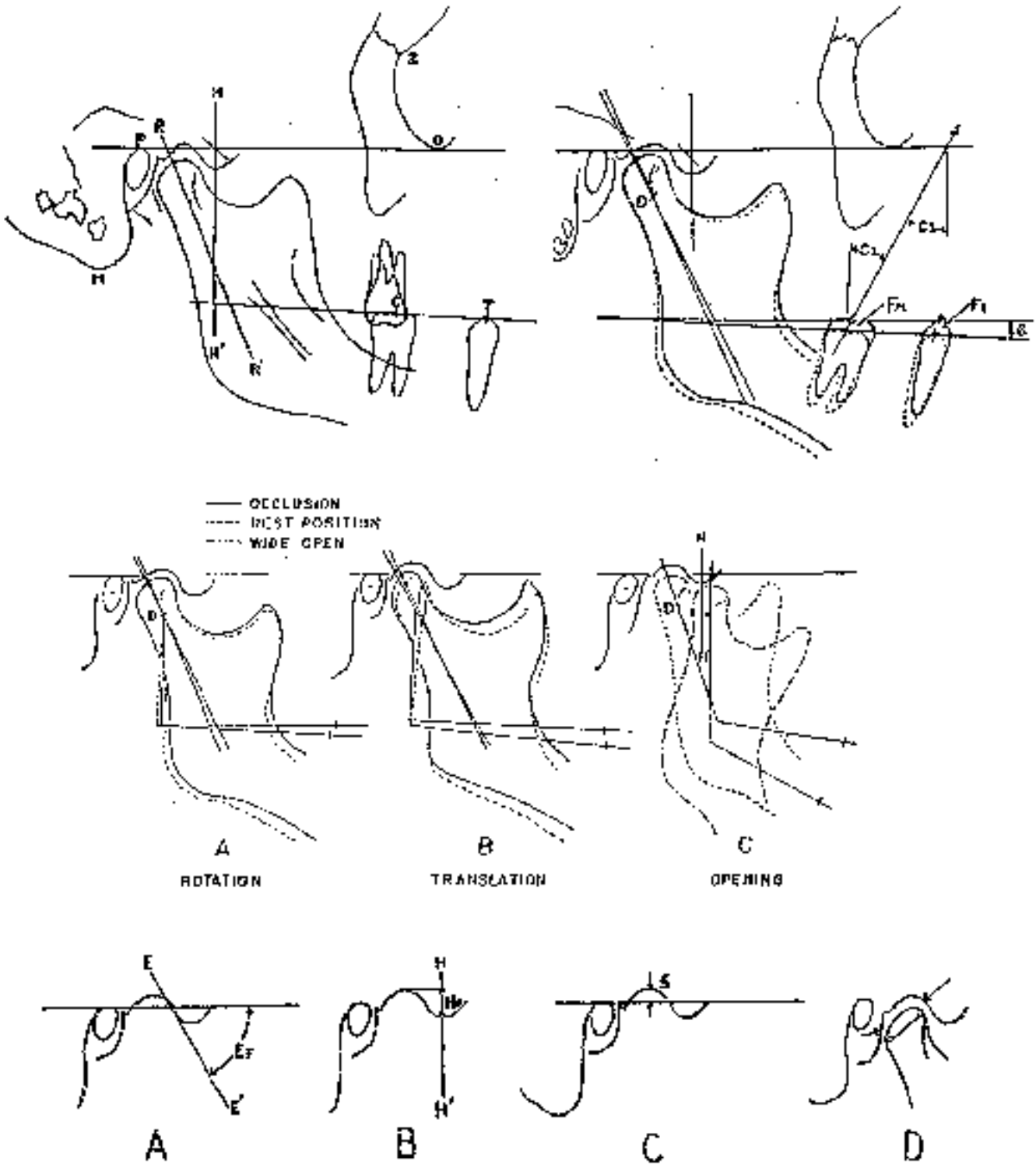

OCCLUSION
REST POSITION
WIDE OPEN
A
ROTATION
B
TRANSLATION
C
OPENING
A
B
C
D

Fig. 13

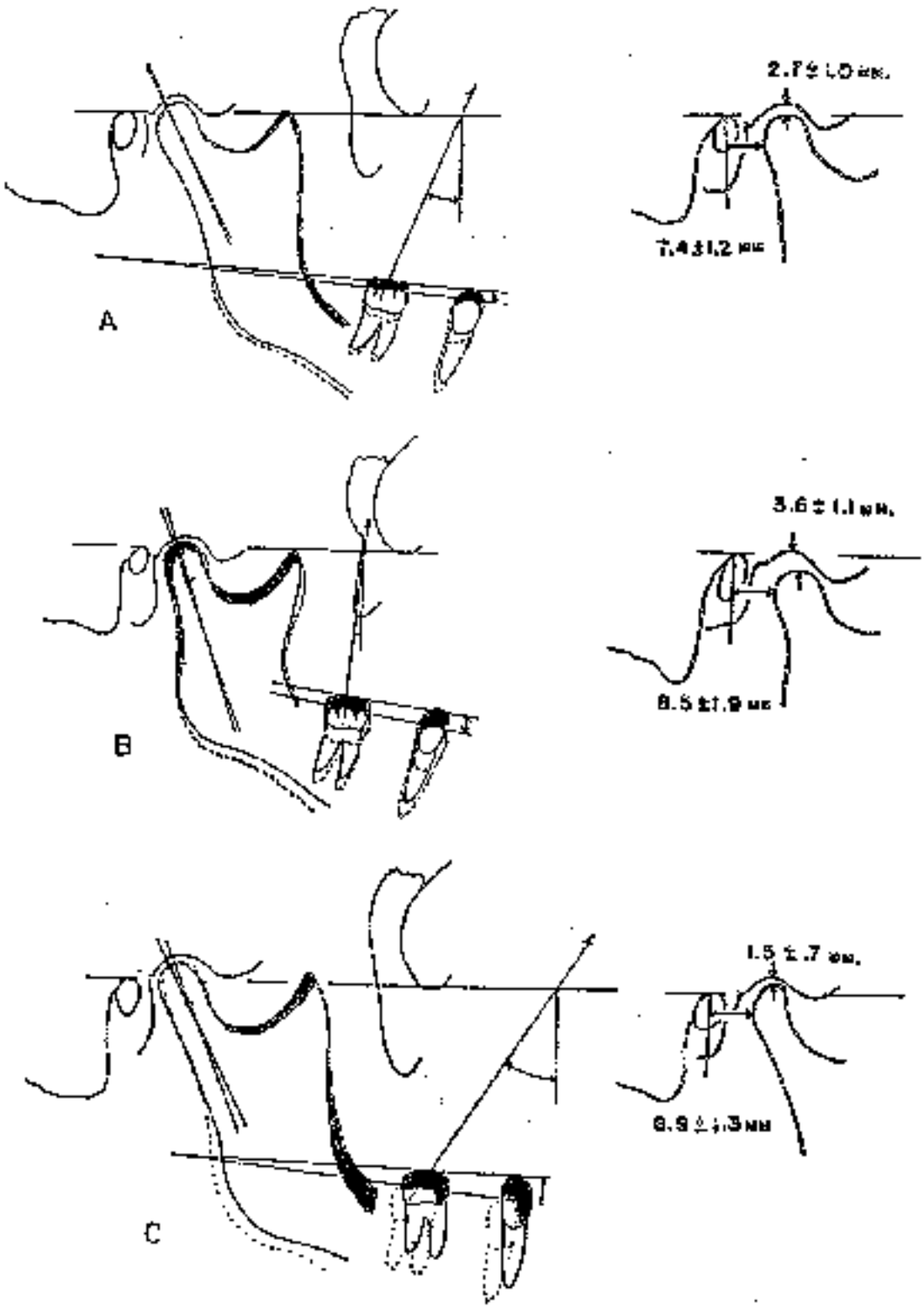


Fig. 14

the medium of the disc, in other words a "physiologic centric" (Fig. 14).

X. The Hierarchy of Occlusion Diagnosis

Perhaps a working proposal of hierarchy of factors in the diagnosis of occlusion may be helpful to the clinician:

1. Presence or absence of teeth
2. Anomalies of teeth
3. Malocclusion
   * Major types
   * Details of variation
4. Facial morphology
5. Muscular conditions
   * Neuromuscular influences
6. Functional parameters
   * Parafunctions
7. TM Joint analysis and imaging
   * Classification of types
8. Cephalometric analysis [Lateral, Frontal]
   * Seven major components
9. Articulator mountings
   * Registrations
10. Kinesiologic considerations

SUMMARY

There are several decisions the clinician must make for diagnosis. These are reached from the line of occlusion, emplacement of occlusion, divine proportions and morphologic factors in the cranial base, and jaws together with local arrangements.

Functional factors involve the tongue and the lips which tend to work reciprocally. This means protruding the lips stimulates a reflex to protrude the tongue.

From a reductionist point of view there are eleven factors in the decision-making process. These are listed on the following page.

FACTORS IN DIAGNOSTIC CRITERIA

1. AGE
   - INTERCEPTIVE - PREVENTIVE
   - CORRECTIVE - REHABILITATIVE

2. MALOCCLUSION
   - CLASSIFICATION
   - EXTENT - DIFFICULTY

3. ORTHOPEDIC RELATION
   - CRANIAL INVOLVEMENT
   - FACIAL STRUCTURE ALONE

4. ESTHETIC CONSIDERATION
   - ETHNIC
   - PERSONAL

5. ETIOLOGIC FACTORS
   - GENETIC - FAMILIAL
   - ENVIRONMENT - FUNCTIONAL

6. TREATMENT POSSIBILITIES
   - EXTRACTION
   - NON-EXTRACTION

7. PSYCHOLOGIC FACTORS
   - SOCIAL - EMOTIONAL
   - FUNCTIONAL IMPAIRMENT

8. ECONOMIC CONDITION
   - PRIVATE
   - WELFARE

9. INDIVIDUAL HEALTH
   - LOCAL
   - SYSTEMIC

10. MUSCLE PATTERN
    - STRONG
    - WEAK

11. GROWTH
    - FORWARD
    - BACKWARD

CONSUMMATE OCCLUSION

CHAPTER THREE

CLINICAL ASPECTS -- MORPHOLOGY

I. Introduction

All the aspects discussed thus far in occlusion are clinically related. Clinical science and clinical research deals directly with the living patient or a direct record thereof. The purpose is now to associate occlusion in detail.

Idealism means thought based on a conception of something as it should be. An ideal exists as an idea but represents a **model of perfection.** An ideal occlusion becomes the starting point for the setting of goals. The human occlusal architectural plan has majesty. **The ideal symbolizes a goal or serves as a principle** that has noble qualities and is unique and changeless.

II. The Ideal Plan of Nature

Keys to Occlusion (Ricketts)

Angle described the relation of the first permanent molars to be the "key" to normal conditions. Diagnosis and planning revolved around those teeth with the upper as the base of reference. Truly it is incumbent on the orthodontic clinician to "set the foundation" correctly, for without proper molar fit as a base the arrangement anteriorly is often incongruent.

The upper to the lower molars can be ideally arranged with each other, but they **both** must be rotated properly. In addition they must be in a specific angulation to the line of occlusion. These two additional properties led the author to state that the upper **second premolar contact with the lower first molar** (#14) is the first real key to the most ideal fit (fig. 1). In other words, it is the key to the key.

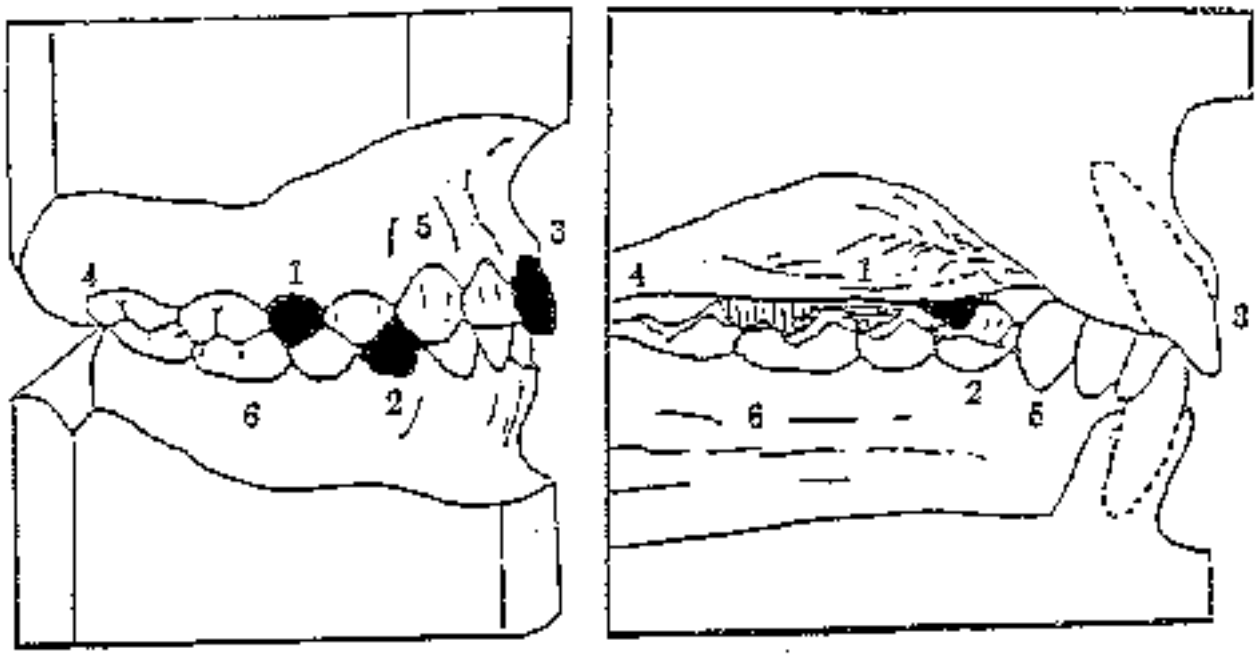
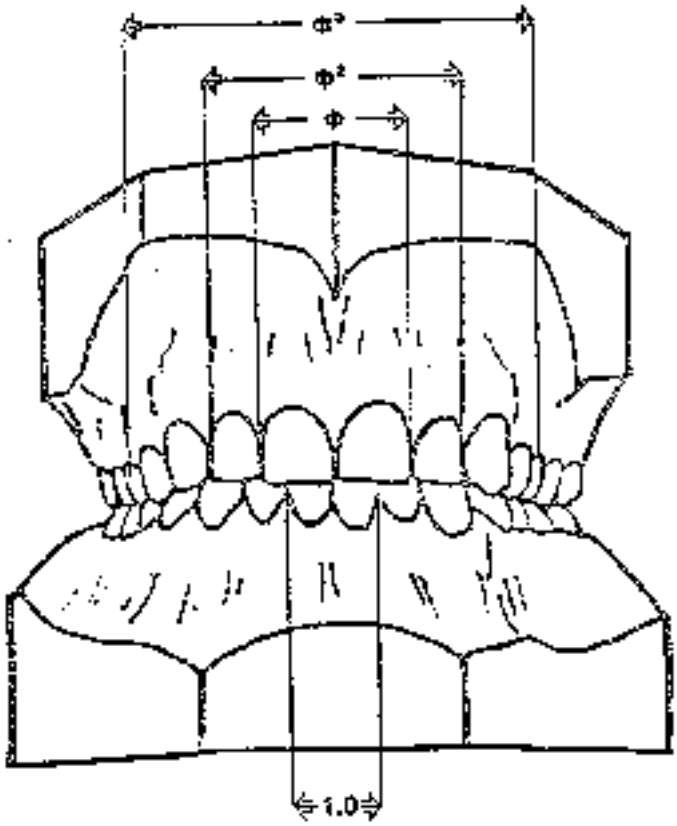


Fig. 1



The second most important "key" is the lower first premolar bucco-lingual position. It receives on its mesial buccal aspect contact #6 which is the distal incline of the upper canine. The lower first premolar is also a tooth that is most critical to arch form. Commonly in orthodontics, as in Nature, this tooth is lingual to an ideal position for best stability of fit.

The third "key" is the interincisal angle and overbite-overjet relation. The interincisal angle is variable, but a mean angle of 130° has been reconfirmed. The overbite and overjet are almost identical at 2.25 mm. and 2.30 mm. The interincisal angle varies with (1) denture height and (2) denture procumbency. The shorter the face and more procumbent the denture the lower the angle. The longer the face and flatter the denture the higher the angle (Fig. 2).

