THE LOGIC AND KEYS TO BIOPROGRESSIVE PHILOSOPHY AND TREATMENT MECHANICS

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THE LOGIC AND KEYS TO BIOPROGRESSIVE PHILOSOPHY AND TREATMENT MECHANICS

CHAPTER ONE

THE EVOLUTION OF ESTABLISHING VISUALIZED OBJECTIVES

I. Introduction

History is a record of events, while the subject of evolution tries to explain the reasons. Any investigation needs to be guided by the truth discovered, not by what some might think, say or wish.

The movement which was to be called "Bioprogressive" twenty-five years afterward, in 1972, had its genesis in 1947. It was developed as a result of experience with Roentgenographic Laminagraphy (lamina = layer) or Tomography (tomo = Greek for "cut"), when combined with the principles of cephalometrics. In retrospect this may be the reason for orthodontics being viewed differently because of the different source of information.

For that body section method, a head-holder was constructed to fit the bed table of the body-section X-ray apparatus. This permitted the standardization of brilliant, oriented cuts through the temporomandibular joint and contiguous structures. It permitted detailed study of treatment changes perhaps for the first time.

II. The Original Research Protocol

The protocol established was for the study of condyle growth and joint behavior during the correction of Class II malocclusion in growing children. Joint

"cuts" (or tomograms) were to be correlated with behavior of the chin. Therefore additional sections through the midsagittal plane were also obtained for cranial base orientation. That cut revealed the mid-cross-section of the sphenoid bone, the occipital bone, and the frontal bone.

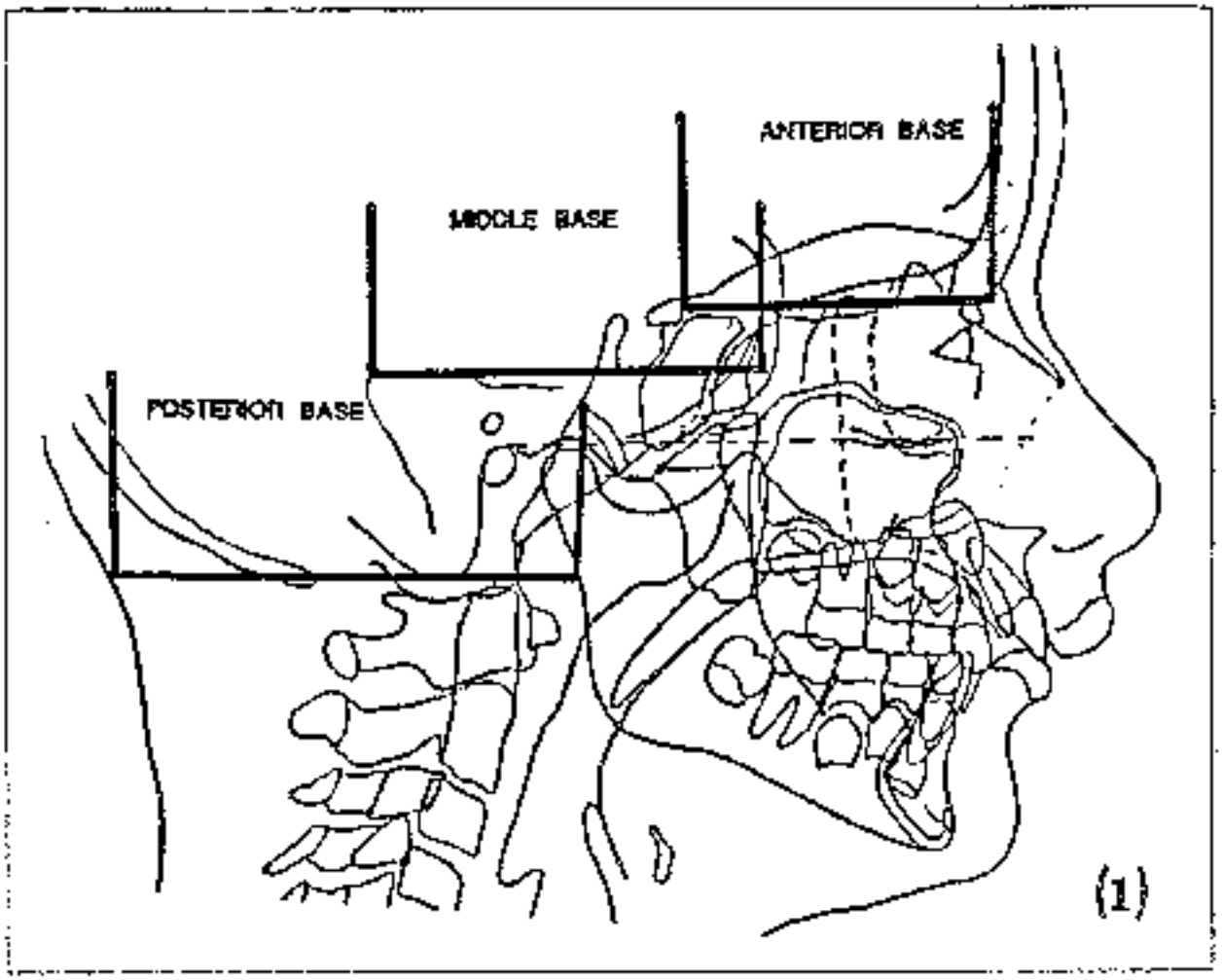
The further objective was to establish references posteriorly to which the temporomandibular joint could be related during the serial study. The area of the joint and the skull base posteriorly was called the "blind spot" due to the cumbersome head-holding mechanisms of the Broadbent cephalometer. Many investigators consequently used only point Sella and the anterior cranial base for study and the drawing of conclusions (Fig. 1).

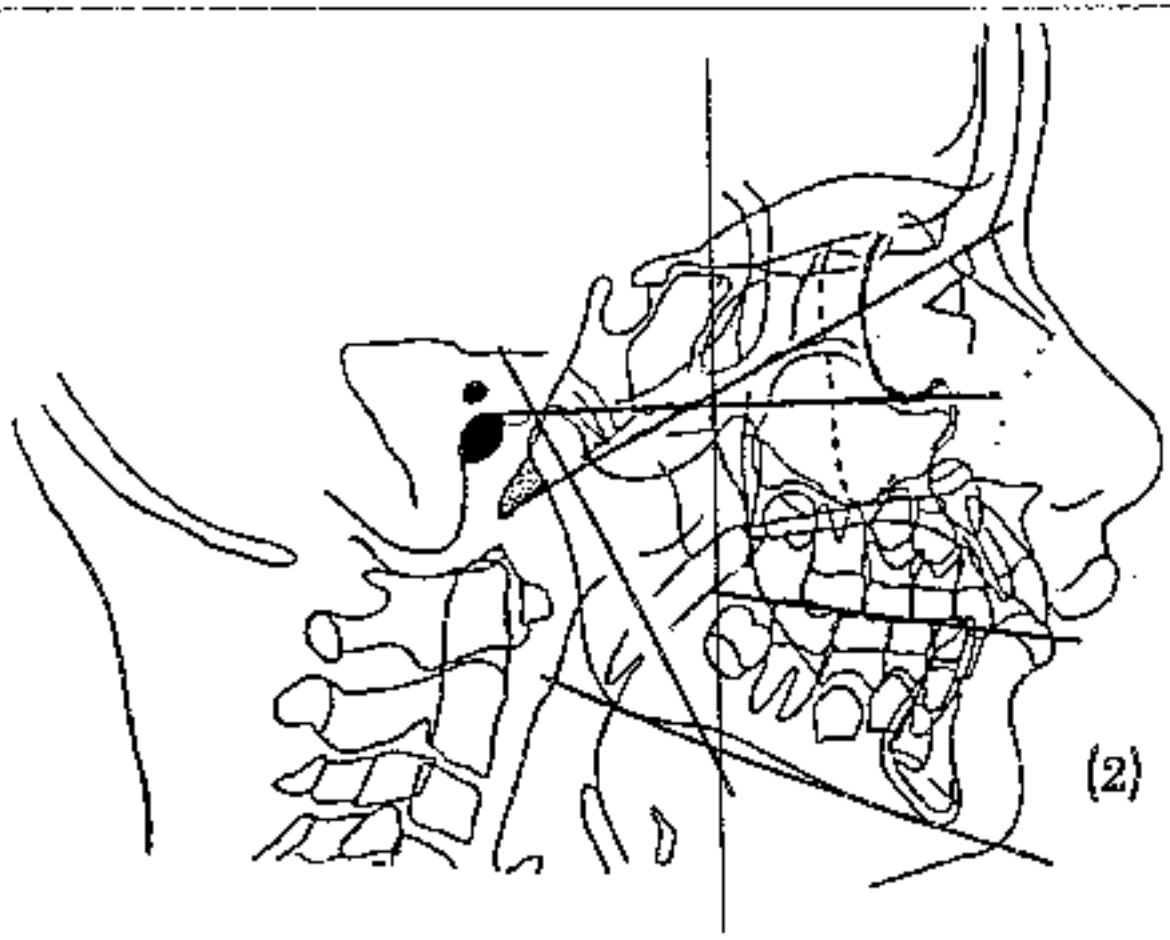
Some new references and planes emerged at that beginning of the laminagraph investigations. The new methods led to the development of a "paper plan" (or a "Growth Prediction Treatment Plan" for designing desired treatment). This, in the 1960s, was labeled the Visualized Treatment Objective, or VTO. Thus, in order to understand "Bioprogressive Philosophy" the development of the VTO should be explained first.

Correction of Weaknesses in Cephalometrics

A glaring error, in need of correction, was the use of the ear rod of the head-holder as a cranial reference for the Frankfort Plane. It was clear that the ear post, employed for head orientation, and used for Porion, often was far from the center of the true external auditory meatus from which true Porion was located. The ear cartilage has been found to be highly variable. The first change, therefore, was to employ anatomic Porion by inspection in order to obtain a true Frankfort Plane.

A second improvement was the obvious need for a reference more profoundly related to the joint in the Posterior Cranial Fossa or face. The central cut, mentioned before, vividly portrayed the basalar occipital and point **Basion**. For the new method


ANTERIOR BASE
MIDDLE BASE
POSTERIOR BASE
(1)


(2)

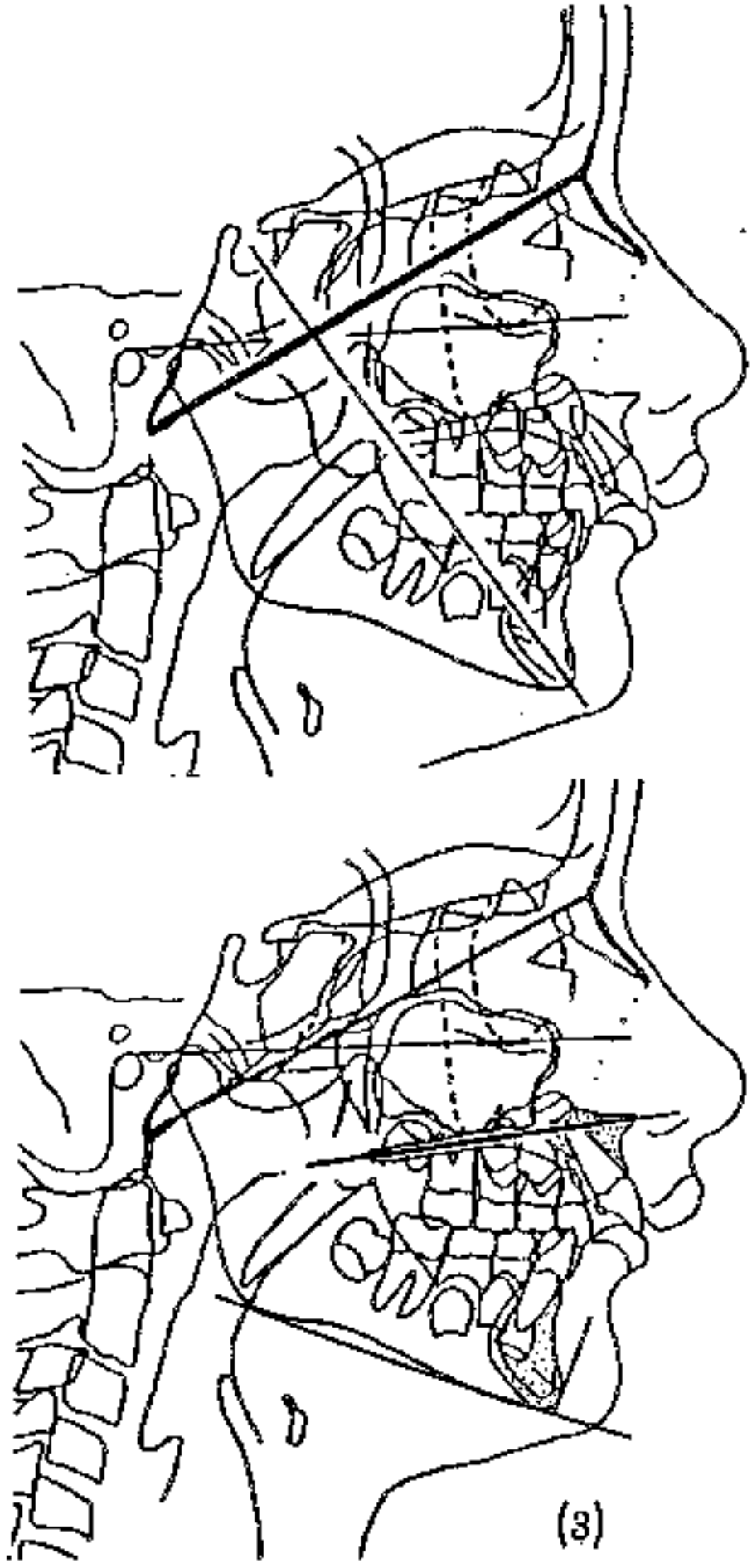
different lines were selected. One was the Basi-cranial Axis -- Basion-Nasion (BaN). The second was true Frankfort with true Porion. A third addition was a plane bisecting the long axis of the condyle called the Condylar Plane which was then related to the Downs Mandibular Plane. The fourth was a True Buccal Occlusal Plane because the incisors were not visible on the lateral cuts and because, also, the incisors were influenced by tongue or lip abnormality. Finally, a vertical was dropped from true Frankfort Plane from the posterior margin of pterygopalatine fossa. Thus, five lines or planes were employed that were new or which were selected in different ways (Fig. 2).

Within only weeks the new scheme for analysis had been devised for the study of joint behavior. During the next three years joint cuts and routine headfilms were collected on more than 100 treated subjects plus hundreds of "joint cases". For a sequential analysis, a more central order was noted when superimpositions were made at the crossing of the T1-T2 XY axis rather than point Sella. Intense and detailed study of the behavior of the teeth was related to changes in the joint and were reported in 1952, 1955, and 1960. Many facts emerged, some of which were quite controversial in interpretation.

The VTO Idea

By 1950 Ricketts had become an assistant to Dr. William B. Downs in the orthodontic clinic at the University of Illinois. Good communication was established with him regarding the joint changes observed. With the new approach, from the joint area and Condylar Plane, new information was offered. Changes in the chin were related more precisely by the Y axis crossing of BaN (XY axis) mentioned before. The lower teeth were measured from the Mandibular Plane registered at Pogonion. For the maxillary teeth the Palatal Plane at Ans was used (Fig. 3).

Downs insisted that investigation be made with the new methods for a



(3)

"synthesis" or a "prediction" to be constructed as a basis for the planning of treatment mechanics. The new Ricketts analytic method was to be reversed as a process for projection of the events in the future.

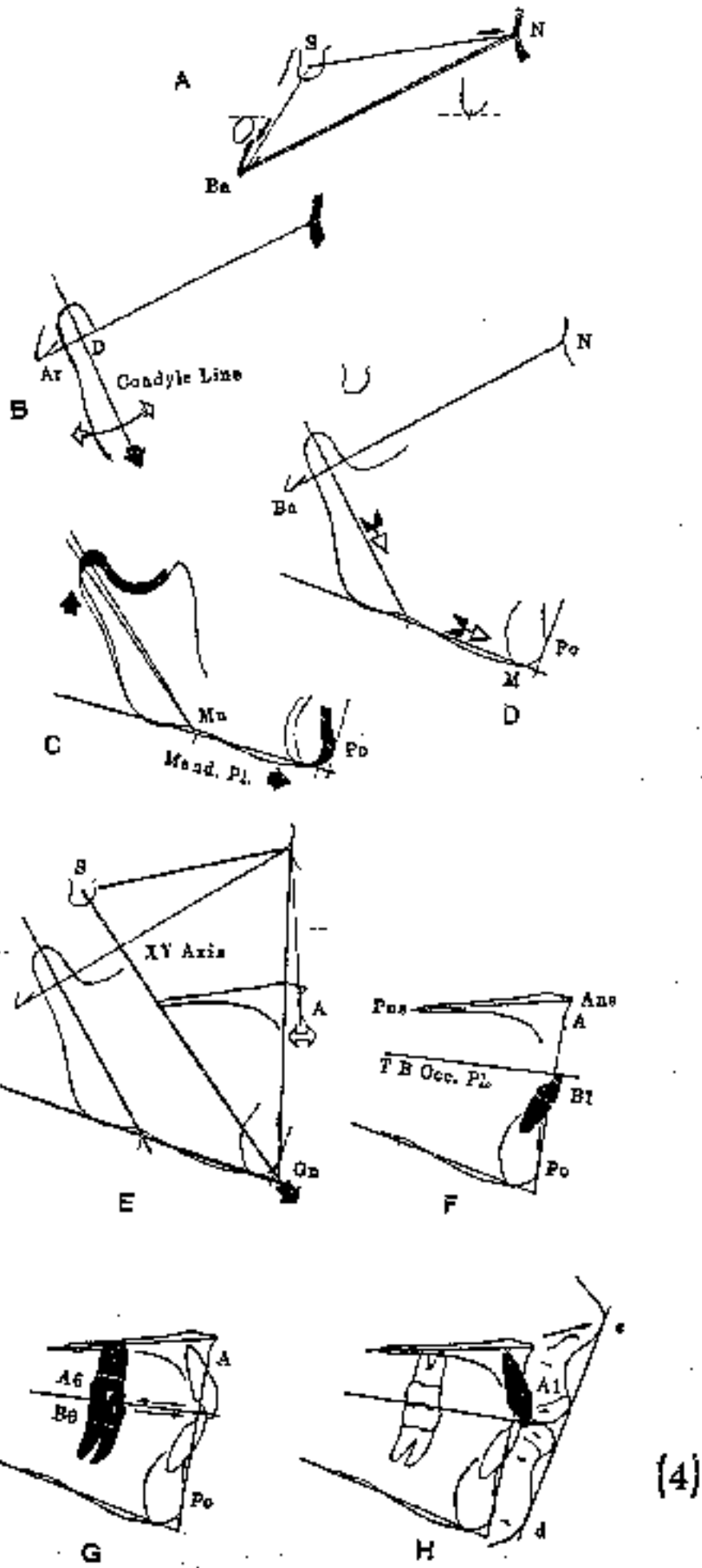
Downs had devised the first clinically applicable analysis. His aim was first to help to diagnose the dental and skeletal relationships and second to use the "pattern" as a reference for designing treatment. He, as well as Brodie, desired to go beyond the "static" matrix as the limits on which to orient the teeth. He sought to include the "dynamics" of growth and alveolar change as a target, together with the input of mandibular rotation which was likely to result from the orthodontic influences.

If the chin were to "swing" forward it would help with Class II correction. If, however, the chin were to go downward or backward it could hinder or complicate the correction and lead more often to extraction. No one at the time realized the extent to which treatment could influence the chin position, assuming that opening was an expression of growth only.

Together Downs and Ricketts reasoned that a "prediction", for estimating future chin position and tooth locations, would require at least four basic factors:

- It would best come through the joint or the posterior area.
- It must be factored for the physiologic changes from the treatment requirements (feedback).
- It must include the basic growth changes as an expression of units of time or modules.
- Esthetics together with function must be a consideration made as a basis for planning objectives.

Thus, it was envisioned that the analytic method employed for growth and treatment was simply to be reversed for projection of the future. The original VTO method (published in 1957) required approximately twenty steps for the cranial base, mandible, maxilla, teeth and soft tissue, in that order (Fig. 4).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III. The First Prediction Results

At Downs' insistence, work was started by Ricketts with the data that had accumulated over the previous three years. Clinical findings were employed to set up, on tracing paper, a treatment objective that would include the dynamics of growth together with the foreseen changes in chin position caused by bite levelling plus intermaxillary traction rather than the static thinking that occurred with considerations from models. It was assumed, in those years, that the alveolar process defined the limits of treatment.

The new effort demanded a reexamination of the original cephalometric conclusions of Brodie et al. and a new search was conducted for greater details of treatment behavior in the individual types. This led to further study of "anchorage" with the techniques of that time. Within three months of trials, "predictions" of the outcome of therapy on Downs' private patients were produced. His acceptance of them heralded their worthiness for prospects for future clinical practice planning.

IV. Clinical Technique Changes

For the next two years, 1951 and 1952, work was done on problems in patients with anchorage loss. Unfavorable rotation of the mandible was studied with head films. It seemed to occur from molar extrusion and to result particularly from interference in the incisor area.

Private Practice and Experiences

The "predictions" of treated cases steadily improved with more data gleaned from treated patients, particularly problem cases. In 1952 Ricketts established a practice in California, and routinely employed the "Growth Prediction Treatment

Planning Scheme" for estimating future behavior (rather than merely checking the method on X-rays of past treatment results). Encouragement for the project came from only four colleagues: Dr. William Downs (University of Illinois), Dr. J. William Adams (Indiana University), Dr. Wendall Wylie (University of California) and Dr. Cecil Steiner in Los Angeles.

By 1955 the first fifty-five retained patients were all exhibited in story-board form at an Angle Society meeting in Chicago. This presentation was a statement regarding the progress of the "prediction" research of the previous five years. The result was that the forecasted mandible was acceptable in 52 of the 55 children. Thus it was 96% applicable. The maxilla was missed 50% of the time. This was because heavier and isolated extraoral traction was now employed, and the predictions were based on findings with primarily full edgewise or lighter forces. Previous knowledge of orthopedic possibilities regarding changes in the palatal plane with extra-oral therapy, particularly cervical traction, had not been available. Immediate correction in forecasts were made after that discovery.

The need for more detailed and more frequent monitoring was obvious. If patients were beginning to go "off the track of the prediction", changes were to be made in the therapy to put it back on track if possible. The predictions or the VTOs were, in other words, no better than the ability of the clinician to execute the mechanical plan, and the plan itself was based on typical behavior with a given modality.

As new techniques were tried, new possibilities emerged! Sequencing loomed as an important aspect of achievement of desired effects. Thus, more detailed treatment was planned to accomplish more precise and specific objectives. "Bioprogressive" techniques were designed at the tracing table in order to correct the flaws of other techniques and to produce desired changes that would fulfill the objectives.