Trimorphic formulas

With the observed distribution of interincisal angles three formulations of interincisal angles were advised. These were labelled Proversion (see Fig. 2), Neutroversion and Retroversion. The plan was to finish most patients at 126° to allow for uprighting typical of metapositioning to a 130° final goal. The Proversion was therefore the most common and was designed to produce 123° angles at finish. The Retroversion was classic for Class III and in long lower face height conditions, and was designed to result in a mean of 137° at debracketing. Neutroversion angulation would produce 130° angles on average before retention.

The fourth "key" is the angulation of the canines both mesio-distally and labio-lingually. These teeth need to be placed in positions to help support the muscles at the angle of the mouth. The lower has different inclinations from that of the upper, but both angle outward. The upper canine is mesially inclined.

The fifth "key" is the second molars. They normally are superiorly placed from the flat upper buccal plane. The normal curve of the occlusion starts at the second molar.

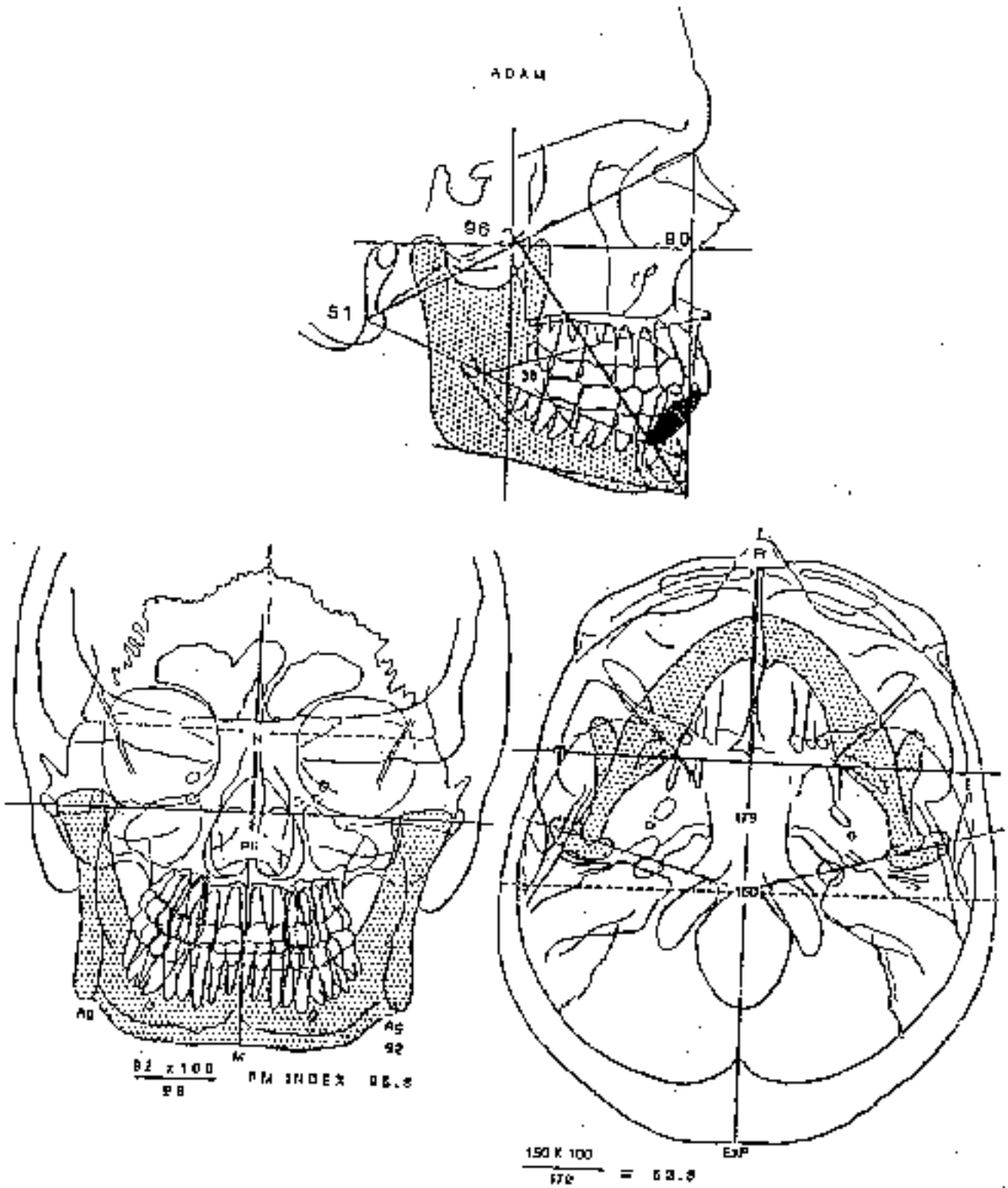


Fig. 2

The sixth 'key' is an arch form which is in harmony with the muscles. Because the muscles originate from the jaws the arch form has secondary association with facial skeletal morphology. Jaw size plays a role in addition to jaw form.

It is obvious that rolling the teeth inward will "lock" the buccal cusps, but the consummate orthodontist will also observe the model from the lingual also.

The Occlusogram

In 1965 the author was challenged by a periodontist regarding conditions produced by orthodontists which he felt were unsatisfactory. A review of the literature revealed that no references were found that described idealization of exact fit of the teeth on centric. A two-year study of hundreds of patients led to a confirmed plan for numbering the points of contacts of the upper teeth with the lower. Ramfjord and Ash had referred to the meeting of the teeth as "contact stops". This label was used in describing the relations ideally.

Thirty (30) contacts were numbered for each side. Six (6) of these were on the third molar and without them twenty-four (24) remained (Fig. 3). The even numbers were buccal stops and the odd numbers were lingual points of contact. Because the lower second premolar lingual-mesial area is normally without contact (except in Class II) and because the mesio-lingual cusp is free in normal function these two contacts (#9 and #13) are absent except in malocclusion. The number of ideal stops was thus reduced to twenty-two (22). If extraction was practiced, three more were eliminated, leaving nineteen (19) as the ideal. The author was shocked to discover that an extracted patient, appearing to be well treated, on critical testing showed only eight (8) contact stops on one side and nine (9) on the other.

Dimensions in the Arch

Orthodontists in practice tend to form habits and patterns which are suitable to their particular idea. Sometimes this can be also of a particular form which affects arch dimension. As a starting base certain locations on the arch have value as

reference (Fig. 4).

The first reference is for arch depth. This is also translated geometrically as altitude. A line from the center of contact on the mesial of the first molar (or distal of second deciduous molar) is employed for measurement to the center of the central incisor edges. This dimension plus the X-ray enlargement factor is correlated with the lateral cephalometric film. The models of thirty ideal normal untreated subjects revealed a mean of 22.23 mm. ± 1.4 mm. Normals were found to have slightly smaller incisor teeth than measured in typical malocclusions.

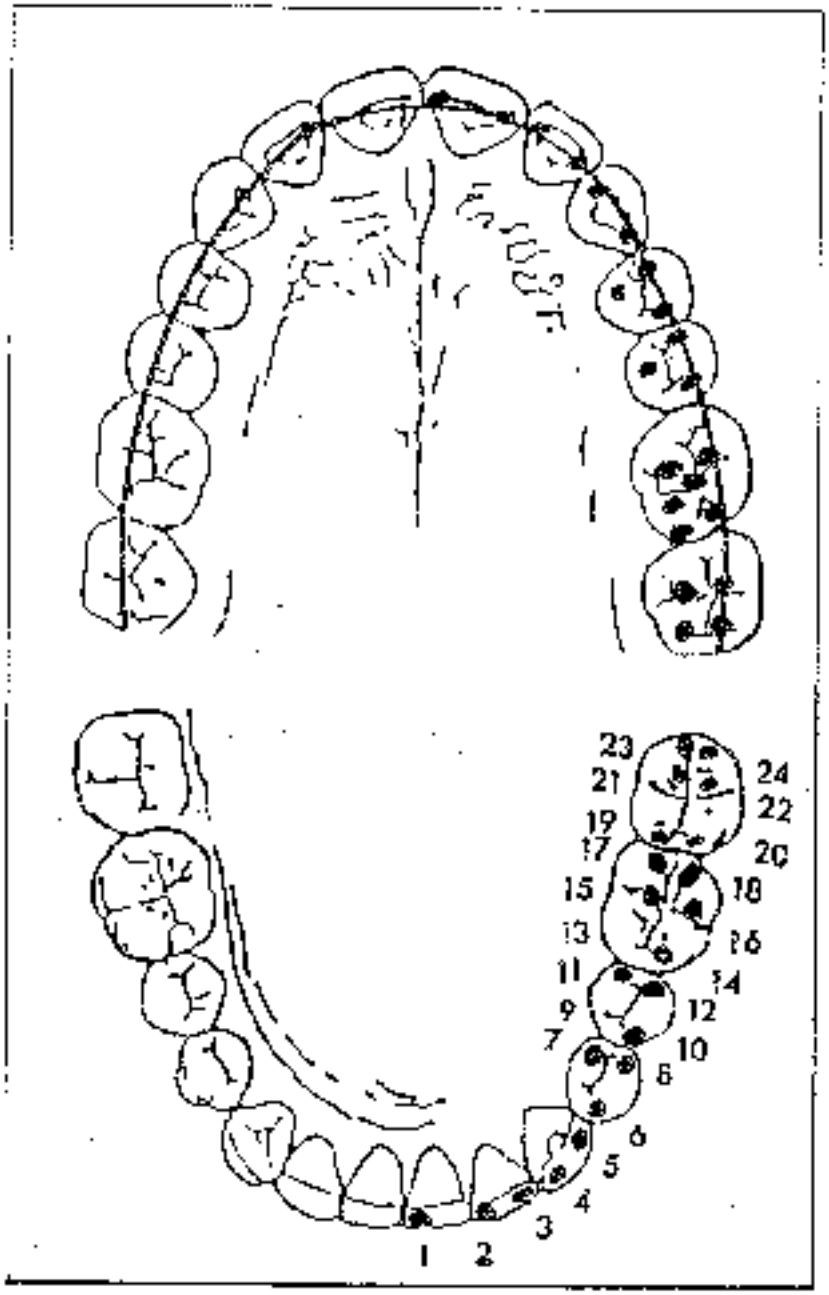
Width dimensions are taken from the widest buccal surface of premolars and molars because that anatomy can be seen in the frontal headfilm. They are definite, repeatable points. The tips of the canines are visible and are employed for measurement. The dimensions found intercanine width, first premolars and the first molar are of greatest value. Rounded out, the numbers are 26 mm., 40 mm., and 55 mm. respectively, with surprisingly low standard deviations.

Comparative Arch Parameters

In order to assess anything, measurements are required and lines of reference need to be established. As samples of untreated normals were analysed certain lines or planes (three-dimensional) became apparent for description and study. One line was termed the buccal line. Another was the buccal occlusal plane.

The Buccal Occlusal Plane

When model after model of the upper were studied there seemed to be a remarkable consistency in the occlusal line of the upper arch (Fig. 5). Seven cusps commonly touched a flat surface. These were: the canine tip, all four premolar cusps and the mesiolingual and distobuccal cusps of the first permanent molar. From that line as a reference the upper central incisor was elevated as a mean of 0.54 mm. ± .053 mm. (Fig. 6). The upper lateral incisor was 1.03 mm. ± 0.50 mm. The upper second molar buccal cusps were elevated 1.95 mm. ± 1.0 mm. This led to the



Occlusogram: By placing articulating paper or other mediums between the teeth in forced occlusal contact, the "contact stops" will be marked on the teeth. Rickells described a possible 30 points of contact on each side with all permanent teeth present. In the absence of third molars and leaving out optional points due to tooth morphology or rotations, an ideal of 22 points was found. This recording and method he called the occlusogram. "Resting points" has also been used in this regard.

Stamp Cusps: These are referred to as cusps residing in the fossa of teeth in the opposite arch.

Fig. 3

Fig. 4

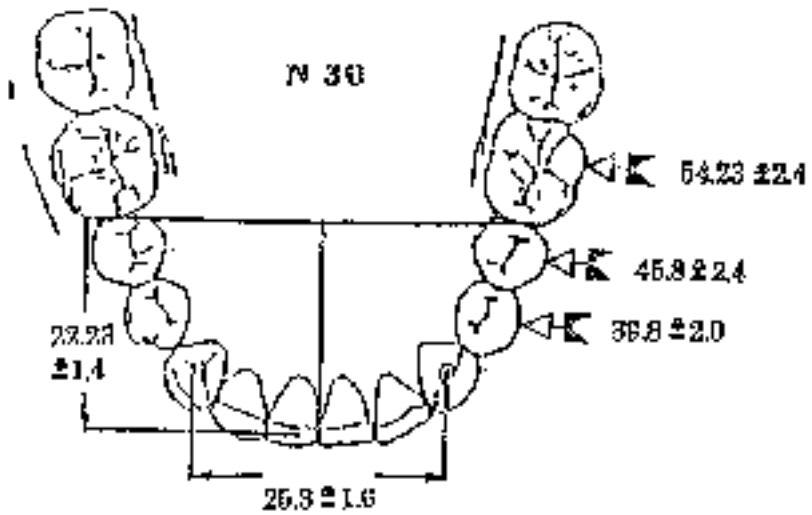


Fig. 5

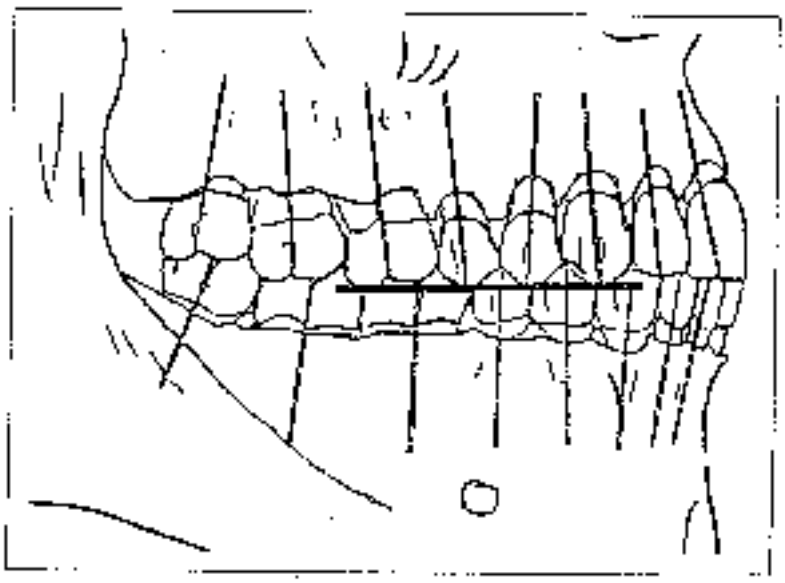
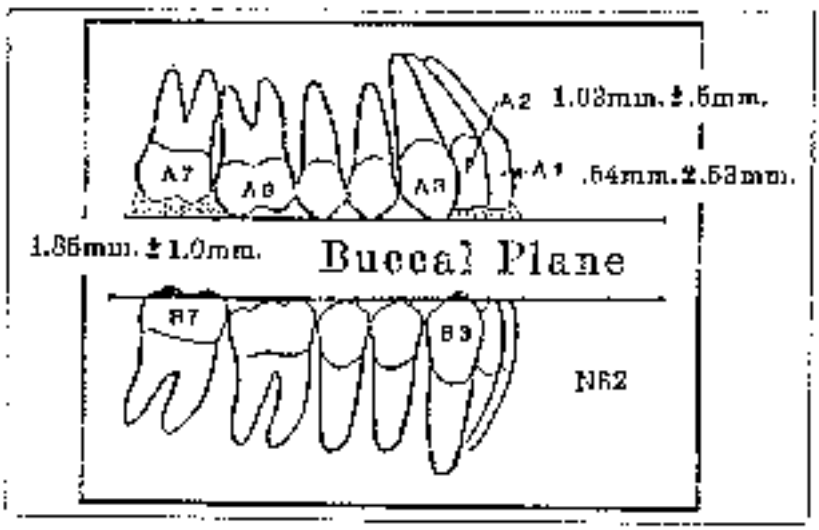


Fig. 6



development of a 2.0 mm. offset tube to the occlusal.

In the lower arch the plane was characterized by only the buccal cusps of the premolars and first molar. However, from that line the lower incisors tended to be also on that level. Thus, the lower plane angles upward under the upper plane when only the buccal cusps are concerned; the curve of the arch starts at the second molars.

The Buccal, Canine and Molar Lines

Surprisingly, on the buccal line in the vertical view many normal models revealed a straight line from the first premolar through the first permanent molar in both arches (Fig. 7). In addition, ideal occlusions tended to display a second line through the buccal of all three molars. This meant a normal change in direction distal to the first molar. Finally, in the lower arch a line tended to exist from the distal of the lateral through the buccal of the first premolar. This again focused attention on the lower first premolar position.

With the buccal line as a reference, the second molar is lingually positioned a mean of 1.9 mm. ±1.01 mm. in the upper, and 2.08 mm.±1.02 mm. in the lower. This measurement points out a most common error in orthodontics, as one laboratory reported that 99% of cases received for positioners had the second molar directly on the buccal line.

Molar Angulation and Torque

When bands are placed precisely at the marginal ridges of molars, no angulation is required for the upper and no torque is required. Forty (N=40) skulls studied with **bands placed with tubes premounted** showed for the first permanent molar a mean of -0.95° but a standard deviation of ±7.69°. This hardly made the torquing of the tube worthwhile. The second molar also showed a wide variation with a −1.11° mean ±8.09°. This too is so slight for these large teeth that it made preadjusted torquing designs insignificant.

The lower molar is a different case. It needs a 5° distal inclination from the

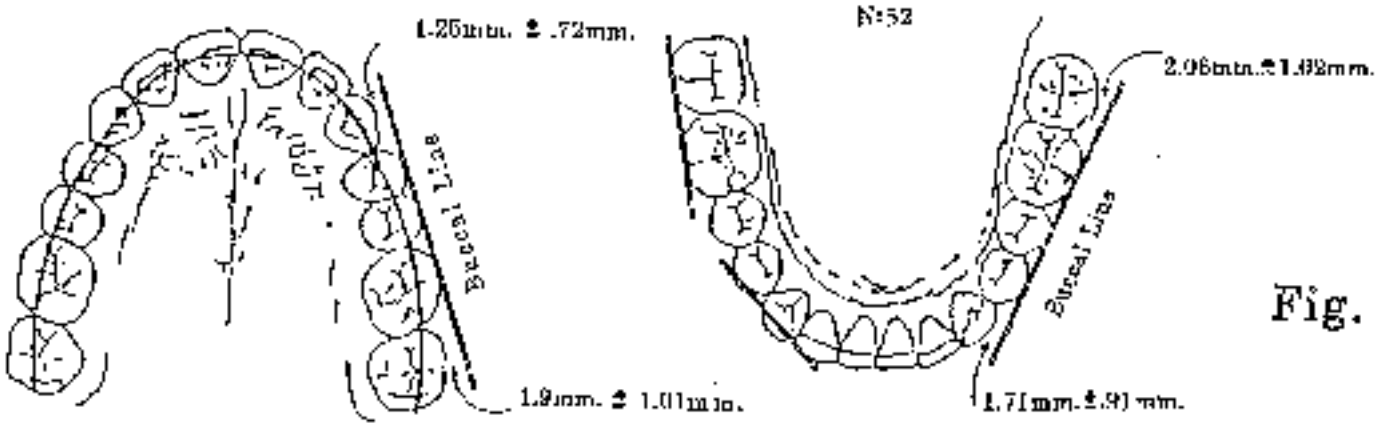

1.26mm. ± .72mm.
N=52
2.96mm.±1.92mm.
Buccal Line
Buccal Line
1.9mm. ± 1.01mm.
1.71mm.±.9) mm.

Fig. 7

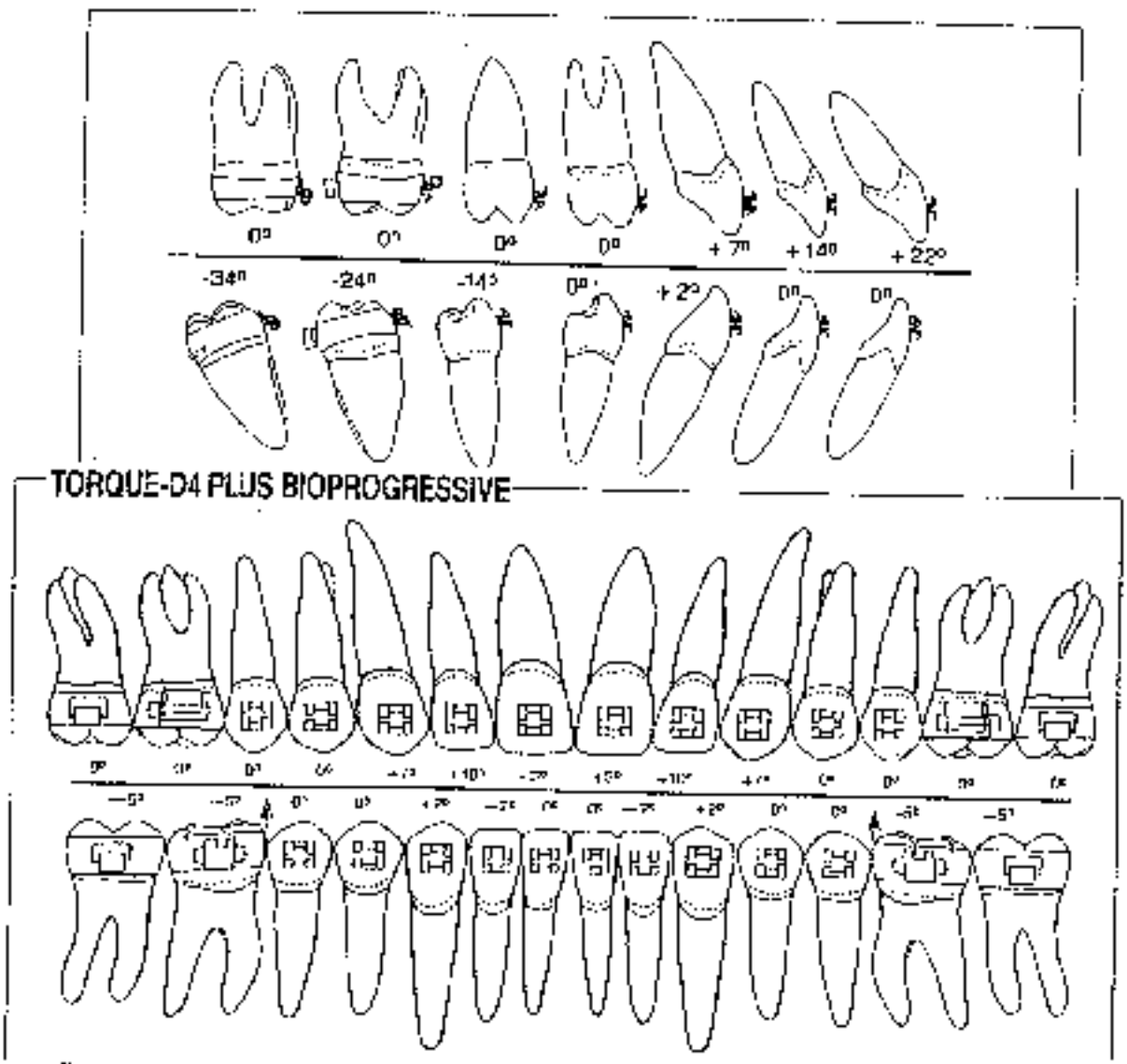

TORQUE-D4 PLUS BIOPROGRESSIVE
RMO ANGULATION-D4 PLUS

Fig. 8

proximal ridges (tube down on mesial) as was established in 1952 (Fig. 8). It also requires 24° torque. The second and third molars increased 10° progressively from the first molar and the second premolar decreased 10°.

Canine Position

The upper canine, due to its thickness, falls inward 1.25 mm. ±0.72 mm. while the lower canine, being thinner bucco-lingually, is located 1.71 mm.±0.91 mm. from the buccal line. This shows clearly that the canine does not lie in the buccal plane or in line with the premolar buccal cusps (see Fig. 7).

Horizontally the upper canine in Class I resides distal to the lower canine. Measured in the labial canine line perspective the upper canine is 2.85 mm.±1.06 mm. distal to the lower.

Canine Inclinations and Torque

The ideal position of the canines has remained controversial. Individual cases can be found to represent virtually any idea, but Nature's arrangement for stability is sought. Experiments were set up on thirty-one Class I skulls for the right and left sides, making a total of sixty-two (N=62). Bands were placed on the canines with +7° torque brackets with 5° angulations which were prefabricated. Rectangular wires were bent at right angles, and 45° oblique headplates were recorded. Measurements when corrected for the torque and angulation were.

Upper canine angulation	-6.2°±7.3°
Upper canine torque	−5.8°±12.6°
Lower canine angulation	−1.6°±8.7°
Lower canine torque	-3.1°±6.9±°

After these findings were made the formulas for the lower preadjusted brackets were reduced to 2° torque and 2° angulation (see Fig. 8). The extreme variation encountered explained why so many different formulas have existed.

III. Arch Form

Three different studies of adequate samples led to the conclusion that essentially five arch forms characterize an orthodontic practice (Fig. 9). Models untreated and long-term stable treated results (N=40) were analyzed. Post-treatment orthodontic casts were analyzed in two hundred thirty cases (N=230). Frontal cephalometric studies were conducted on twenty normal skulls (N=20).

The results showed two conditions of great interest. First was that the arch form and size of the upper and lower were remarkably similar. Second was that the orthodontic population fell essentially into five major forms shown.

Pentamorphic Arches

The normal form, at 37.5%, and the ovoid, at 25%, made up almost two-thirds of the cases. The tapered, at 15%, and the narrow tapered, at 12.5%, represented about one-fourth of the cases. The narrow ovoid, characteristic of many commercial arches in 1976, was only 10%. Since then the arch forms requested from manufacturers have changed more toward the normal form.

IV. Root Ratings

The surface-bearing area of root needs to be reviewed as a part of the subject of occlusion and particularly anchorage differentials (Fig. 10).

Our theory is that **one gram of force per one square millimeter of root surface** in the direction of movement is the starting base for movements of teeth within the alveolar and for tooth intrusion. These values are to be different for affecting changes in the cortical bone of the ridge where they are cut in half. In establishing cortical anchorage, however, they are doubled and tripled. Heavier pressure may move teeth faster but will also tax anchorage needlessly. Also, greater pressure may resorb roots. The value of each tooth in three dimensions should be memorized as a starting base. The individual clinician can change the force per unit

PENTA-MORPHIC® ARCHES

RICKETTS®

Arch Selector

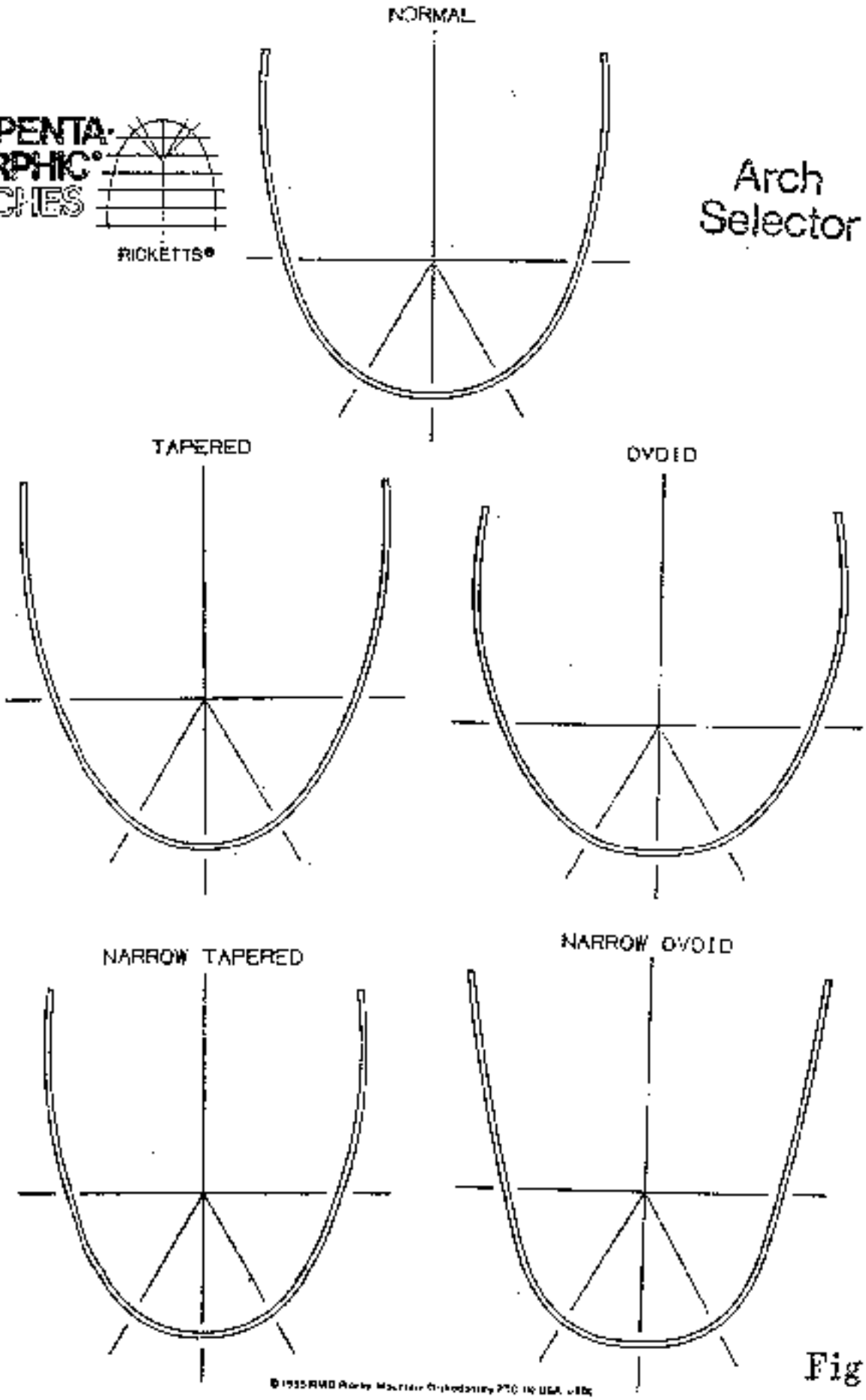


Fig. 9

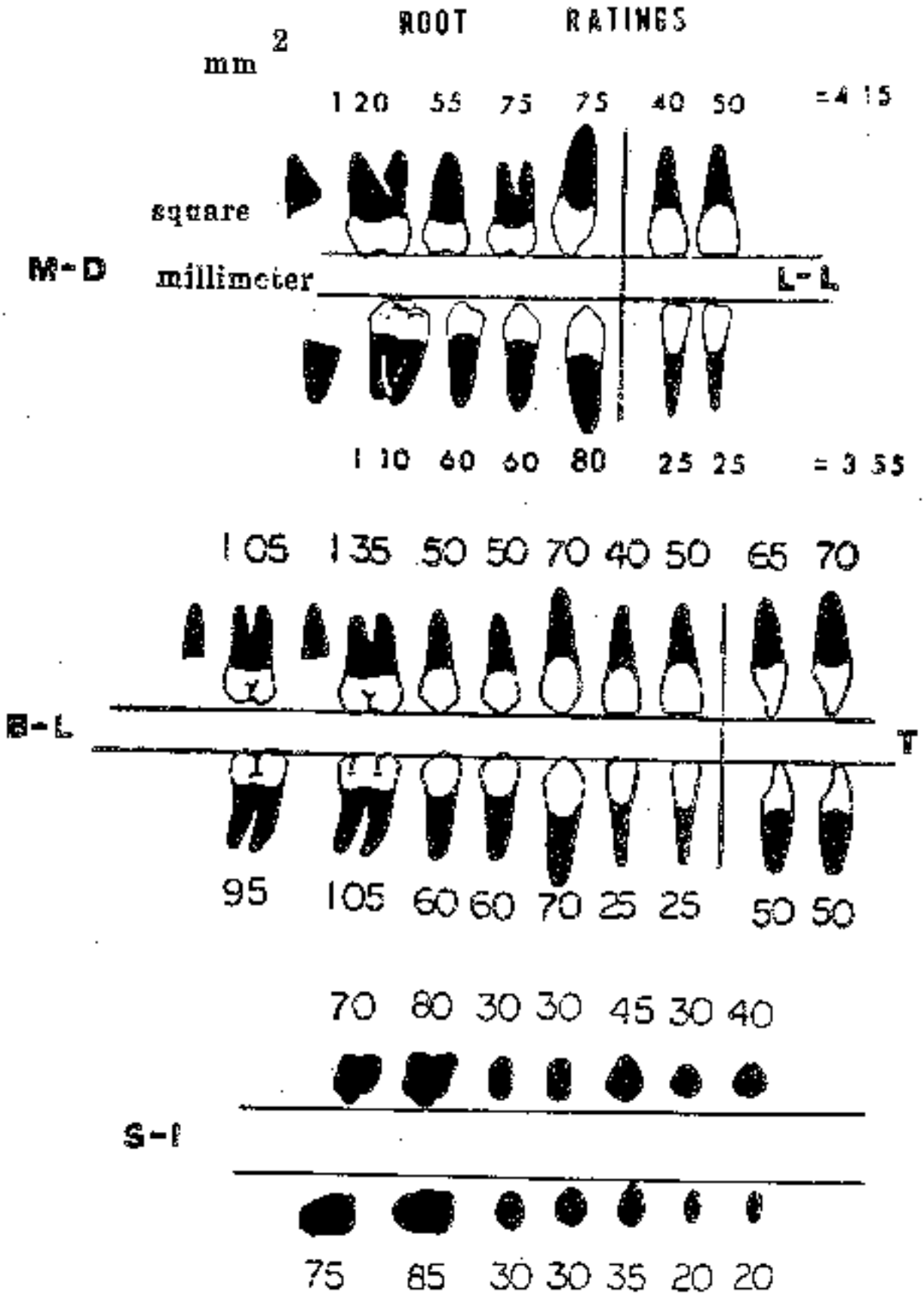

ROOT RATINGS
mm 2
1 20 55 75 75 40 50 =4 15
square
M-D
millimeter
L-L
1 10 60 60 80 25 25 = 3 55
1 05 1 35 50 50 70 40 50 65 70
B-L
T
95 105 60 60 70 25 25 50 50
70 80 30 30 45 30 40
S-I
75 85 30 30 35 20 20

Fig. 10

ares as he chooses, but care should be taken for anchorage loss and integrity of the bony crests.