Two years' normal growth for the particular patient was employed as a starting matrix. That was then combined with the feedback from the perceived effects of the mechanics to be employed. The cybernetic circle was ultimately devised (Fig. 5). Thus, following the determination of the chin position, orthopedics on the maxilla was planned. Occlusal plane changes were then estimated and teeth were placed according to the individual practical needs. Finally, soft tissue was grown and modified as it would be affected by changes in the teeth and jaws. **That was in essence the VTO philosophy at the start of its movement in the profession.**

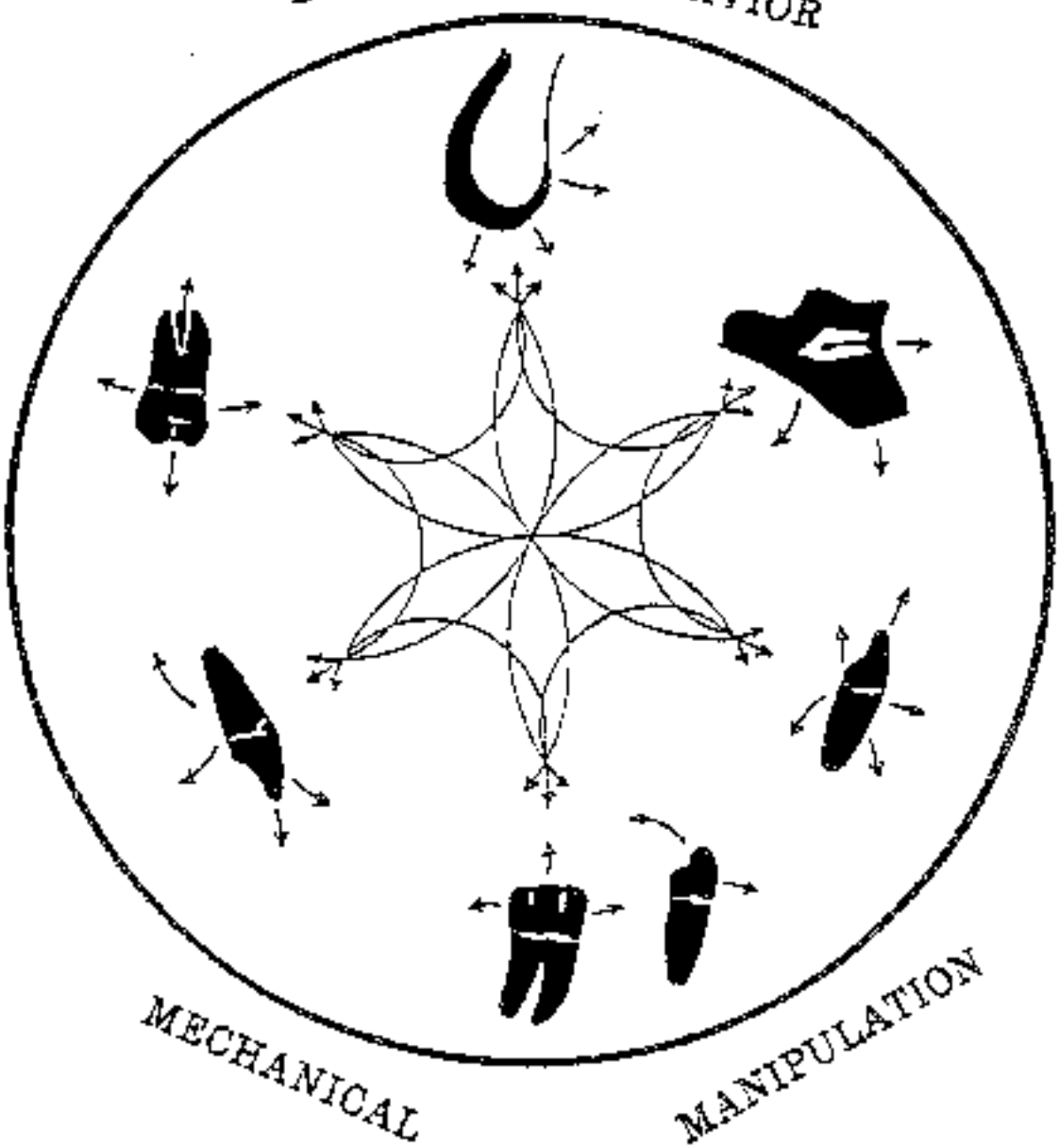
Modification of the VTO

By 1959, when Dr. Downs was consulted regarding the dearth of interest in the VTO, he suggested that it was too difficult for the capability of the typical clinician. In his view, the VTO should be simplified. As a result, attempts were made to make it easier, by circumventing the joint area. A return, unfortunately, was made to SN and the Y axis. This approach, although less accurate, was greeted with enthusiasm by some clinicians, such as Holdaway. Assumptions were made for changes by "reading" the characteristics of the mandible. That technique was ridiculed, however, by Johnston.

Problems also later arose from the use of the Facial Axis alone, or the Mandibular Plane angle by itself (Fig. 6).

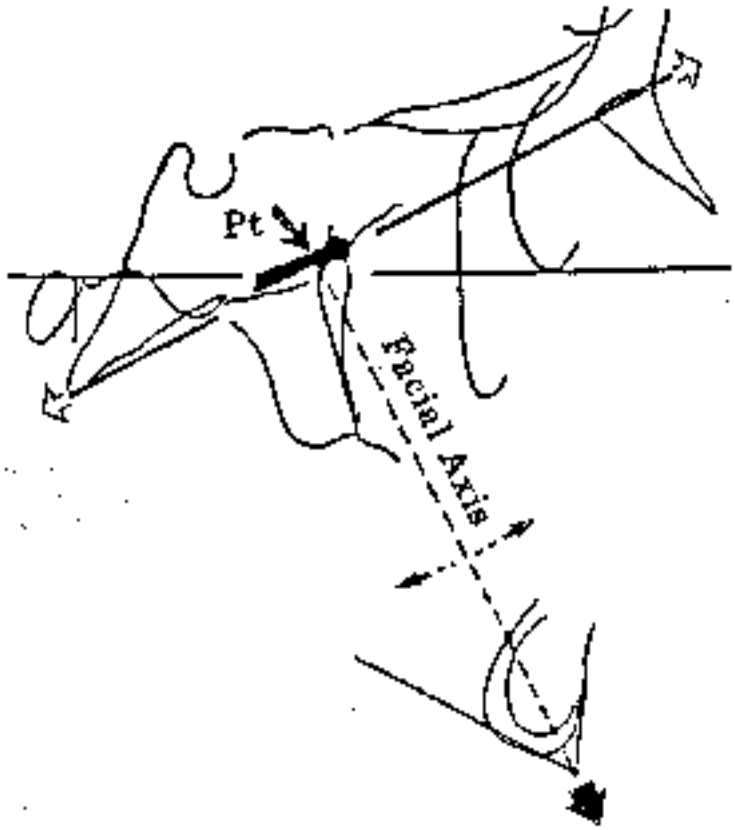
In 1963, Bjork published his material on implant studies and showed that the lower border of the ramus resorbed and the angle drifted with growth. In 1965, after difficulty in using the mandibular canal for superpositioning, Ricketts located Xi Point by measurement for the ramal centroid (Fig. 7). A vertical point was needed on the symphysis, and Protuberance Menti (Pm) was selected as a result of implant findings to be used together with Pogonion (Po).

In addition, the Sella orientation had been found to be misleading for



CYBERNETIC CIRCLE

FOR PLANNING (5)



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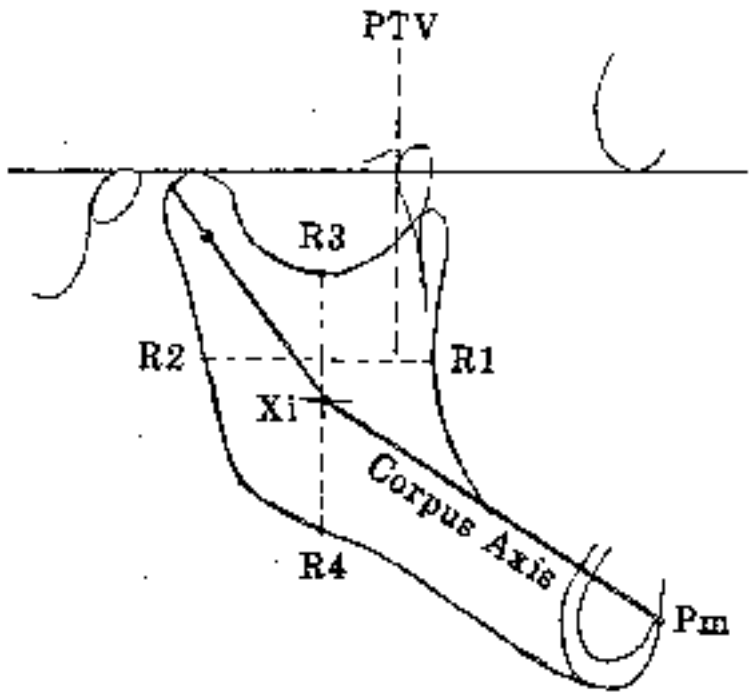


(7)

forecasting. The need for a more "central" facial point became obvious. The lower border of foramen rotundum was selected as a pterygoid base reference and called Pterygoid Point (Pt) (Fig. 8).

Thus, by 1965 three new points had evolved. These were Pt, Xi and Pm. With these, new studies were conducted for a possible improvement in the old original method. The basal skull was enlarged on the BaN plane, according to data accumulated. The Condyle Axis and the Corpus Axis came into existence (Fig. 9).

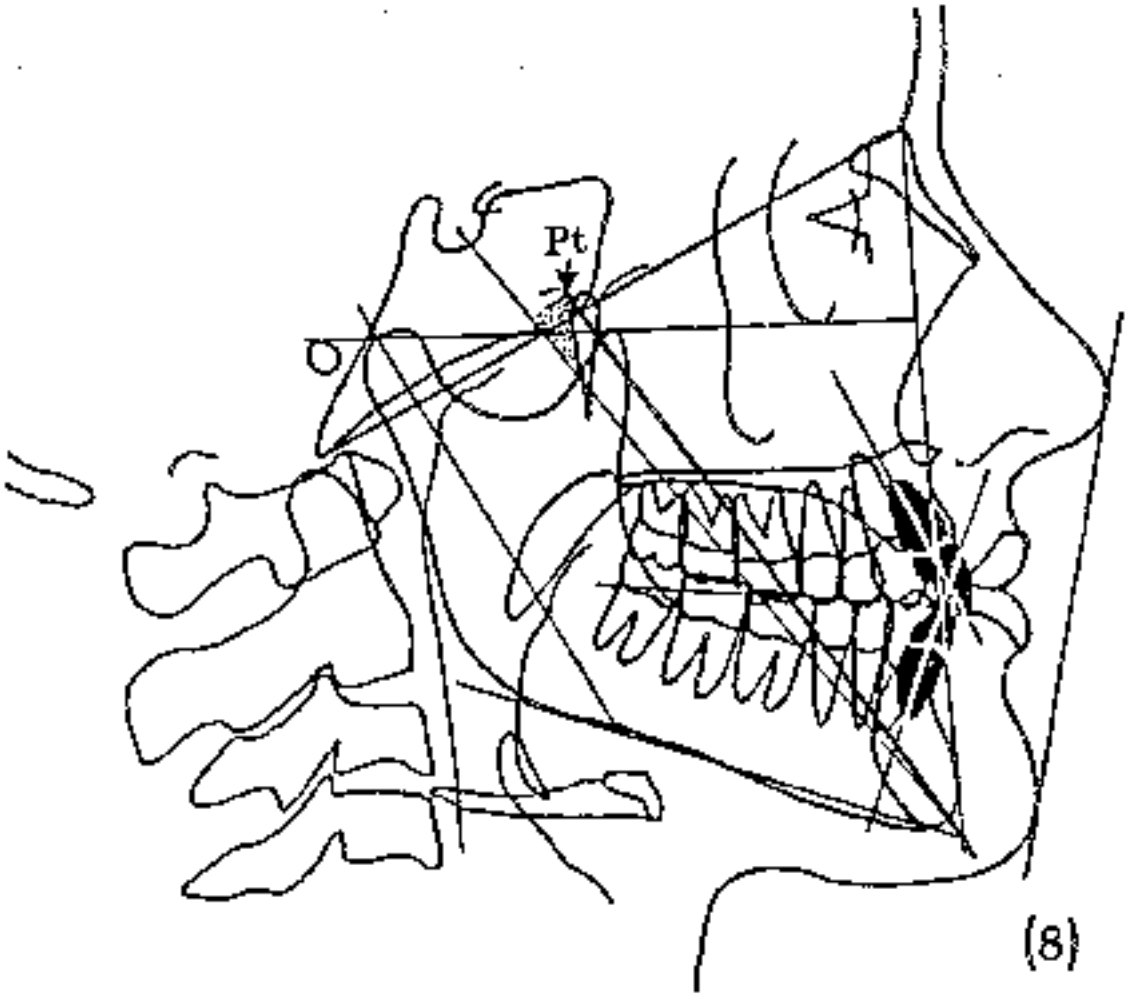
V. Computer Research

In 1965 the computer was employed for cephalometric research. By 1969 the work confirmed the new points. Hence, still different analyses were formulated. The planes were employed for monitoring growth and treatment changes (Fig. 9). The new corpus-condyle axis matrix was programmed on the computer for short-range forecasting. Computer programs were established (for short range) in 1970.

Arcial Growth of the Mandible

By 1969 it was obvious that the mandible, in the absence of treatment or pathosis conditions, bent upward in the ramus with natural growth. This meant growth was behaving on a curve. Experiments and simple logic from biologic factors directed the location of an arc which was constructed by the use of a new point, Eva, at the center of the base of the coronoid process to be used together with Pm for the radius of a circle. A triangle formed from Eva and Pm was used to find a point of true radius (Tr). The growing arc was modified by apposition and drift of the various processes. This new technique worked in long-range forecasting 5 to 15 years or to maturity. It was discovered in 1971, just two hundred years after Hunter's hypothesis in 1771 (Fig. 10).

The building of the rest of the face around the predicted mandible was more of



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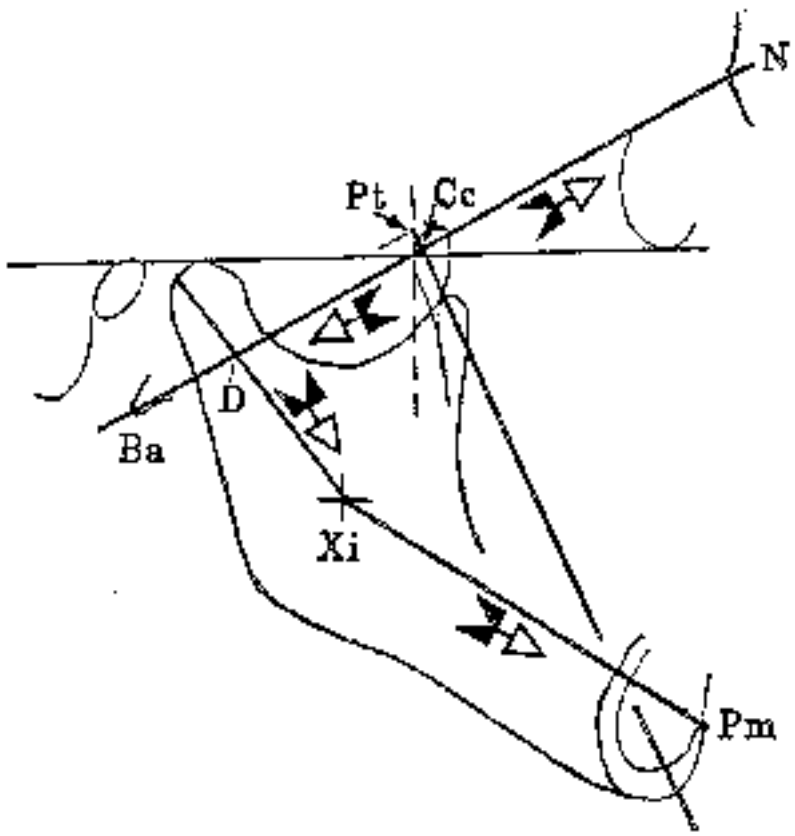
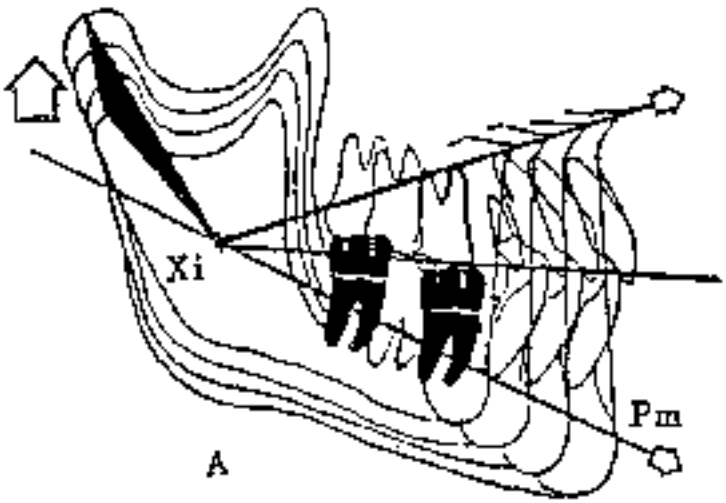


(9)

ARCIAL GROWTH



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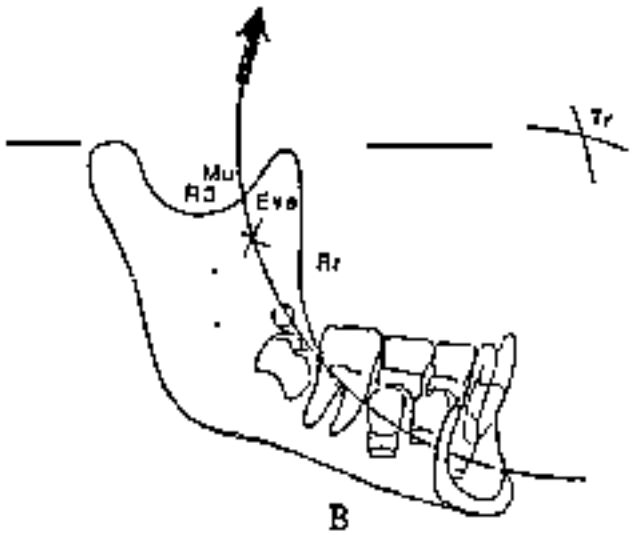

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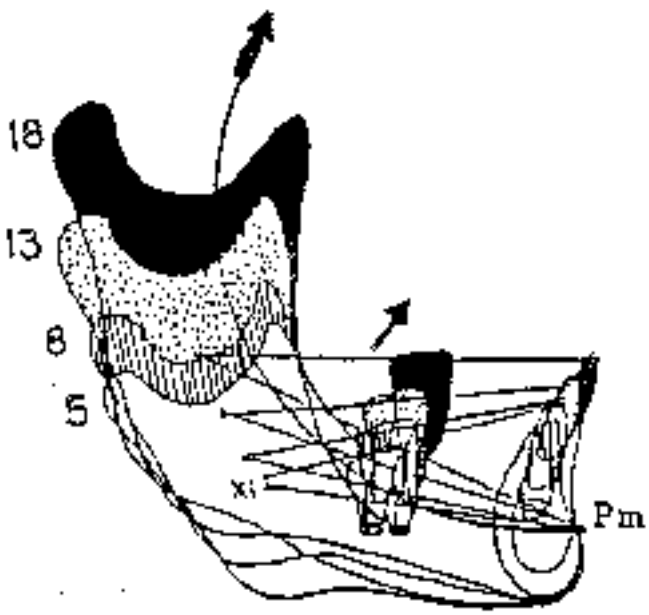

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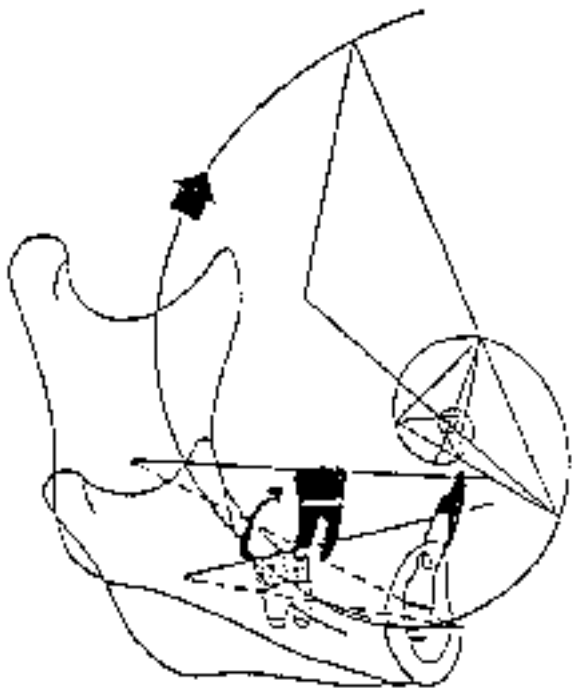