SUMMARY

More than two dozen individual studies were performed to determine the nature of the fit of the teeth and the characteristics of normal morphology. For greater detail the reader is referred to *Provocations and Perceptions in Cranio-Facial Orthopedics*.

Six keys were offered as checkpoints for analysis. The consideration of the lingual occlusion justifies the occlusogram because in the living patient they cannot be viewed from the lingual.

Arch dimensions, arch form, and teeth positions were described. Size and morphology of roots permit a rating scale for clinical use.

CONSUMMATE OCCLUSION

CHAPTER FOUR
THE CLINICAL SCIENCE OF OCCLUSION

I. Introduction

Science by definition implies systematic analysis and exactness. Absolute certainty in biology is virtually impossible. However, generalizations and principles need to be presented which apply to everyday circumstances. Description is the first level of science. Facial growth and occlusal development need to be related for the occlusionist to understand how things get to the state they become.

Thus the characteristics of development, the forces of occlusion that operate, and the prediction of outcomes serve as the basis for profundity at the clinical level.

II. Skeletal Growth of the Jaws

Stated succinctly, the facial bones form a matrix for the oral cavity, and the cranial base comprises the superstructure for their support. Computer research led to the location in the lateral view of a general center from which radial development occurs. Like rays from a center, growth behavior tended to branch out in all directions as if it were radiant energy at work (Fig. 1). Gnomons also were observed to display the vertex of angles or bases at the entrance of neurotrophic bundles (Fig. 2). The center was most commonly at the sphenopalatine area, specifically at the foramen rotundum. The gnomonic behavior or bases for allometric formation was located at the divisions of the fifth nerve and labelled the Polar Phenomenon.

In the frontal view transverse growth was evaluated. A Bipolar Phenomenon was found because two nerve and blood supplies are present (Fig. 3). Values for

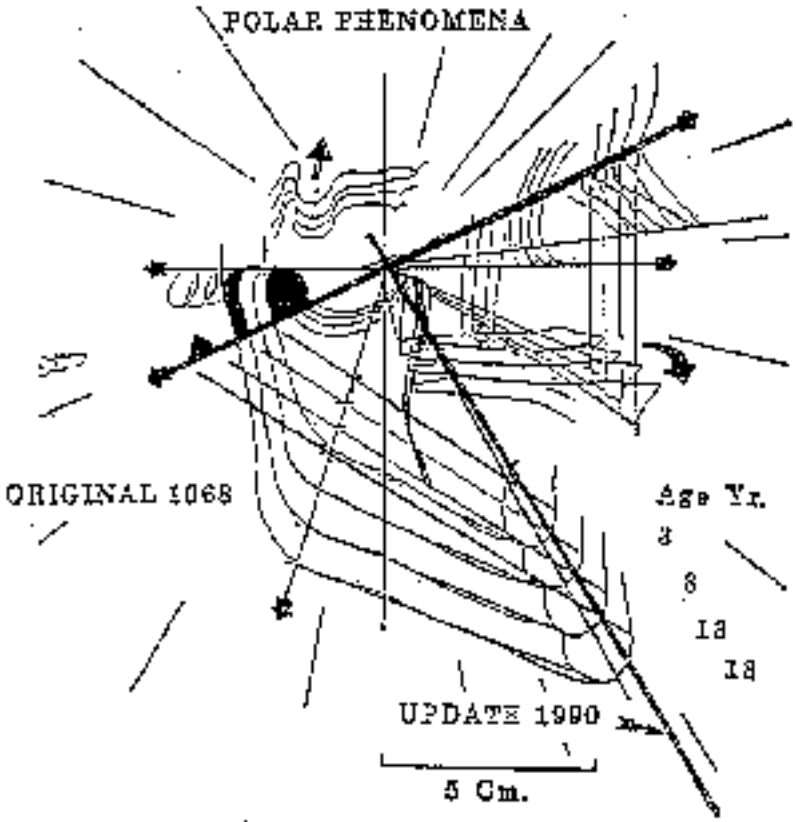

POLAR PHENOMENA
ORIGINAL 1068
Age Yr.
3
8
13
18
UPDATE 1990
5 Cm.

Fig. 1

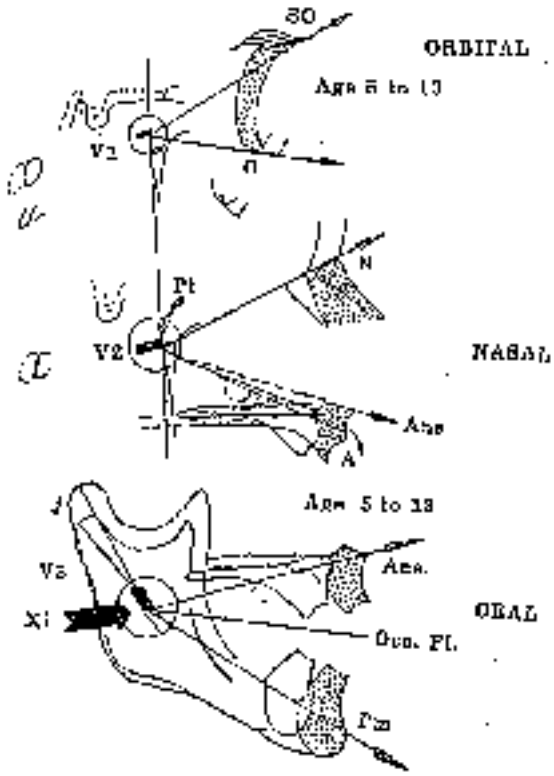

SO
ORBITAL
Age 5 to 13
V2
N
Pt
V2
NASAL
Ang
A
Age 5 to 18
V3
Aes.
XI
ORAL
Occ. Pl.
Tm

Fig. 2

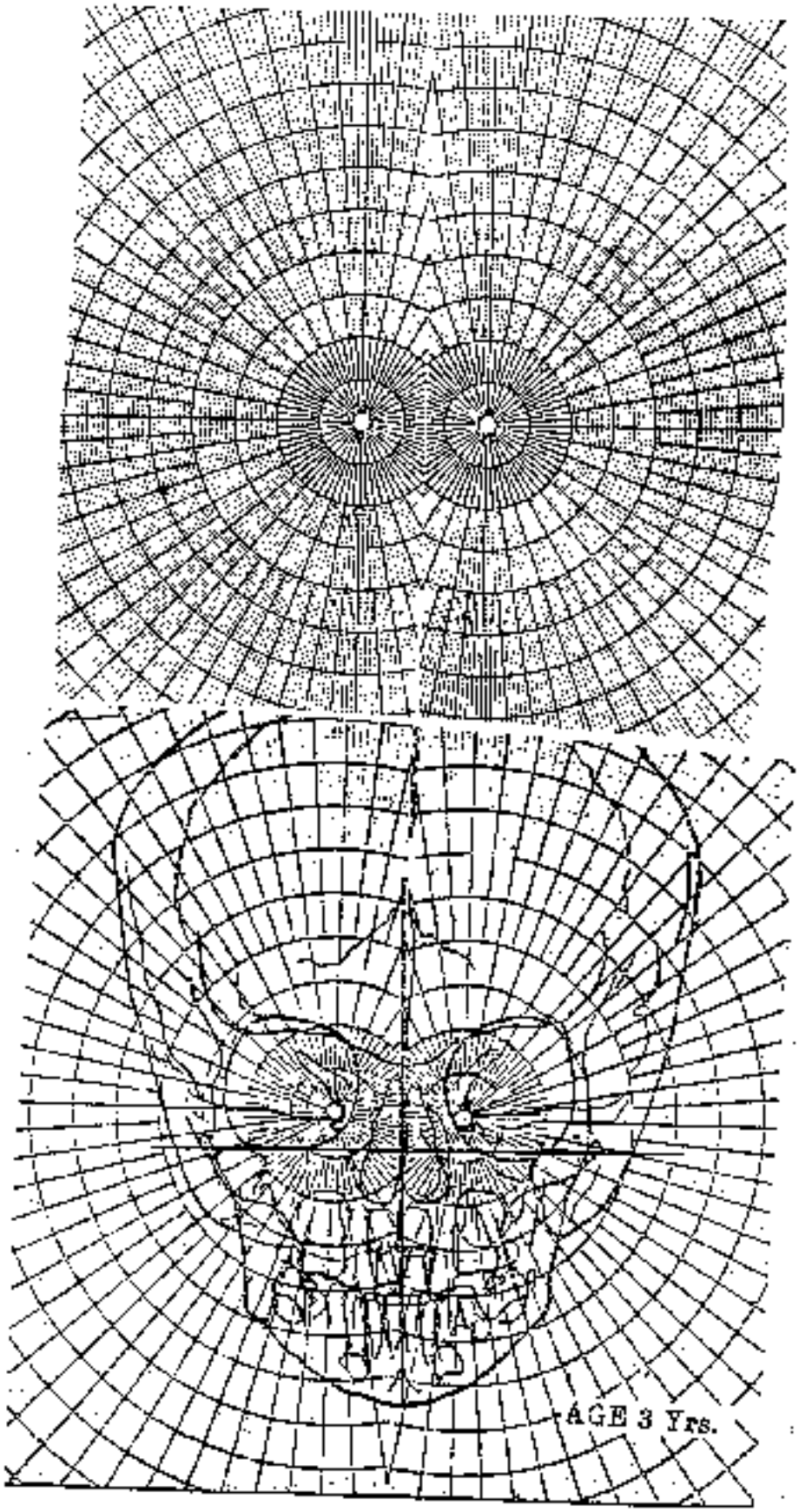


Fig. 3

growth increases in the nasal cavity (Ne), the upper jaw (J), and the mandible (Ag) (trihedral entrance) were determined. These serve as basic references for morphologic analysis and growth or treatment changes in the frontal as well as the lateral (Fig. 4a and Fig. 4b).

The corpus axis condyle axis was seen to bend or close with natural growth by about 0.6° per year. This suggested a growth arc of some nature. Points were located at the base of the coronoid process and protuberance mentis which were used as the radius to form a working growth arc and which appeared to be the leg of a logarithmic spiral (Fig. 5). Thus the mandible, it would seem, tends to grow not unlike the ram's horn.

Positional Analysis for the Chin and Point A

In order to display and analyze change in a systematic way, a simple positional analysis was proposed for the mandible, represented by the chin, and for the maxilla, represented by the palatal plane at ANS and Point A.

Position One using the Basion-Nasion plane at Cc Point, revealed the greatest order. A mean increase of 2.5 mm. was seen. The chin at Gnathion moved forward (or the axis rotated) less than 2° in ten years (Fig. 6).

Position Two was determined by shifting forward to Nasion on the BaN Plane. The behavior of the angle BaNA was almost absolutely constant. Rarely indeed did normal growth show a reduction of this angle. Although some subjects displayed very minor increases in this angle, nevertheless the orderliness of behavior is remarkable.

These two positions simplified growth and behavior analysis.

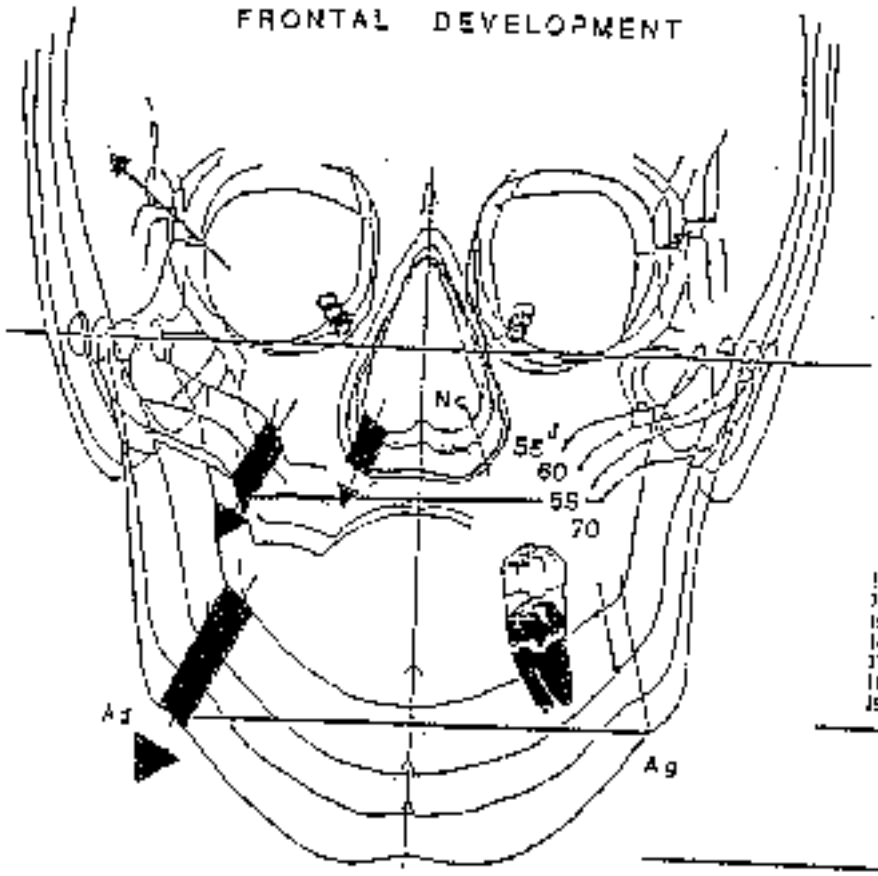
III. Development of Occlusion

References are likewise needed for the development of occlusion. For the maxillary teeth the traditional palatal plane (at ANS) was not improvable even though drift with growth is known. The occlusal plane drops posteriorly, and the

Nc

Age [illegible]	Age 10—25.5	Age 17—29.0
[illegible]	11—26.0	18—29.5
[illegible]	12—26.5	19—30.0
[illegible]	13—27.0	20—30.5
[illegible]	14—27.5	21—30.0
[illegible]	15—28.0	22—32.5
[illegible]	16—28.5	23—33.0

FRONTAL DEVELOPMENT



Age 6—1.4 mm		
[illegible]—1.2		
8—6.0		
9—7.8		
10—7.6		
11—8.4		
12—9.2		
13		10.0
14	Bs	10.8
15		11.6
16		12.4
17	Males	13.0
18		14.2
19		15.0

Age 5—68.25	Age 10—77.50	Males
6—69.6	11—78.05	Age 17—82.38
7—70.05	12—79.40	18—78.50
8—72.50	13—81.75	19—80.35
9—73.55	14—83.10	20—81.20
10—75.0	15—84.45	
11—76.25	16—85.80	Ag