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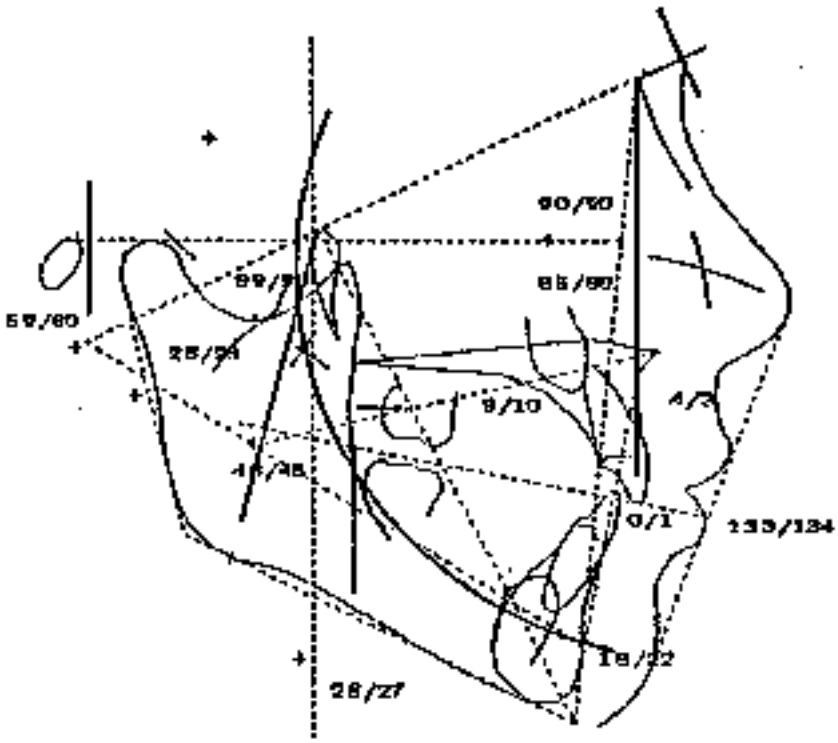
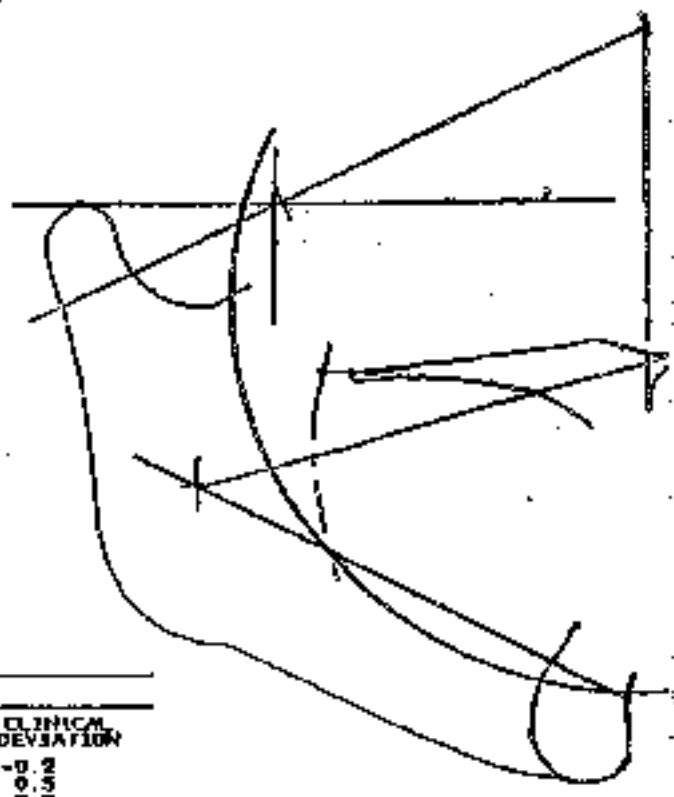
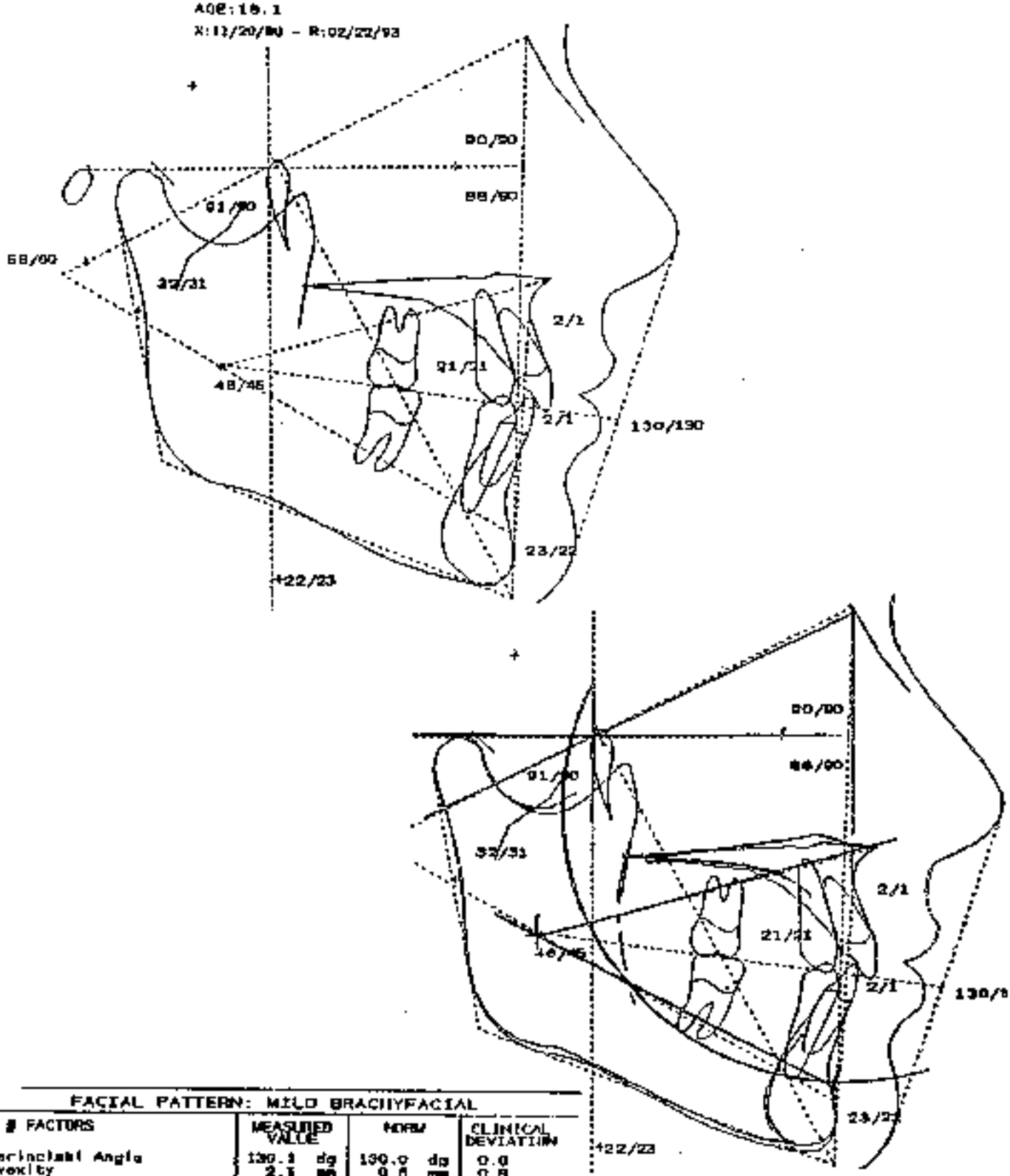
BEFORE





FACIAL PATTERN: MESOFACIAL					
FACTORS	MEASURED VALUE		NORM		CLINICAL DEVIATION
Interincisal Angle	132.7	dg	134.0	dg	-0.2
Convexity	4.2	mm	3.3	mm	0.5
Lower Facial Height	48.2	dg	45.0	dg	0.3
Ar Molar Position to PTV	1.3	mm	9.7	mm	-0.1
Ul to A-Po Plane	0.2	mm	1.0	mm	-0.3
Ul Inclination to A-Po	17.7	dg	22.0	dg	-1.1
Facial Depth	84.8	dg	85.0	dg	-0.3
Facial Axis	90.5	dg	90.0	dg	0.1
Maxillary Depth	92.6	dg	90.0	dg	0.1
Mandibular Plane to FH	26.2	dg	28.7	dg	-0.1
Mandibular Arc	25.8	dg	25.0	dg	0.1
Total Facial Height	59.2	mm	60.0	mm	-0.1

(10A)



FACIAL PATTERN: MILD BRACHYFACIAL					
# FACTORS	MEASURED VALUE		NORM		CLINICAL DEVIATION
Interincisal Angle	130.1	dg	130.0	dg	0.0
Convexity	2.1	dg	0.0	dg	0.8
Lower Facial Height	45.7	dg	45.5	dg	0.2
A6 Molar Position to PTV	21.0	mm	21.0	mm	0.0
Bl to A-Po Plane	1.8	mm	1.6	mm	0.2
Bl Inclination to A-Po	21.5	dg	22.0	dg	-0.5
Facial Depth	88.3	dg	89.6	dg	-1.4
Facial Axis	80.7	dg	80.5	dg	0.2
Maxillary Depth	90.3	dg	90.0	dg	0.3
Mandibular Plane to FH	21.9	dg	23.3	dg	-1.3
Mandibular Arc	32.1	dg	30.7	dg	1.4
Total Facial Height	57.7	dg	60.0	dg	-2.3

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(10B)

a challenge. When it is realized that the mandible is suspended by muscle, and that maxillo-mandibular relations are determined by muscle behavior plus some ligaments and fascia, the problem of absolute certainty is understood. Despite that, a remarkably accurate technique was developed by the use of the mandibular arc, growth gnomons and with practical guides for age, sex, size, and particular morphology (see Fig. 10).

VI. Problems with Communication and Education

It will soon be half a century since that VTO idea was conceived and published in 1957. What has kept it from acceptance and common, routine use? In a 1990 study, it was found to be employed by ten percent (10%) of orthodontists. It was found to be practiced by only one percent (1%) in other sections. Maybe speculations can be made in retrospect because it certainly has worked, and has provided a great advantage to the clinician who learned how to use it. The reasons for lack of acceptance may have been one or more of the following:

1. It was too new for its time. Many were not yet using cephalometrics when it was proposed.
2. It was too awesome, and too complicated for the average knowledge and ability.
3. It was too time-consuming and difficult for the value received by the clinician.
4. It required too much training and was disturbing and frightening.
5. Many detractors denied its validity, wanting it eliminated.
6. Many had too much pride to admit it could be of help.
7. Some felt a simplistic view of models was quite adequate for diagnosis

and treatment planning.

8. Some could not conceive how growth could make a contribution to the outcome, so why bother?
9. Many wished to wait until malocclusions were fully developed before starting, but often only a bit of growth remained for prediction at that time.
10. Many did not accept the possibility of maxillary orthopedics or mandibular control.
11. Many wished to rely on their mechanical skill and in essence disregarded biology.
12. Some felt variation was so great that a *forecast* could make no difference in the plan.
13. Many practiced the motto "When in doubt take 'em out!", so detail of position of teeth was not sought. They tended to accept whatever their technique produced.
14. Some assumed the mandibular plane angle was enough of a prediction for a treatment plan; hence, the conclusions of extraction or for high-pull headgear in patients with high angles.
15. Most believed that excessive opening rotation during treatment was the result of the "growth pattern" expressing itself and not iatrogenic. Further errors in the rendering were considered to be errors in growth forecasting alone, not the miscalculation of treatment effects.
16. Many wanted to know about its popularity, believing that if not many were using it the forecasting principle couldn't be all that good.
17. Many were so blinded by conceit that they proclaimed they didn't need it (or anything else) to diagnose, prognose, or monitor their successes or failures. They rejected cephalometrics altogether.

Present Conditions

But with all that negative thought, the method was found to have great merit, not just for the VTO but also later in the longer range VTG, or Visualized Treatment Goal to maturity. To accept the second-hand statements of opposition, without the test of personal experience to follow it throughout its complete process, was to keep alive a faith in all clinical decisions without it. To discard its truth, without personal verification of its benefit, was to be overwhelmed with ego.

Every clinician should remain a student and be humble, willing to sacrifice the time to learn and maintain a deep yearning for knowing the truth. Have humbleness, sacrifice and curiosity been lost by our youth and has teaching in our schools been altered for personal gain and expediency alone? With the VTO and long-range goals the profession as a specialty has the distinct opportunity to advance.

SUMMARY

The idea of setting up treatment on tracing paper was precipitated in 1950. The success of an endeavor to 'predict" the outcome was contingent on three factors. These were (1) a knowledge of growth projected on the individual patient's makeup; (2) a knowledge of the influences of given mechanics on that growth matrix; and (3) the ability of the orthodontist to produce results that conform to the "blueprint".

Weaknesses in cephalometrics were corrected and new planes were established for analysis and for projection. Changes were made and the evolution of these was described. As new treatment possibilities emerged so did the objectives change.

The computer was a breakthrough for research. Without it, the progress would not have been made, or made much more slowly. With it new patterns emerged.

There have been problems in the communication of the idea and procedure of

the VTO and VTG. The evident reluctance was discussed. Opportunities with this idea are unlimited.

THE LOGIC AND KEYS TO BIOPROGRESSIVE PHILOSOPHY AND TREATMENT MECHANICS

CHAPTER TWO

THE PLANNING PHILOSOPHY

I. Introduction

There seem to be two kinds of clinicians. One professional may be involved in the thinking process of just straightening permanent teeth alone. This leads to a concentration on the model. For that person, treatment planning may be conducted with static thinking or rearranging the teeth as if fixed on an articulator. That orthodontist may treat to the convexity or rely later on jaw surgery for maxillo-mandibular correction. The horizontal dimension is a main focus for sagittal arch length, for arch relation and correction by tooth movements alone. The "ridge" is a principle guide, and treatment to him or her is fraught with remarkable limitation.

A second professional thinks biologically and thinks dynamically. Growth, physiologic change, induced skeletal change and biology now occupy the consciousness. A three-dimensional view is present, and the fourth dimension -- time -- enters into concern.

If there is one characteristic that marks the Bioprogressive thinker it is the discipline to consider the whole patient now and far into the future. Further, this clinician's idea is to provide care for all ages. Thus the earlier the start the more a long-range prognosis to maturity becomes an issue. Consequently, the progressivist is apt to take more seriously the diagnosis, prognosis and planning procedures.

II. Essence of the V.T.O.

In the end the purpose of diagnosis and prognosis is to supply information for the establishment of a treatment regime. Theoretically, the better the diagnosis and the forecast of the future the more correct will be the plan, the more cogent will be the effort, and the less will be the risk. Thus, planning -- in a sophisticated or refined and properly developed manner -- is dependent on the **depth of the supply of information** regarding the condition to be treated.

To plan is to devise a treatment sequence beforehand. The **design** is the final outcome resulting from the skill employed for its construction. A **project** uses imagination for an extensive enterprise. (We project the future depending upon the individual.) A **scheme** can refer to an analysis or a summary form. All the foregoing ideas refer to visionary and systematic programs aimed toward the attainment of a proper end result.

The visualized treatment objective, or V.T.O., is actually a design. The idea to preconceive the needs and produce a tangible image as a precursor to actual anchorage planning was an evolutionary event discussed in Chapter One. It was born during the era of the doctrine of limitations in orthodontics that developed in the 1930s and 1940s. With clinical experiment and trials of new materials and techniques, starting in 1950, many of the old canons of limitation belief began to crumble. Isolated extraoral traction, sectional mechanics, application of the quad-helix, crib appliances, mandibular positioning, the development of utility arches for intrusion and arch length increases, the use of cortical anchorage, and the use of concatination of wires all produced different results from those produced by continuous older straight-wire methods. After twenty years, in 1967, Ricketts challenged the traditional practitioners with many new ideas. Some thirty of the older concepts came to be questioned and new possibilities were proclaimed.

III. The Possibility Doctrine

Possibility is that which is capable of being produced. An argument is presented when prescribed treatment is to be judged "depending upon the circumstances". Some do not agree on the conditions and factors under question. Planning treatment **practicably** is something which can be readily affected under the conditions prevailing. **Feasible** refers to that which is deemed to be carried through to the most successful conclusion. Hence, a clinician's design before acceptance should be evaluated for possibility, practicality and feasibility, or the PPF test.

A clinician is unlikely to plan to do something he or she conceives of as impossible, impractical, or damaging. Therefore, an effort is made to avoid procedures deemed unworthy for application.

Many fundamental clinical possibilities or major truths surfaced in the 1950s and 1960s. They should have been communicated, debated on a uniform basis and rejected on scientific grounds if unacceptable. However, time has proven at least twelve major principles to be worthy of consideration.

Principles

The following principles are being embraced and practiced by clinicians on a world scale:

1. Any tooth can be intruded with light continuous pressure in the range around 1 gram per mm. in cross-sectional root area.

2. Molars can be moved distally, particularly when isolated, and premolars may drift according to compensatory phenomena.

3. Skeletal change (or orthopedics) is achievable particularly in the maxillary complex and temporarily in the mandible.

4. The lower incisor and lower arch can be moved forward, but muscle is a source of resistance, particularly the sublabial area of the lower lip.

5. The oral environment can be changed within limits and soft tissue surgery can be employed for greater limits.

6. Cortical bone supplies better anchorage and cortical avoidance preserves anchorage during differential movements.

7. Lateral expansion, with proper pressures can effectively create arch length without alveolar bone destruction.

8. Inter-canine width in the lower can be increased up to normal limits for the patient.

9. Extraction is not a guarantee against future incisor imbrication, and early removal of lower third molars when indicated will assist in arch development.

10. The "unlocking" principle has several applications.

11. Sequences and sectioning of arches permit changes not possible by the use of straight continuous arches.

12. Reasonable and useful predictions can be made as guides for mechanical anchorage planning and for esthetic and functional objectives.

The important fact of all these possibilities is that **all modalities do not produce the same results**. It thus becomes a matter for the clinician to **select the appliance to best accomplish a specific objective**. Decisions are made relative to the accomplishment of the objectives. The second obligation is to select priorities, in sequences, from the appliances available, for the fulfillment of the plan.

IV. The Fundamental Uses of Cephalometrics

The application of current cephalometrics requires a good knowledge of anatomy. New points and planes and measurements have emerged and can be

learned easily with study and experience. Many of the older cephalometric methods have become outmoded and obsolete in the light of contemporary knowledge. Special training in proper use and interpretation is most prudent (see *Progressive Cephalometrics -- Paradigm 2000*).

It is most important that the individual clinician be prepared for analyzing the effects of his own treatment.

For contemporary clinical diagnostic and planning sophistication, there are seventeen imperatives the clinician should master, divided into three groups. The first group is diagnostic and analytic; the second group is for growth and monitoring analysis, and the third is for planning treatment mechanics, as follows:

A. The Ultimate Application

Analytics

(1) Conversion of information from the model,
(2,3) Summary Analysis (lateral and frontal),
(4,5) Comprehensive Computer Analysis,
(6) Divine Proportion analysis and Harmonic Equations, and
(7) TMJ imaging.

Serial

(8) Polar Growth phenomenon,
(9) The five-positional summary behavioral analysis,
(10) Arcial mandibular growth analysis,
(11) Treatment Possibilities.

Planning Objectives and Anchorage for Construction

(12) Long Range Forecasting,
(13) Visualized Treatment Goal (VTG),
(14) Visualized Treatment Objective (VTO),
(15) The sequences for Cybernetic circle,
(16) Analysis of the VTO for calculations of anchorage required,
(17) Selection of treatment modalities to execute the plan.

1. **Analytics**

(1) Model Conversion

An orthodontist tends to observe models but often does not measure. Norm values and ranges of variation in arch dimensions offer a frame of reference for the decision making process. In addition, the conditions in the model are not equated to the lateral and frontal headplates. By measuring widths and depths in the arches the model is correlated to the X-ray for a more succinct description and evaluation. The normal data and a given patient may illustrate the procedure (Fig. 1).

(2,3) Summary Analysis

The selection of points and planes are described in "Progressive Cephalometrics -- Paradigm 2000". Fourteen measurements are employed in the lateral for evaluation of the cranial base, mandible, maxilla, mandibular and maxillary teeth, and soft tissue. Fourteen measurements are used in the frontal as a summary abstraction. In the frontal, points should be equidistant from the central plane. Lower intercanine width, lower first premolar widths, and first molar widths (Fig. 2) are compared to the model for prognosis and planning.

(4,5) Comprehensive Analysis

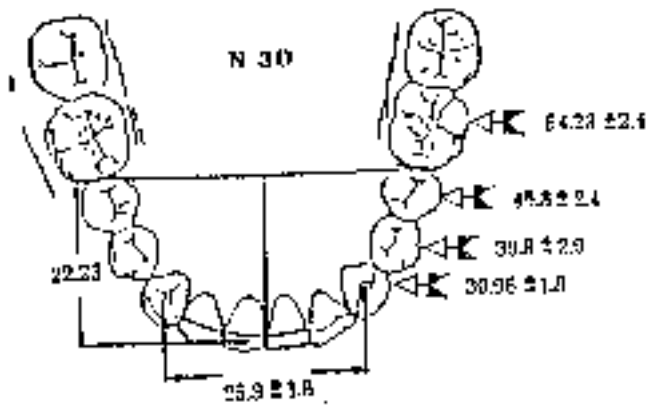
This is delegated to the computer. Many measurements are used and other analyses are covered for a system to answer most any question arising on a morphologic basis. The analysis is divided into families of measurements organized into different fields for ease of communication.

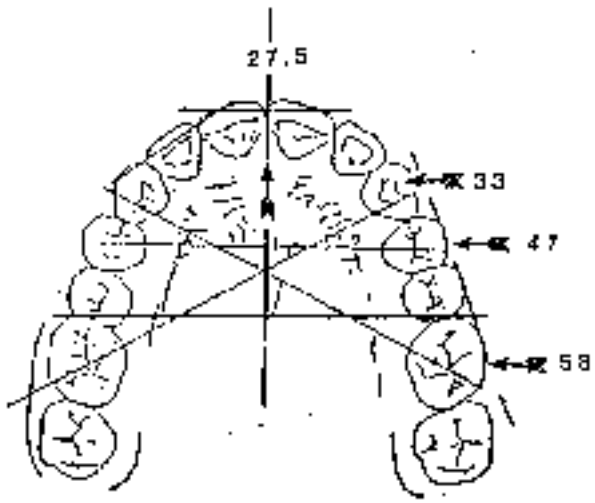
(6) Divine Proportion Analysis

Wide use of this analysis has yet to come. The "golden cut" or "divine proportion" is a value of 1.0:1.618 relationship between parts. It is of immense value in orthognathic surgery for esthetics as well as function. There is a total of twenty proportions that have application in the lateral and frontal headplate together with the frontal photograph. These, together with some other relations, have been called the "Harmonic Equation" Analysis (Fig. 3A and 3B).

(7) Temporomandibular Joint Imaging

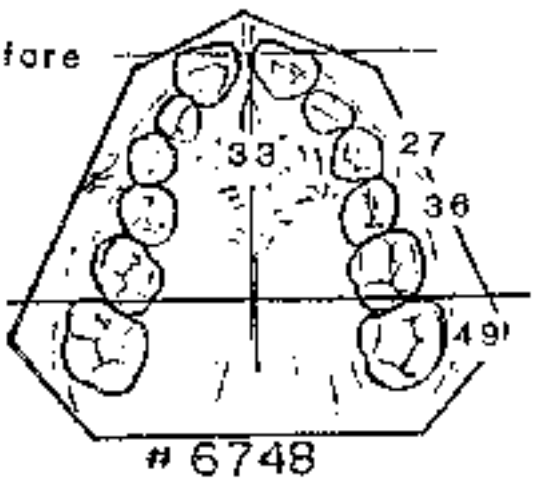
The popularity of the MRI image has even further justified the use of Tomography. Data for normal morphology and relations has been reverified (Fig. 4). Isolated joint X-rays should be interpreted together with cephalometric films.