Fig. 4a

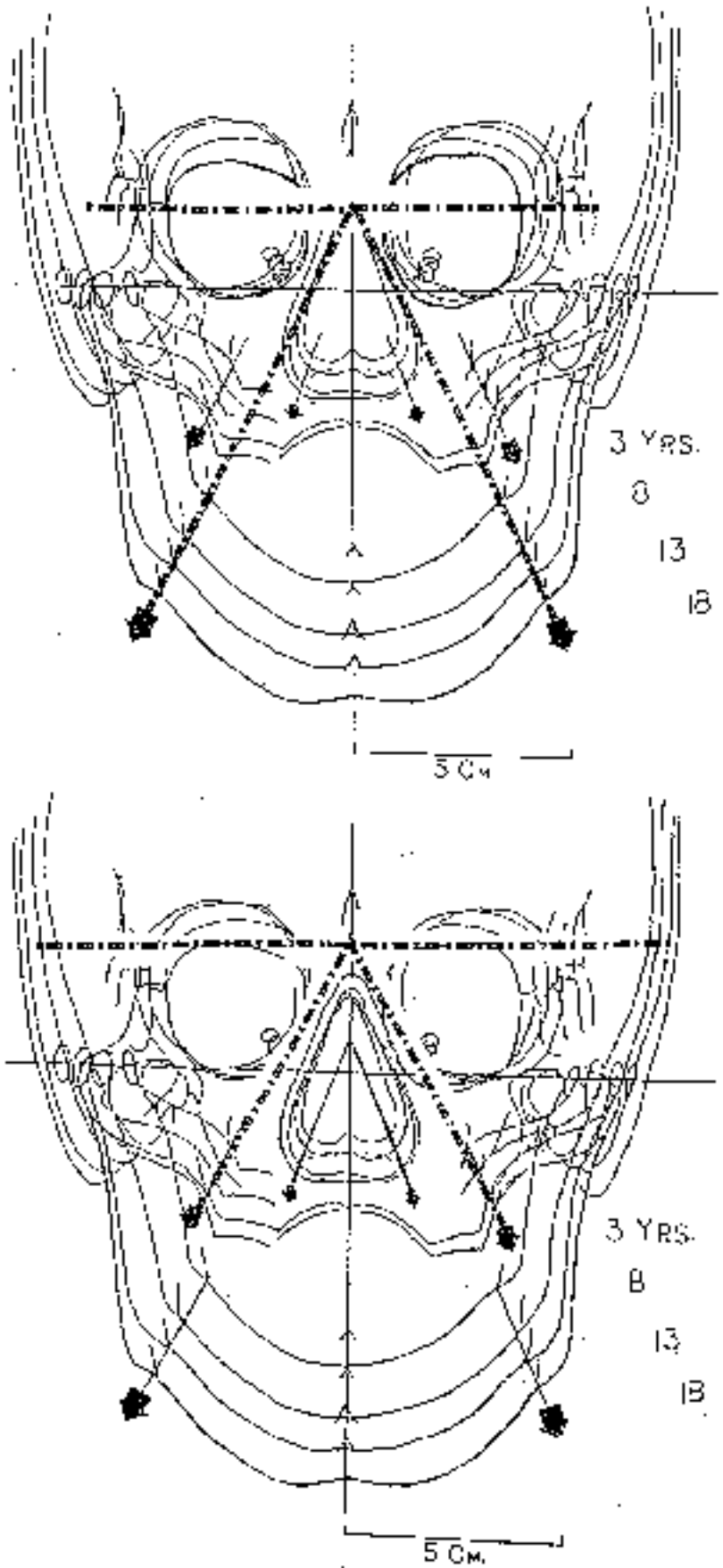


Fig. 4b

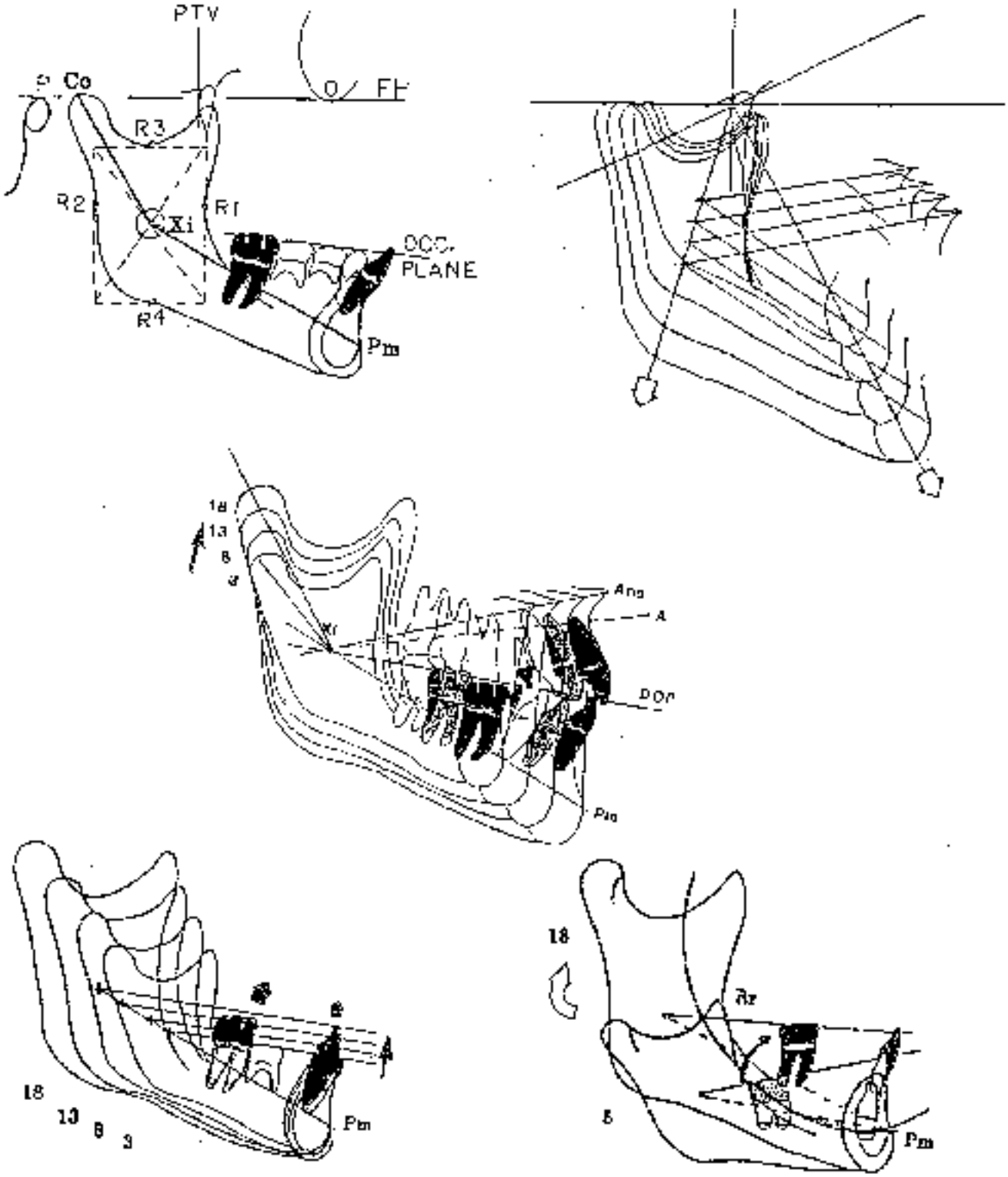
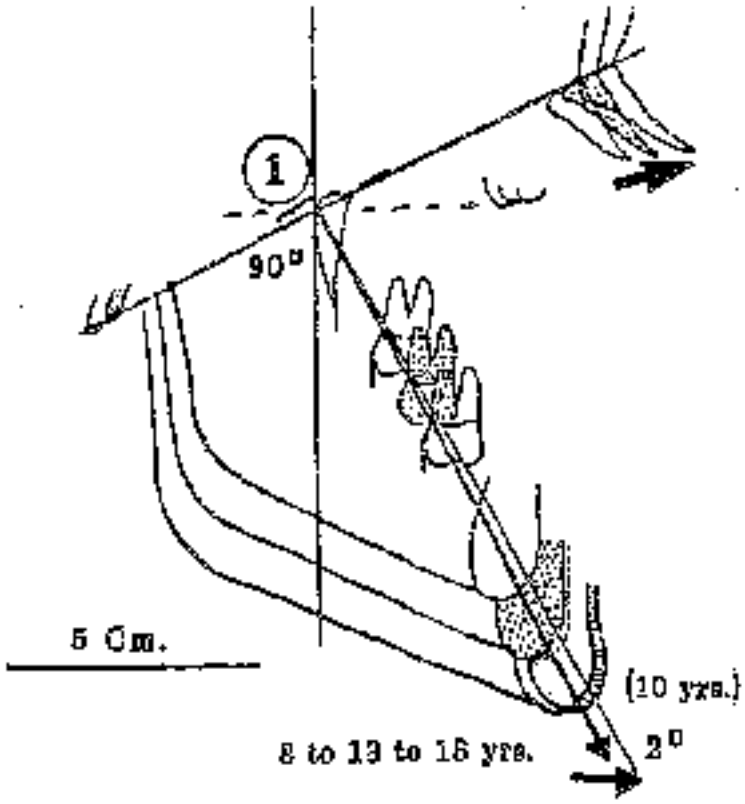

PTV
Co
O
FH
R3
R2
R1
Xi
R4
OCC.
PLANE
Pm
18
13
8
3
Ang
A
DOr
Pm
18
13
8
3
Pm
18
Ar
5
Pm

Fig. 5



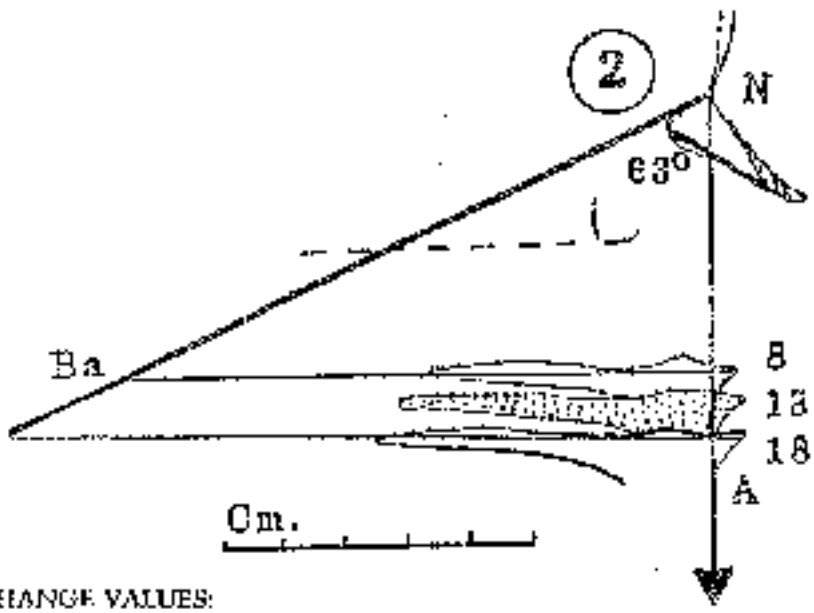
POSITION ONE

FUNCTION: Indicator of Direction and Amount of Growth (or change in chin)

CHANGE VALUES:

Direction: 0° (+2° in 10 years)
Standard Variation:
1.5° at 5 years
2.0° at 10 years

Amount: 2.5 mm. each year,
or 10 mm. each 4 years.
C.D. = ± 0.5 mm. each year



POSITION TWO

FACTOR: Basion-Nasion at Nasion

FUNCTION: Indicator for Direction and Amount of Growth (change) in Anterior Maxilla

CHANGE VALUES:

Direction: 0° Standard Variation ± 1.0
(Very rare cases slightly +)

Amount: For ANS Vertical,
1.15 each year.
C.D. = ± 0.25 each year.

Fig. 6

denture migrates forward in the process (Fig. 7). A third position is thus established in which the denture develops 0.7 mm. per year posteriorly and 0.4 mm. per year anteriorly, while the denture moves forward 0.3 mm. per year.

The fourth position requires the use of Xi Point at the centroid of the ramus. As this is connected to Pm point, the corpus axis is constructed. The beauty of its usefulness lies in the order it displays to the occlusal plane (Fig. 8). The molar and incisor tend to develop upward vertically in parallel. The molar tends to develop at right angles to the original corpus axis at about 0.5 mm. per year. The incisor erupts bodily backward about 0.7 mm. per year from this vantage point.

From the arc of mandibular growth, which is biologically the true picture, the occlusal plane follows Xi Point, and the entire denture moves forward in order to create posterior space for succeeding molars (Fig. 9).

Forces of Occlusion

Angle described "forces of occlusion" that were held to operate during the development of occlusion. Others have been added and put into a hierarchy.

The force of **eruption** has been theorized to be about 0.2 grams per mm. of the circumference of the root.

There is a mesial component of **drift** that apparently comes from the molars. This would be estimated to be less and possibly also the result of function.

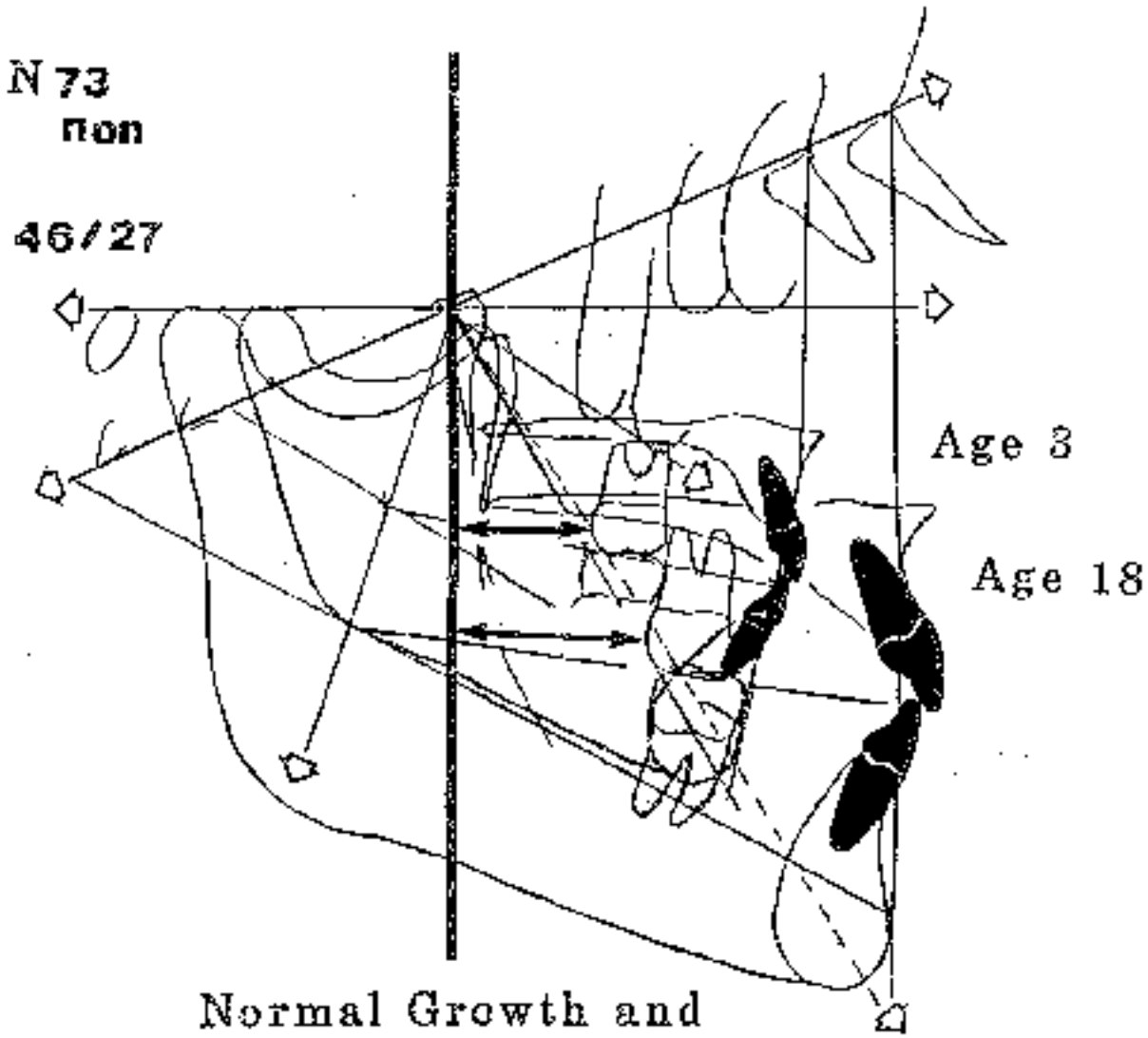
The **incline plane** becomes a guiding influence, hence the importance of tooth position at the time of eruption.

The resting and active pressure of the lips **and tongue musculature** are factors in development and retention.