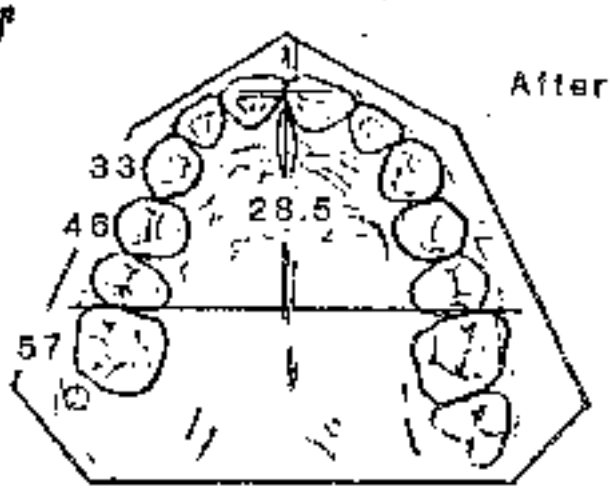


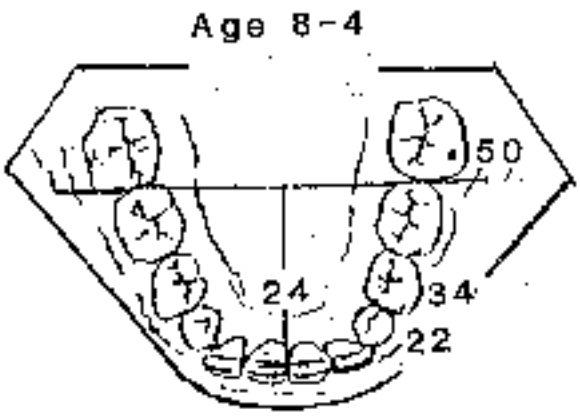


NORMAL DIMENSIONS

G.A. ♂







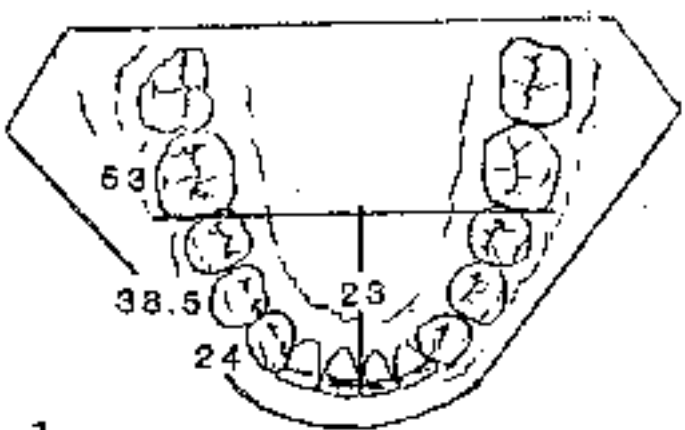


Fig. 1

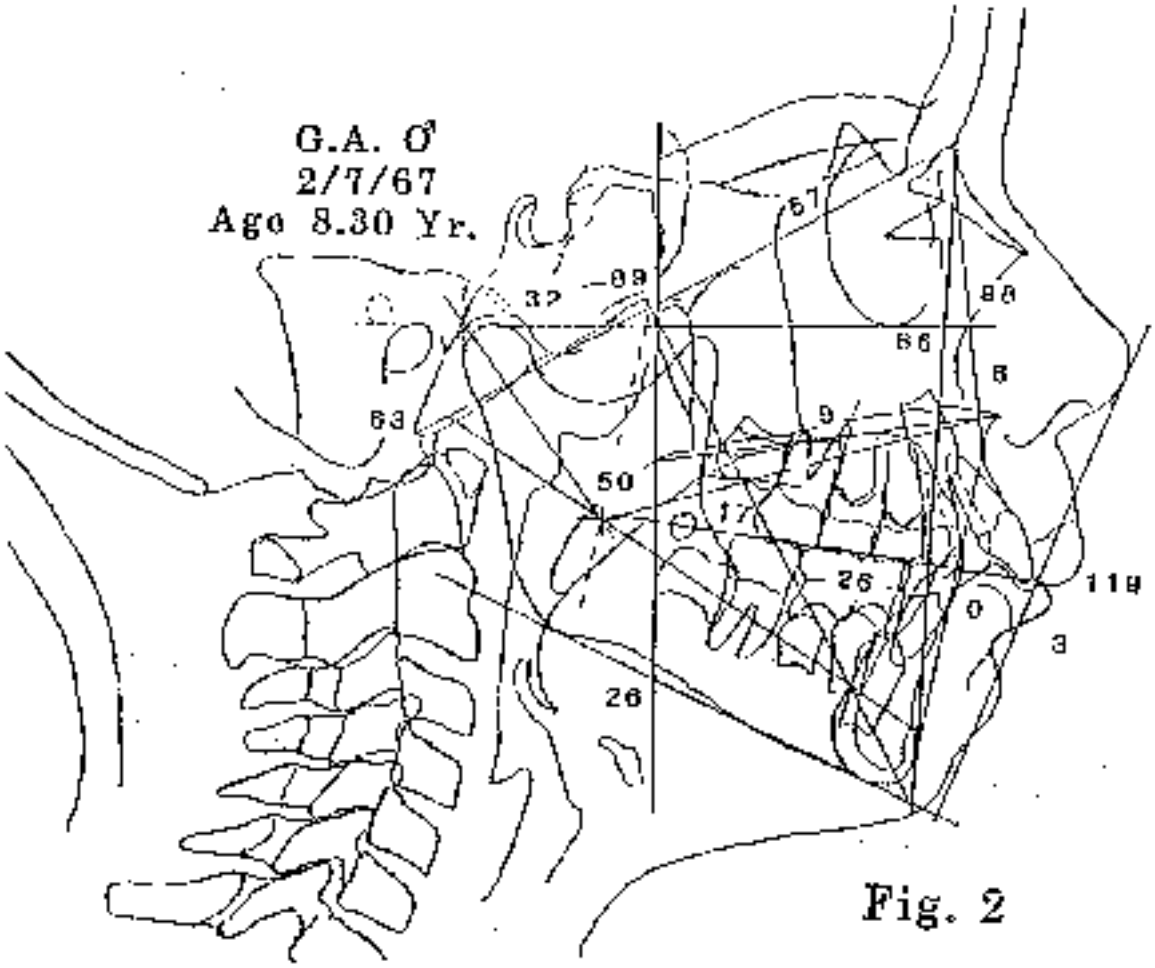
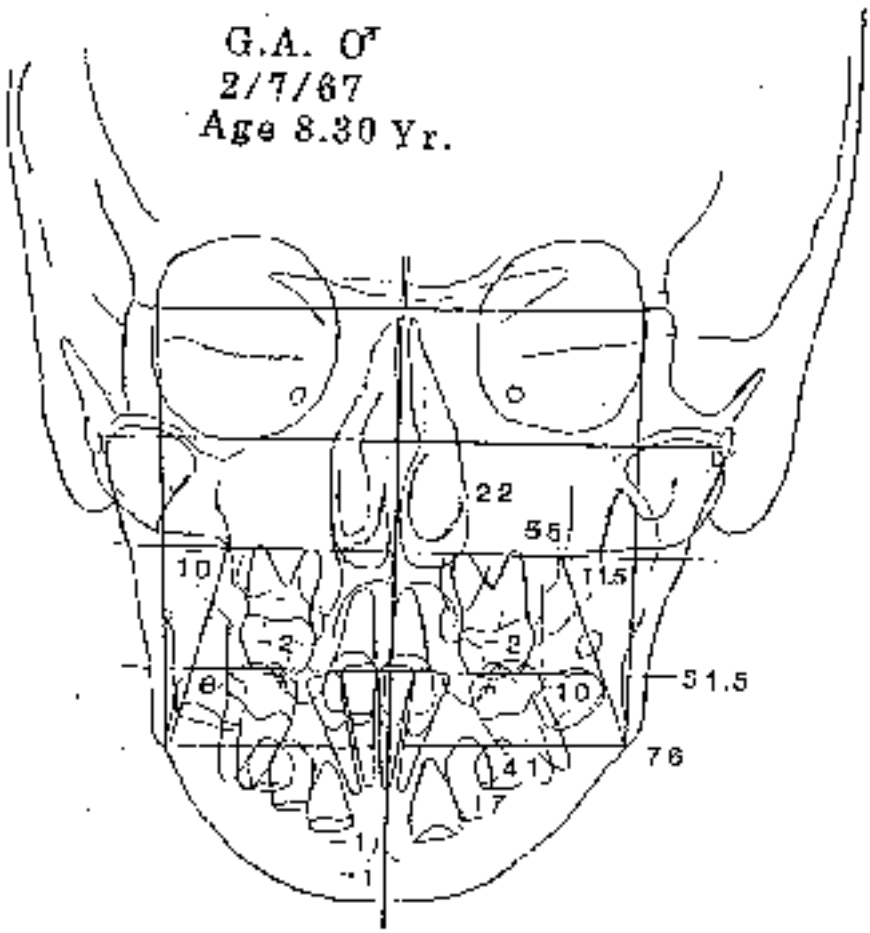

G.A. ♂
2/7/67
Age 8.30 Yr.
67
-89
86
66
6
63
9
50
17
26
0
119
3
26

Fig. 2


G.A. ♂
2/7/67
Age 8.30 Yr.
22
55
10
11.5
-2
-2
51.5
10
76
41
17
-1
-1

R

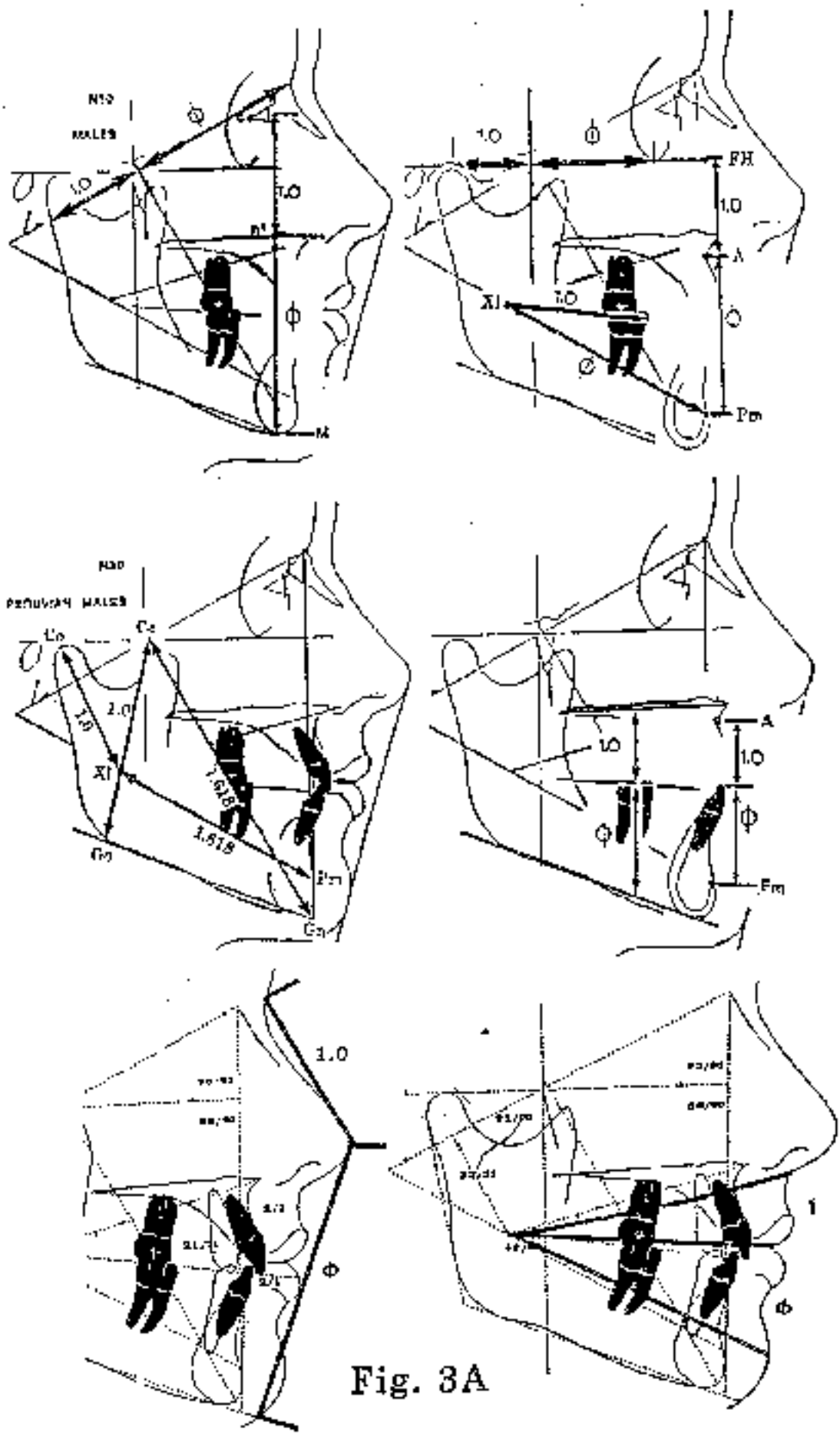
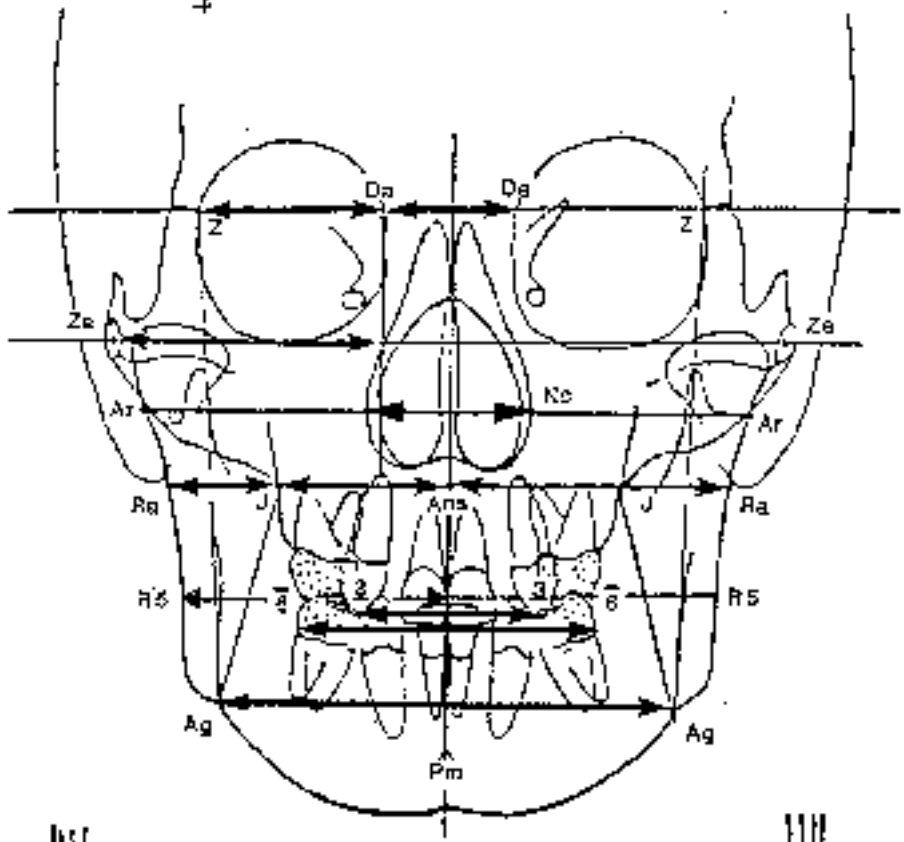