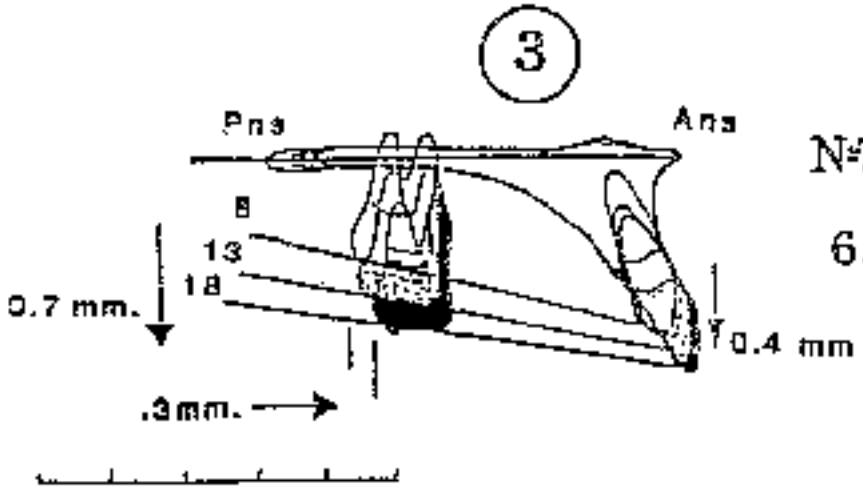
The **muscles of mastication** are also limiting elements as well as driving elements for the operation of milling the occlusion into a unit.

Growth of the jaws constitutes a force.

Pain is a factor that cannot be discounted.

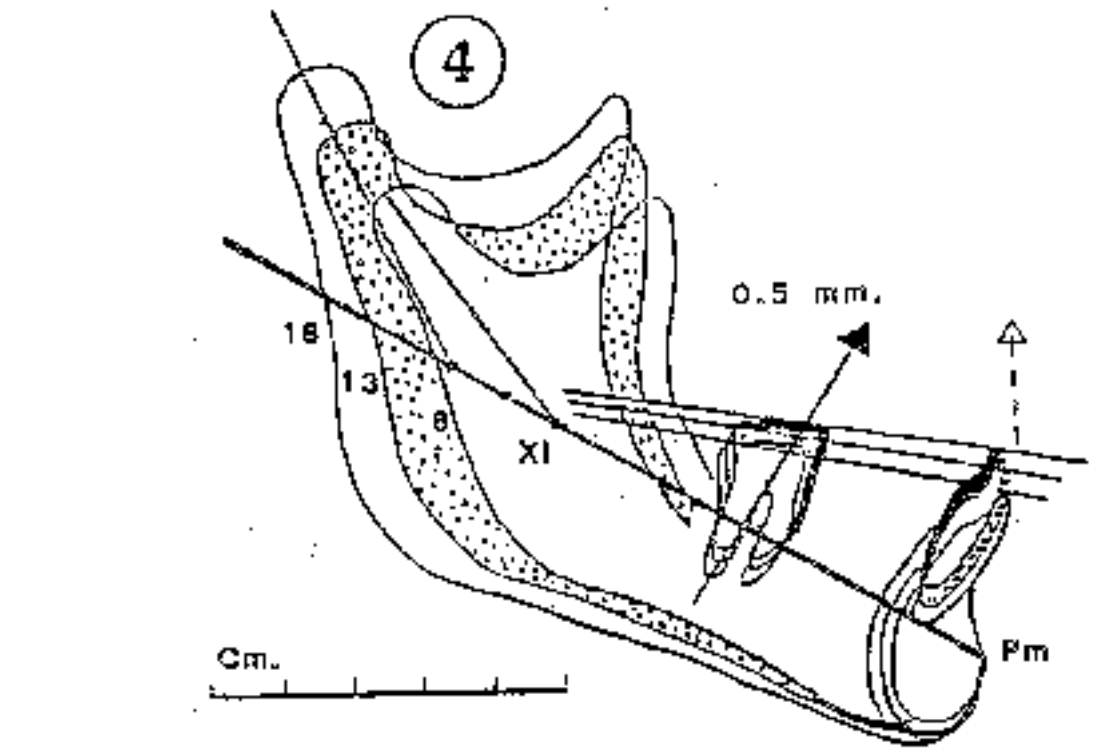


Normal Growth and
Developement of Occlusion



N=73 Untreated 46/27
M F
6.7 Yrs. to 18.4

Fig. 7



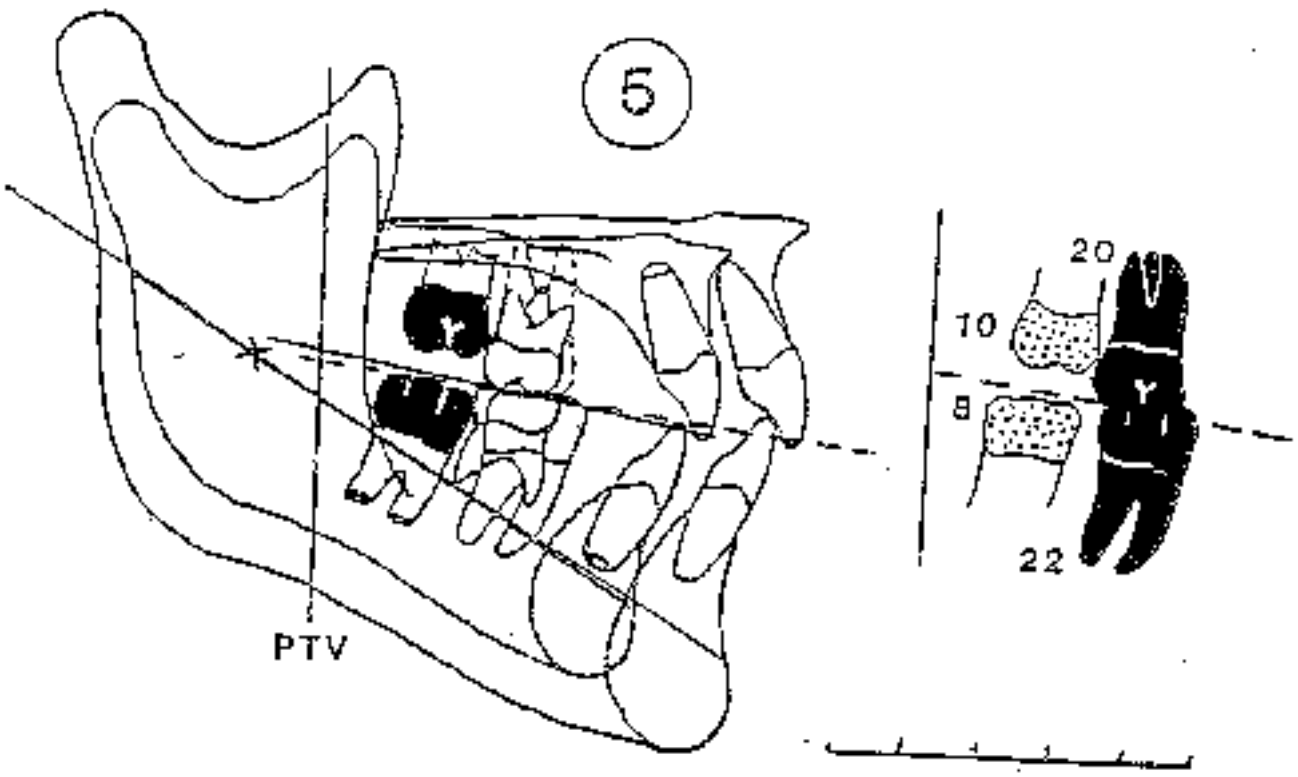


Fig. 8

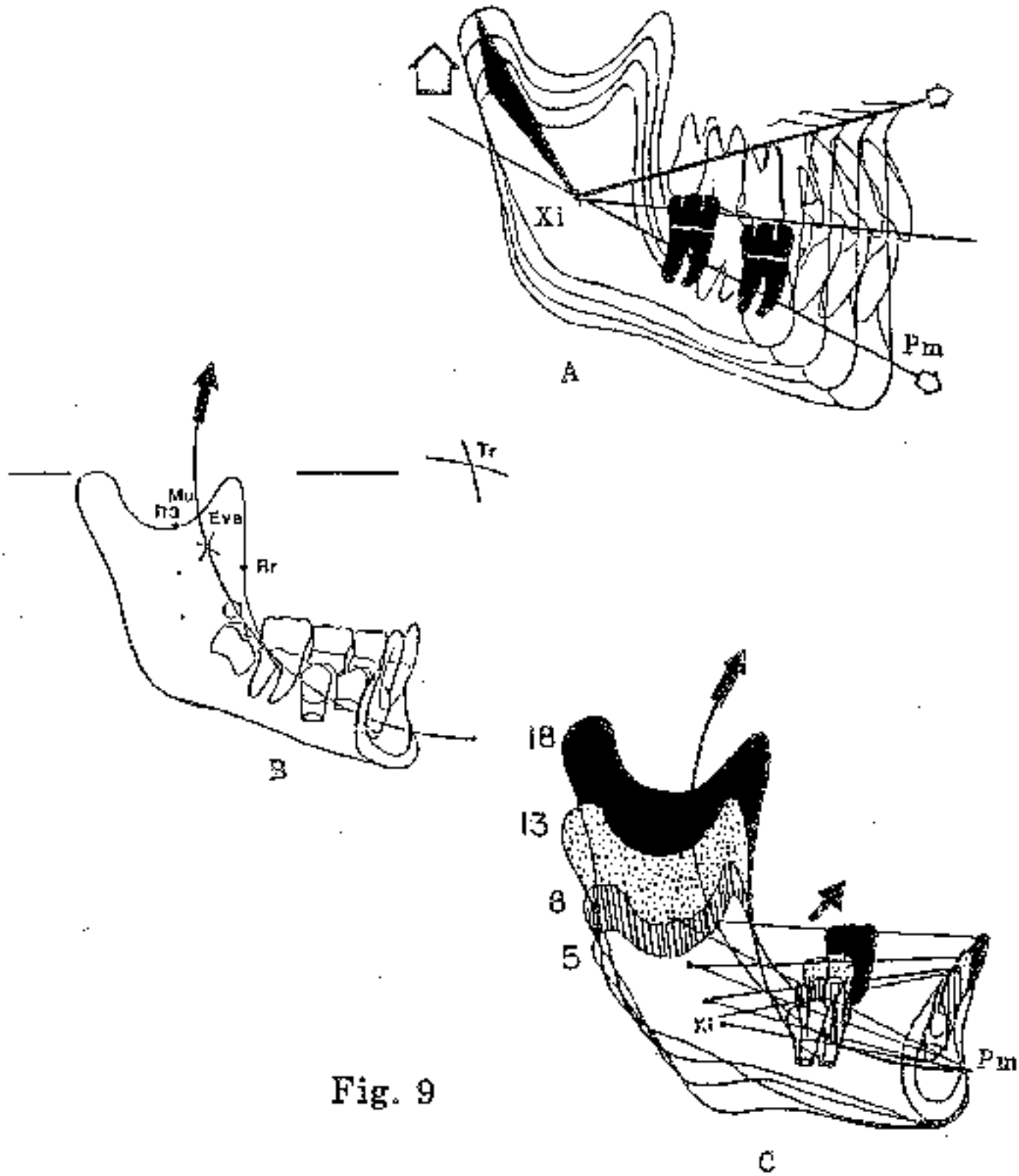


Fig. 9

Degenerative changes in the condyle lead to changes in occlusal relations, particularly progressive opening of the bite (Fig. 10).

Semantics

Certain terms need explanation, while others need clarification.

Compensation is a term employed to define the process of tooth positioning to the skeleto-muscle apparatus. The lower incisor in particular compensates in response to the convexity of the face and also to lower face height (Fig. 11).

Adaptation is limited to the sense of the process by which the neuromuscular system learns to function around the denture with development or treatment.

Relapse is a term employed to describe conditions returning to their previous state.

Metapositioning is a normal process following treatment in which the forces of occlusion operate to finally place the teeth into congruous states. It is the normal settling process towards idealism and should not be confused with the concept of relapse (Fig. 12).

IV. Pathologic Occlusion

Health is not a state of cure of a disease but rather freedom from the likelihood of having a disease or infirmity.

"Pathos" means diseased, and pathology means the study of disease. An alteration of function, loss of efficiency, atrophy or hypertrophy, resorption, osteoporosis and other conditions occur without inflammation, but all are pathological. What is sometimes called adaptation is actually pathology.

A review of records of patients referred for temporomandibular problems resulted in a list of 100 complaints or symptoms. These were classified in six categories. However, the immediate pathology of occlusion consists of muscle symptoms, pain (anywhere in the apparatus), attrition, mobility of teeth, and lesions

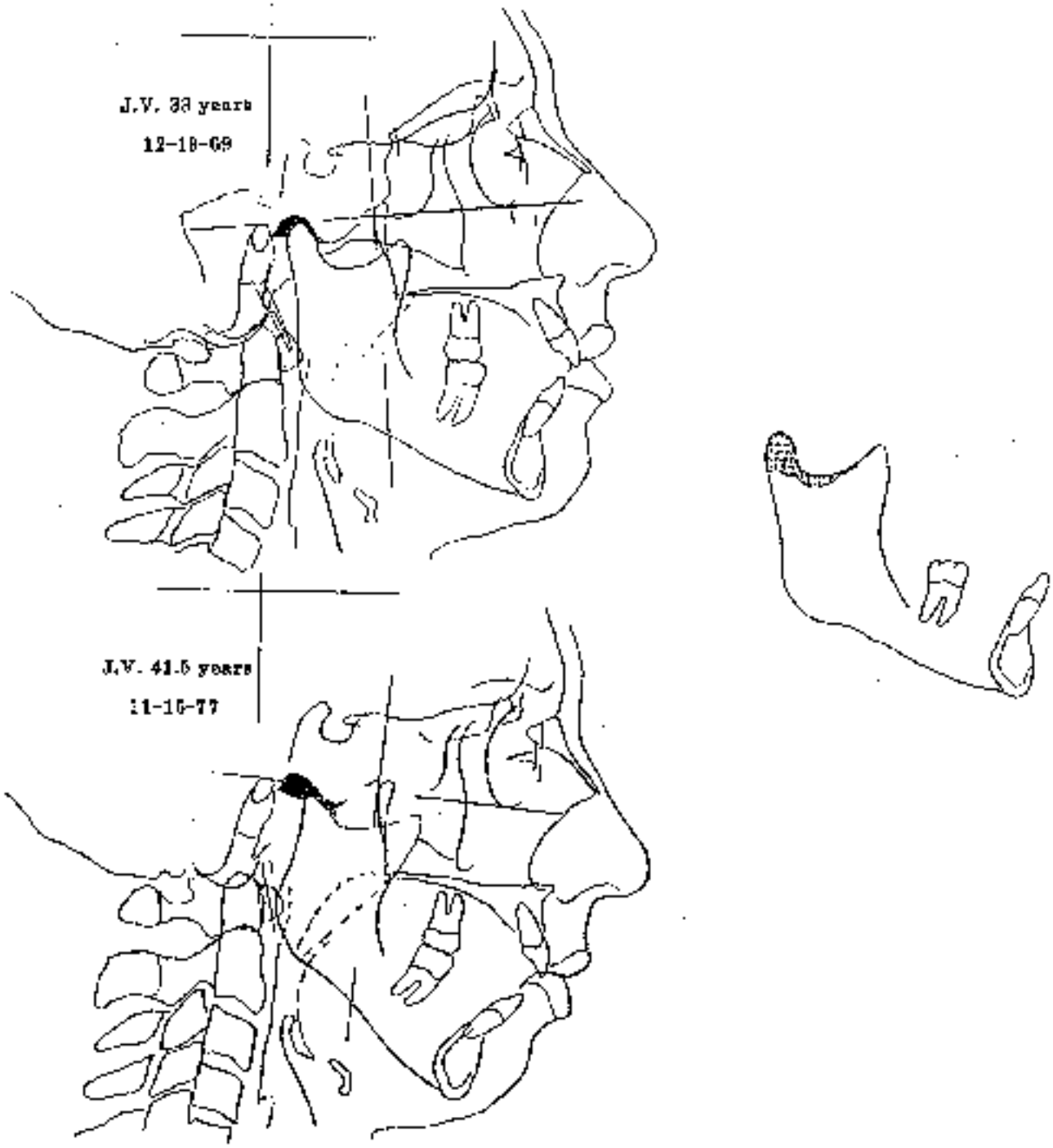
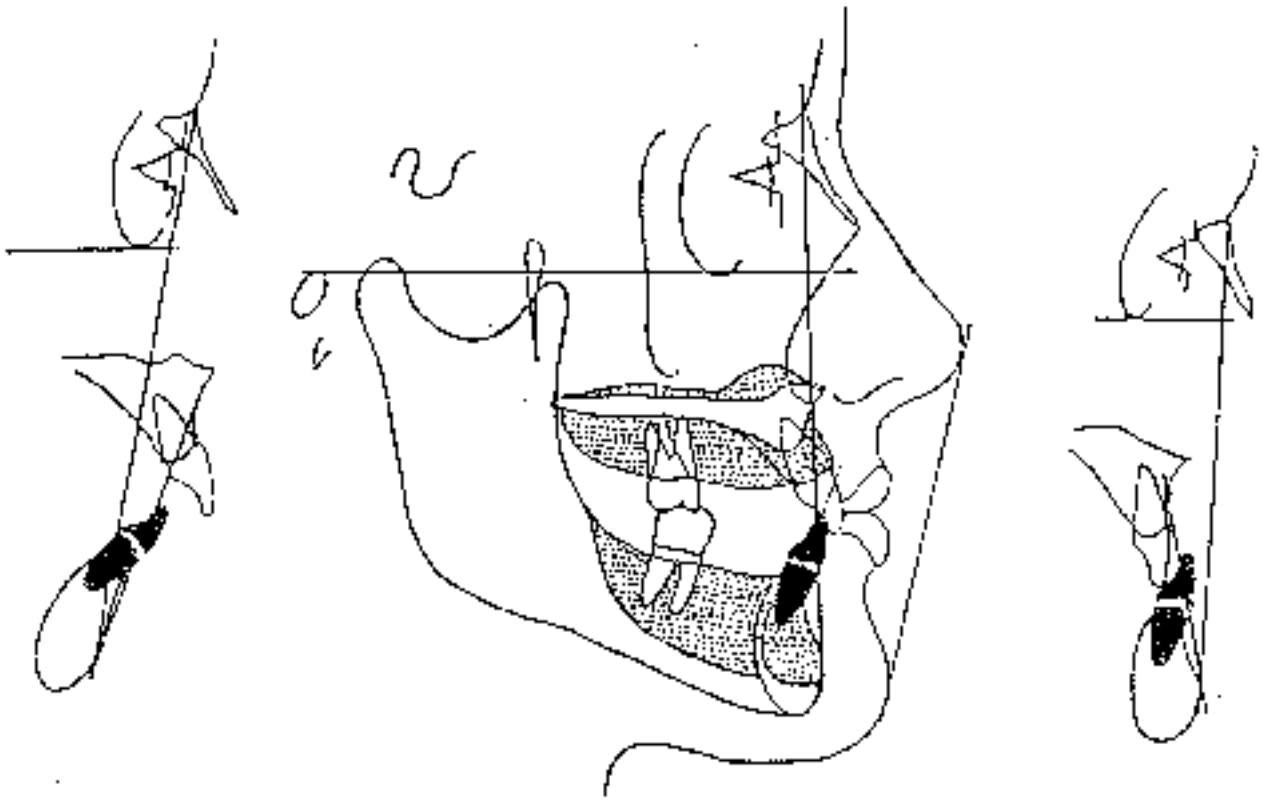


Fig. 10



DENTURE COMPENSATION

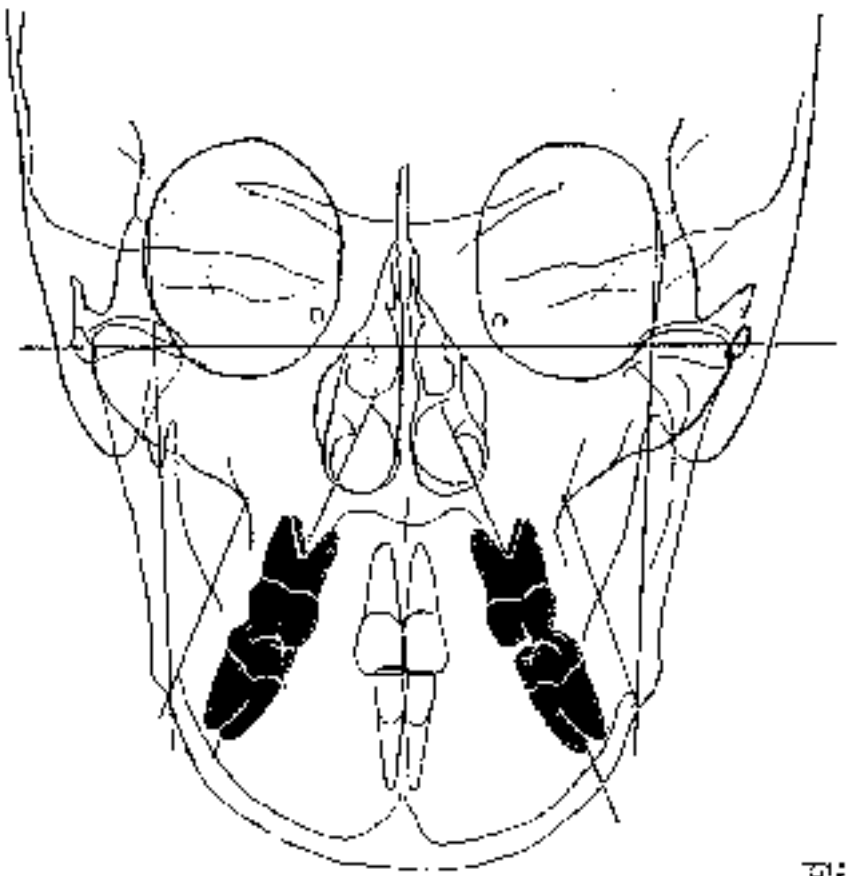


Fig. 11

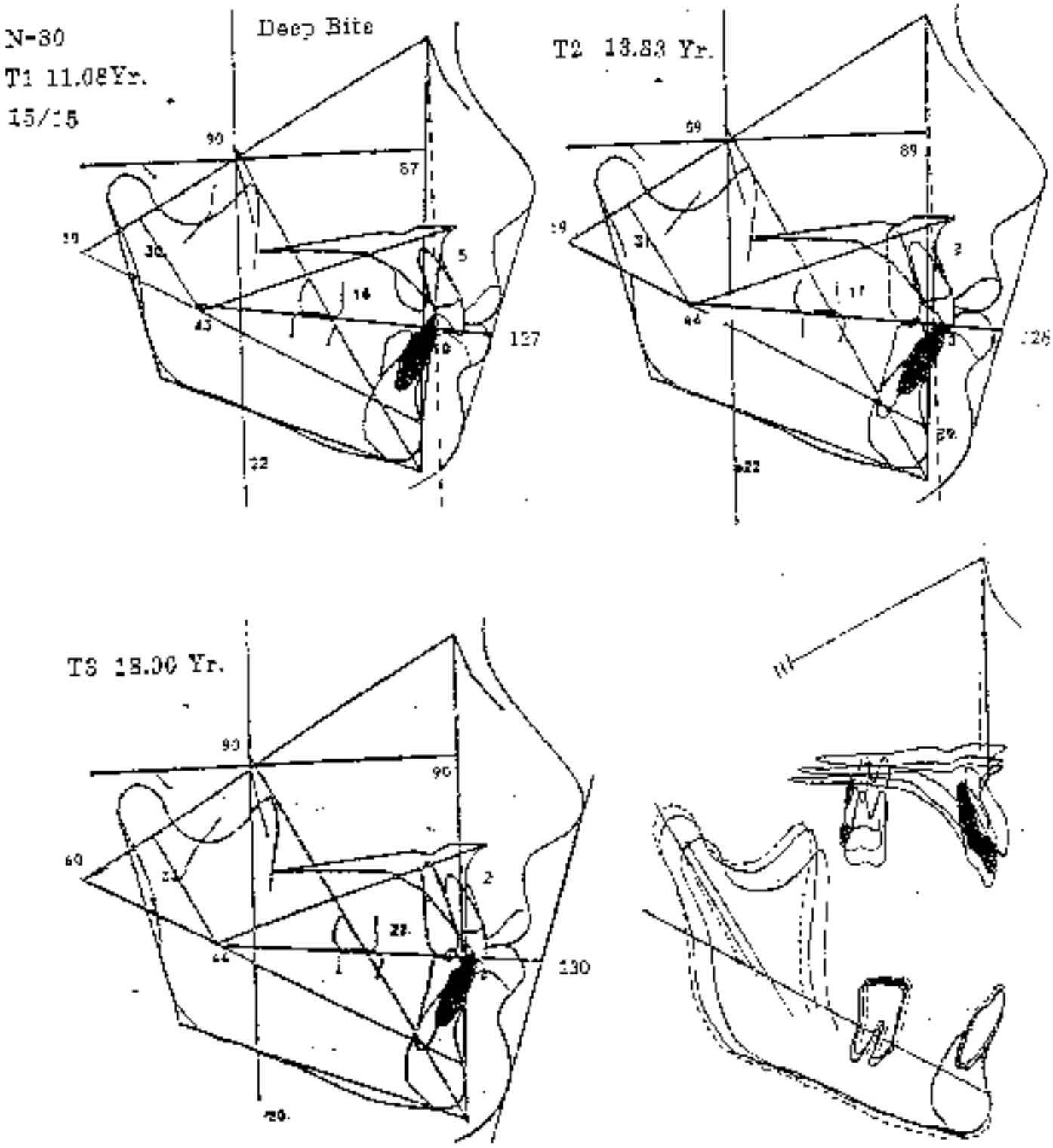


Fig. 12

of soft tissue.

V. Aging of Occlusion

Older people display quite a variation in the life of the dentition. There is much evidence that the potential in human life is 120 years. Thus the teeth after age 60 must last longer than they have up until now survived. With already a life expectancy of 80 years, our children today may have an expectancy of 100 if prudent living standards are practiced.

Caries has ravished occlusion in the past. Missing teeth are decidedly a factor in patients' dental longevity welfare. The second most critical factor is periodontal disease, which is also progressively being related to the immune system. Attrition is a factor which is connected with diet and with habits and stress.

Geriatric dental studies by the author in a veterans' hospital population failed to support the theory of loss of vertical facial height when teeth were present. The loss of teeth was correlated with circumferential muscle changes. The mandibular form did not "age" in the absence of degenerative joint disease.

Theoretically, hypercementosis can accommodate normal occlusal wear. The theory that cusp wear and flattening is a natural, accepted event is being severely challenged by gnathologists.

VI. Prediction of Development

Clinical practice is full of predictions. Every appliance and every adjustment is based on expectancy of favorable events. When anticipations do not materialize, then adjustments and compromises are practiced. Many clinical practices in orthodontics of fifty years ago were based on the belief of limitations. One of those was that growth and development could not be forecast -- period -- end of discussion. The result was that either growth became discounted or broad sweeping conclusions

were drawn from 'reading the pattern' such as brachyfacialism or dolichofacialism grossly assessed from the mandibular plane or other inconclusive factors.

Starting in 1950, the author began setting up patients' cases on paper rather than plaster. Two years' growth was combined with anticipated effects of the orthodontics required as a feedback procedure. It was originally labelled a Growth Prediction Treatment Plan, and later a cephalometric synthesis, as a putting together of growth treatment anticipations and arranging the occlusion in keeping with individual needs. Still later it became known as the VTO (Visualized Treatment Objective, as labelled by Holdaway). As technical procedures were improved, and as more information on growth accumulated, the successes far outnumbered the occasional erroneous prediction which was found to be more likely than not **iatrogenic**. Until 1970 these forecasts were not attempted beyond two to three years. But in-depth computer work led to the discovery of the growth arc and revealed new biologic reference points and new gnomic patterns. After these discoveries long-range growth forecasting became plausible (Fig. 13). This became the basis for the VTO, which meant visualization of the long-range goals for up to 15 years. The findings were so good that in the end it was amazing when it *didn't* work. The process was actually likened to simulation, as is applied in many industries.

In 1990 a detailed long-term study confirmed the forecasting procedure and led to even greater detailed successes. Individual correctional factors were discovered to alter mean values which in themselves tended to average out over time. Sexual growth cutoffs worked quite well and confirmed the use of wrist plates (Fig. 14).

Growth of soft tissue estimates were easier than expected once the skeletal reference points were accurate. Long-term occlusion development followed expected behavior. Correction for eruption and tooth behavior in children with certain oral habits, of course, is totally speculative, based on the continuation or cessation of the habit (such as thumb sucking).

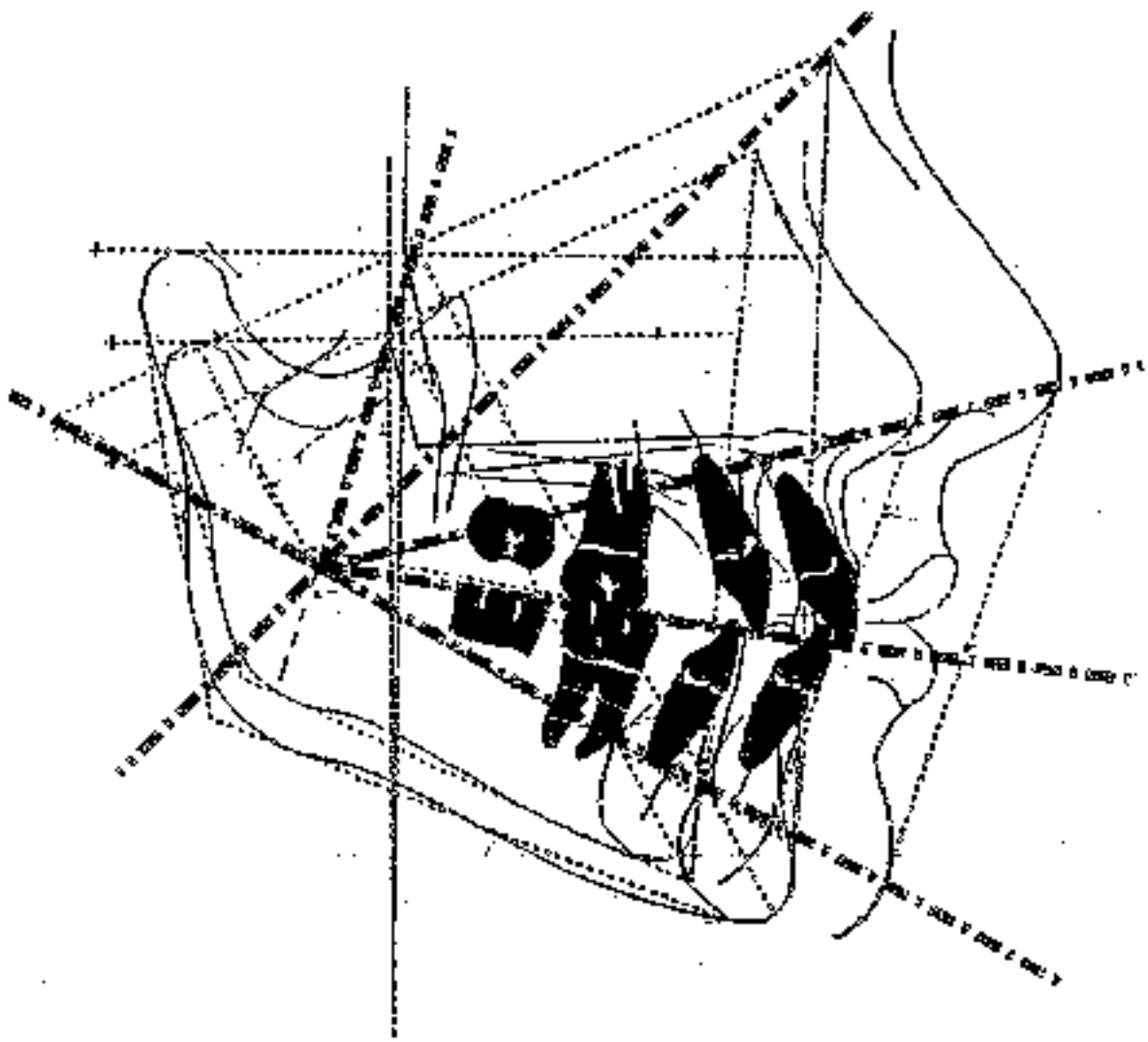
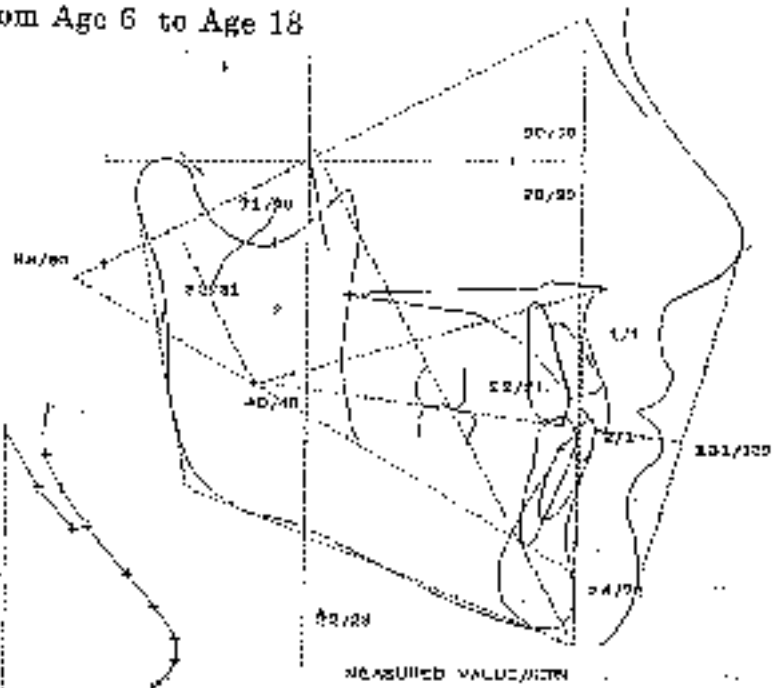
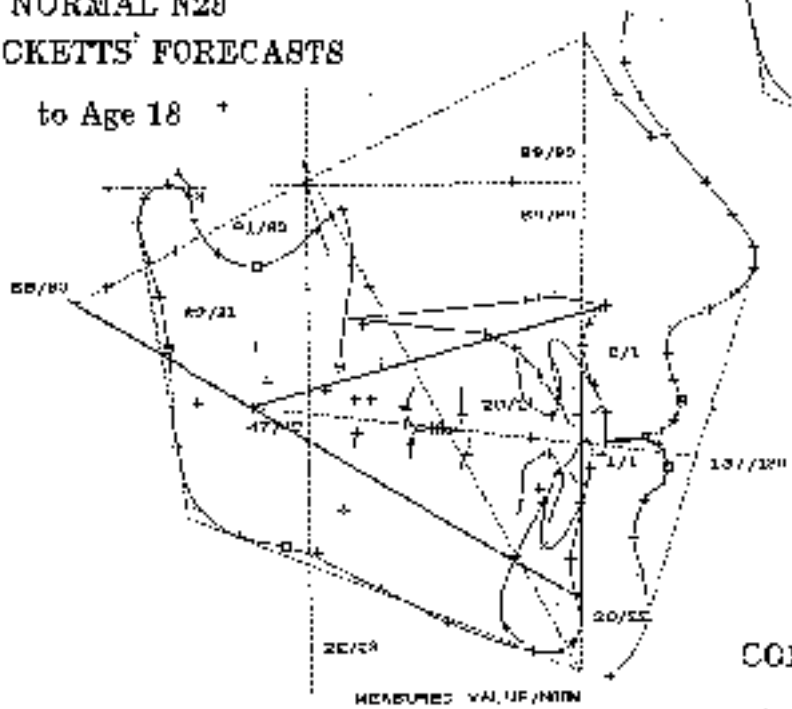


Fig. 13

NORMAL ACTUAL
From Age 6 to Age 18



NORMAL N28
RICKETTS' FORECASTS
to Age 18



COMPARATIVE FIT
to Age 18

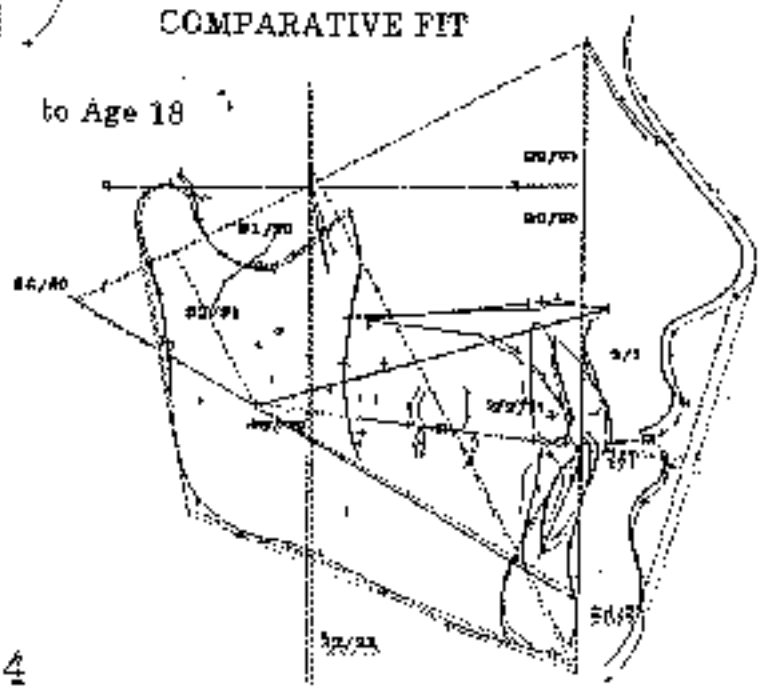


Fig. 14

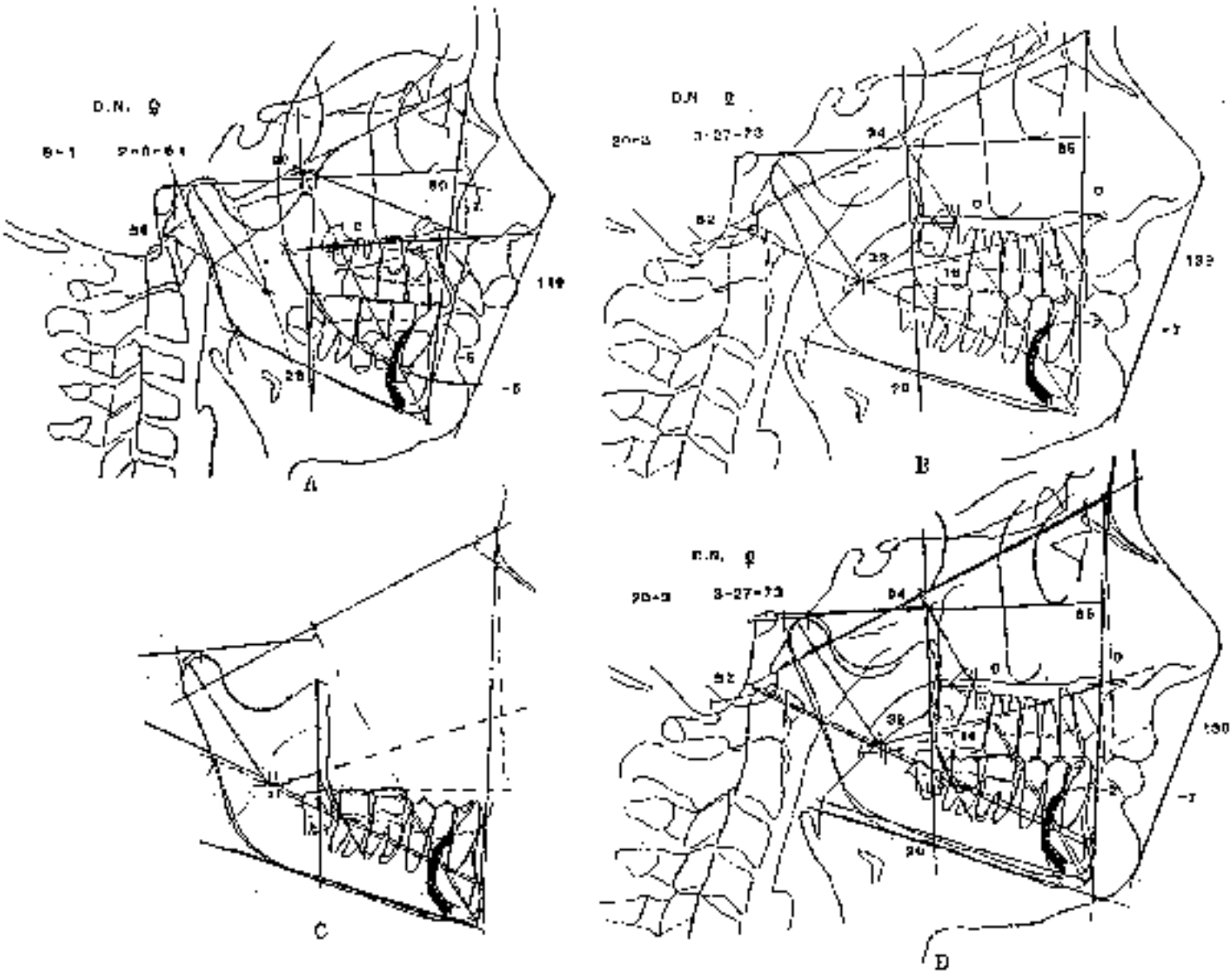


Fig. 15

It's amazing indeed that the profession as a whole has not taken advantage of these techniques.

Accuracy Testing

Several studies have been conducted on "blind test" material. Amazing successes have been rendered ever in long range.

It should be understood, however, that a VTO is an objective that is visualized on paper. It is to be used as a tool for establishing objectives based on demonstrated possibilities with specified modulation. When a VTO is not fulfilled it is not the VTO but rather the execution of the plan that is questioned. Retro studies of patients treated by one or another method cannot be employed to test the accuracy of the original design. The builder may not have had the blueprint to follow!

Thus the VTO and VTG are tools for selection of appliances, the sequencing of appliances, and the planning of anchorage. This is the practical clinical value to the clinician correcting malocclusions (Fig. 15).

The STO is the Surgical Treatment Objective, and is a subject unto itself.

VII. Physiologic Centric (Clinical Attainment)

The infant is without teeth in the oral cavity. The function of the jaws at birth is for breathing and suckling: hence the mammalian temporomandibular joint. When harder foods can be managed by the digestive system, teeth arrive. By now the baby can sit upright, talk and scream and make itself known, all of which are functions of the face.

The teeth erupt and seek opposition to their counterparts in the other jaw. There has always been mystery surrounding how the teeth know when to stop erupting and wait for the opposing teeth to meet them. How does a "centric", so unique to each animal, develop? In the human it would seem to be a product of the postural apparatus of the head because following accidents of the neck the centric will

change. The anterior occlusion is related to tongue and lip function. The posterior occlusion seems to be related to the mandibular foramen which is a center of motion. Both are uniquely associated with the divine proportion phenomenon.

But the question arises, how is this centric to be checked on a clinical basis? Traditional practice has been for the dentist to hand-manipulate the chin and gain relaxation of muscles for a hinge action in the joint. This means the diagnosis is made from the ligament. While this procedure might work well when normal joint integrity is present, and ligaments are firm and the strapping secure, derangements are common, and it is wondered if clinical procedures actually contribute to their development.

The condyle position in centric should be in a state of readiness to disarticulate the teeth, which means it should be in juxtaposition against the eminence via a normal disc. This is attained through the normal stabilizing effect of the **lateral pterygoid muscle**. This muscle in turn is balanced by the posterior fibers of the temporalis, its antagonist. The resulting equilibrium is the fact or the reality of condyle position.

The normal centric is not located at a border movement. Centric means towards the center. The condyle position is nearly centered in the fossae from a gross standpoint. Whenever the condyle is pulled posteriorly too far it moves behind the disc and displaces the disc forward. The ligament must therefore stretch. All joints are held together by muscle equilibrium in the final analysis.

To test for a physiologic centric the patient is to sit upright, look straight forward and about one pound (0.4 kg.) of resistance is placed on the chin with the forefinger. This resistance activates the external pterygoid and helps fix the condyle in its readiness state (Fig. 16). On closing from this position the patient closes directly into the habitual centric that is comfortable and secure. When, with practice, the teeth do not close into the centric, factors can be examined for

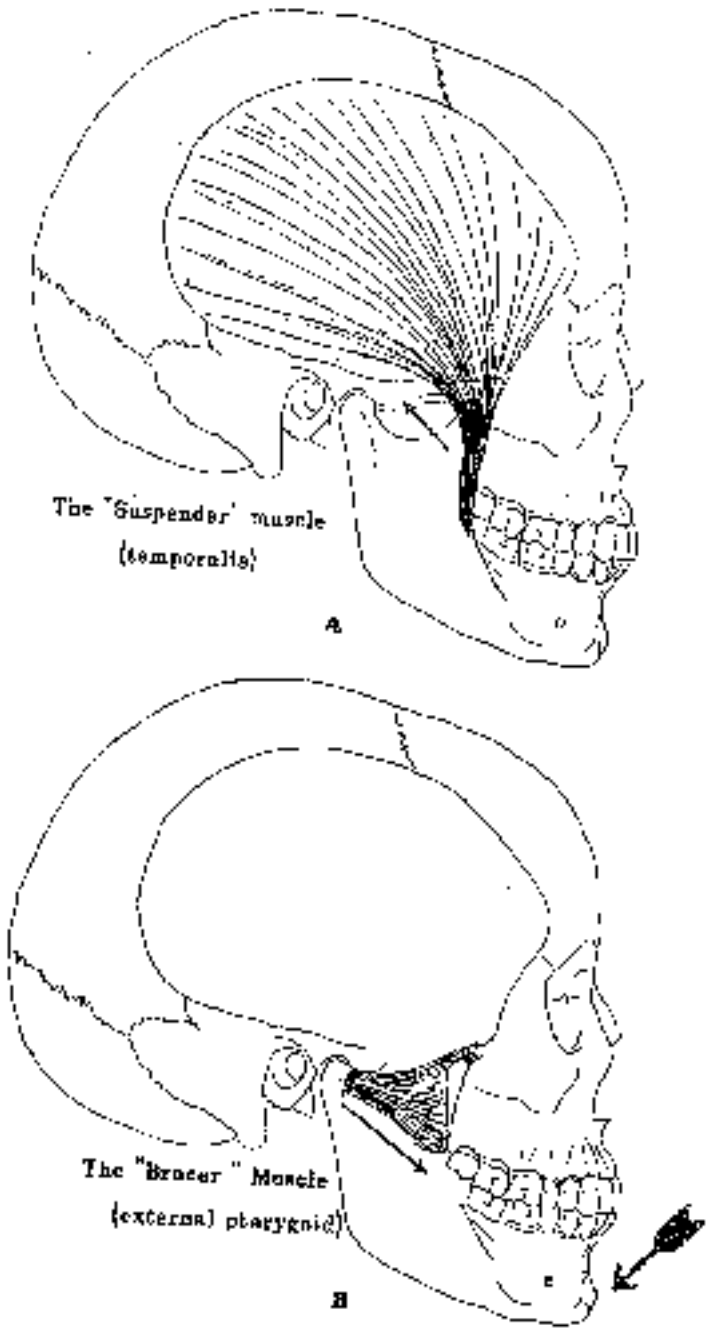

The "Suspender" muscle
(temporalis)
A
The "Bracer" Muscle
(external pterygoid)
B

Fig. 16

abnormality of tooth positions.

The description and procedures for the diagnosis and treatment of joint conditions require a separate manual.

SUMMARY

Clinical science in occlusion requires a depth of knowledge. New analyses for morphology and growth have been developed for sophistication in the field.

Cephalometric setups have replaced plaster setups for help in simulating results. The computer is being applied and, as with all elements of technology, improvements continue to take place.

Development of occlusion and aging are contingent on the forces of occlusion which are biologic in character. These need to be considered by any astute clinician.

The principle of arcial growth of the mandible essentially constitutes a general law. All mandibles in all races, with normal growth, grow on an arc. The extentions of five processes on the mandible vary with individual characteristics. This knowledge forms the basis for the ultimate sophistication of the occlusionist, as it also leads further to appreciation of degenerative processes that may occur.

CONSUMMATE OCCLUSION

GENERAL SUMMARY

"Consummate" implies a bringing together or the act of completly summing up or fulfillment of a goal. When considering the factors to be included in the subject of occlusion from definition, to complete diagnosis to senile and termination processes, it becomes vast in context. Four chapters were organized as a semi-overview of the subject of occlusion, but when analyzed about forty sub-subjects make up a wide array of related phenomena.

All aspects are, of course, clinical. However, the first group of subjects including the controversies in the field, were labeled **theoretical**. All factors are also to be a basis for diagnosis, but the tools for obtaining records for making decisions regarding conditions in the head, face and jaws, teeth and musculature have continued to become more sophisticated.

Clinical aspects start with **morphology** and tooth-to-tooth relationship. This was then expanded to the subject of **growth and development** and a consideration of the manner in which conditions reach the status they ultimately exhibit.

The subject of occlusion has captured the interest of all dental scholars. The author for over half a century has witnessed the subject to expand from the meeting of the teeth to the posture of the body.

Many books have been written on the subject of occlusion, but many books could likewise be written on each single component of the subject. The purpose of this book is to serve as a manual for reading and a guide for direction.

AMERICAN INSTITUTE FOR BIOPROGRESSIVE EDUCATION
7430 E. Butherus Drive
Suite F
Scottsdale, AZ 85260
(480) 948-4799 fax (480) 443-8837
robert@morganics.com