Fig. 3A

♂ ADULT COMPOSITE N82



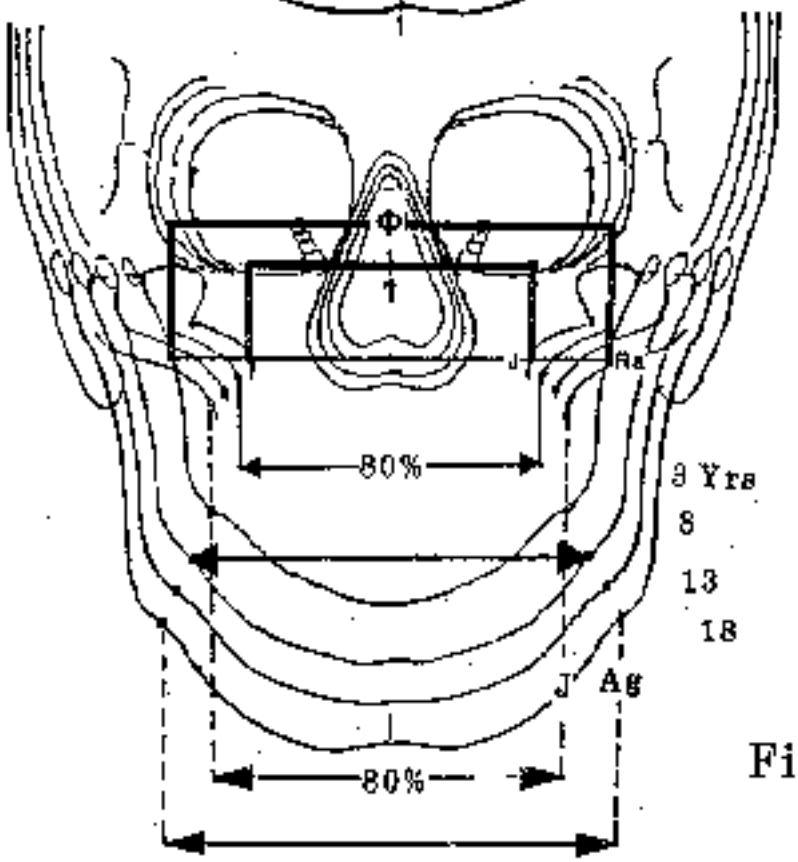


Fig. 3B

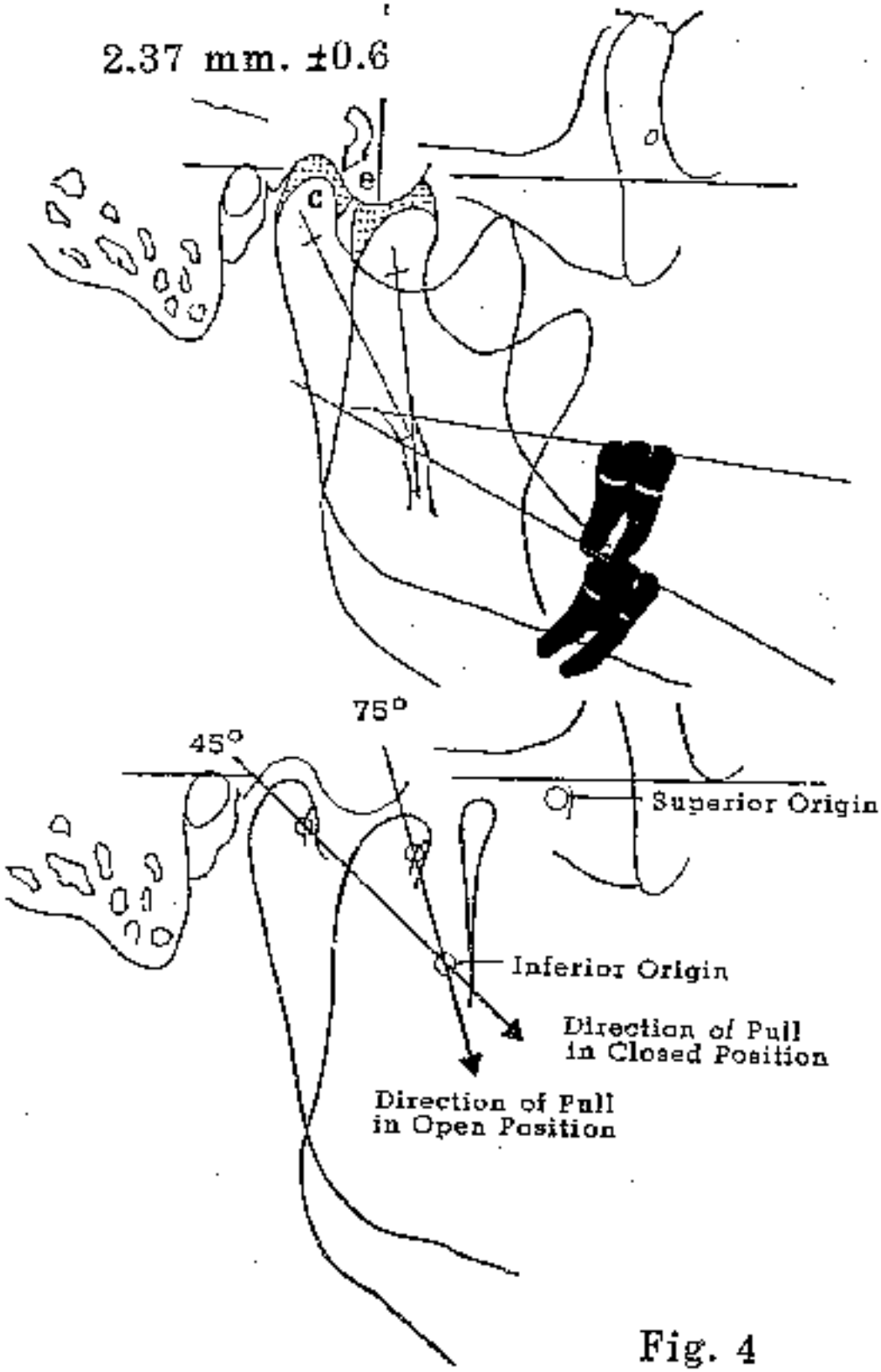

2.37 mm. ±0.6
e
c
75°
45°
Superior Origin
Inferior Origin
Direction of Pull
in Closed Position
Direction of Pull
in Open Position

Fig. 4

2. Serial (Sequential)

(8) **Polar Growth Phenomenon**

From studies of trustworthy composites and polar grids, centers of growth were identified. For a central base for the face, the Basion-Nasion Plane registered at Cc was found to produce the greatest order during growth. In addition, the vertex of angles at the entrance of branches of the 5th nerve were found to characterize gnomic or allometric growth.

In the frontal, two centers were found, one at each foramen rotundum. For a practical center one point at a crossing of the frontal Frankfort Plane with the central sagittal plane was employed.

(9) **Five-Positional Summary Behavioral Analysis**

In order to provide a simple, orderly and trustworthy basis for determining treatment changes, as opposed to growth changes, an analysis was developed. This was for skeletal change of the chin position and the maxilla. The patterns of normal eruption and development of each arch was also described for a reference base (Fig. 5). The Facial Axis, Nasal Plane, Palatal Plane, and Corpus Axis formed the base of reference. Means and standard deviations yield a reliable starting frame of reference.

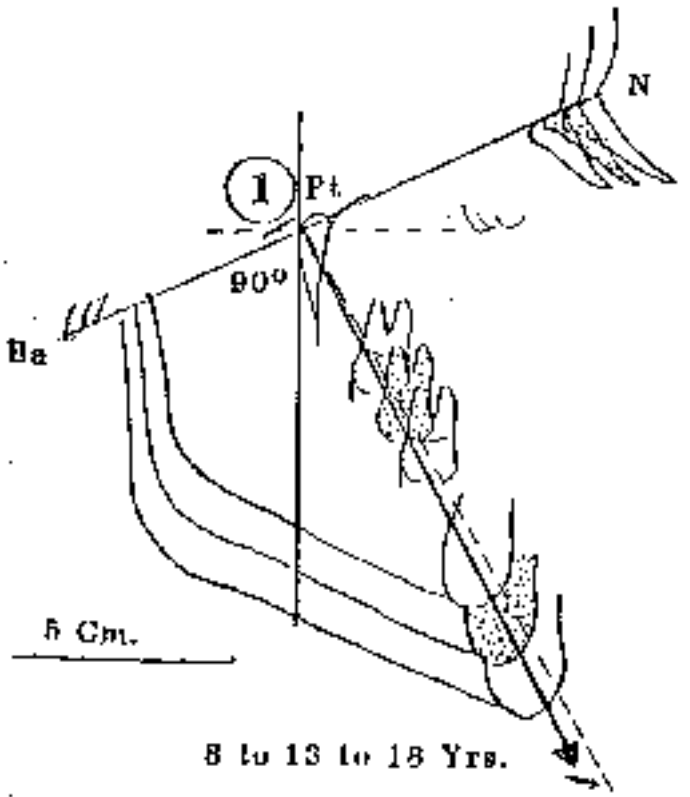
(10) **Arcial Mandibular Growth Analysis**

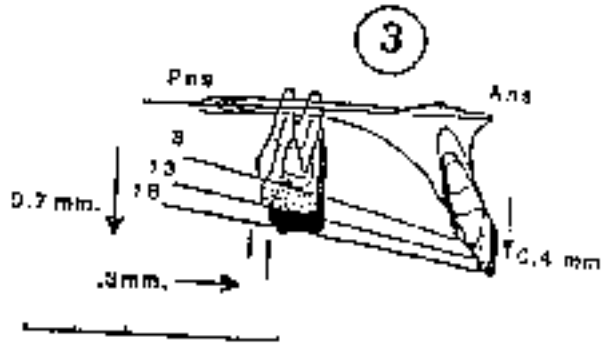
The composites of normal growth in several samples all showed the mandible to bend at the junction of the corpus-condyle axis. This clearly indicated that the normal human mandible grows on the arc of circle, or spiral. Research led to the identification of a point at the base of the coronoid to be employed with Pm point on the chin to form an arc for forecasting. When superimposing isolated bases the Pm point is used together with the external oblique ridge to most truly depict growth and eruption of mandibular teeth (Fig. 6).

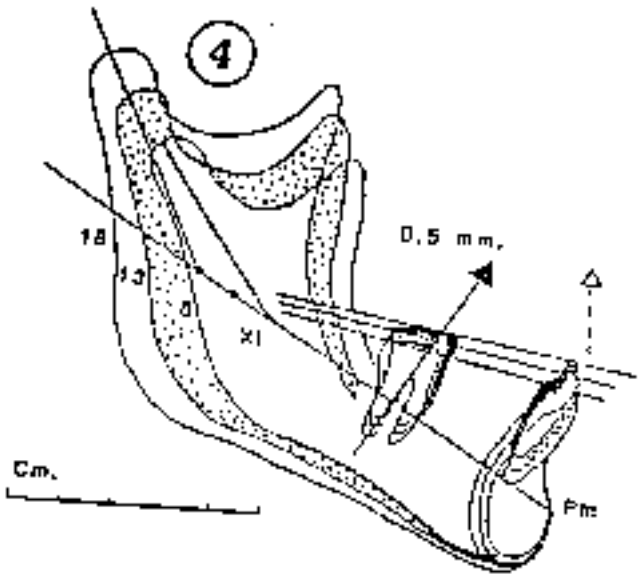
(11) **The Range of Treatment Possibilities**

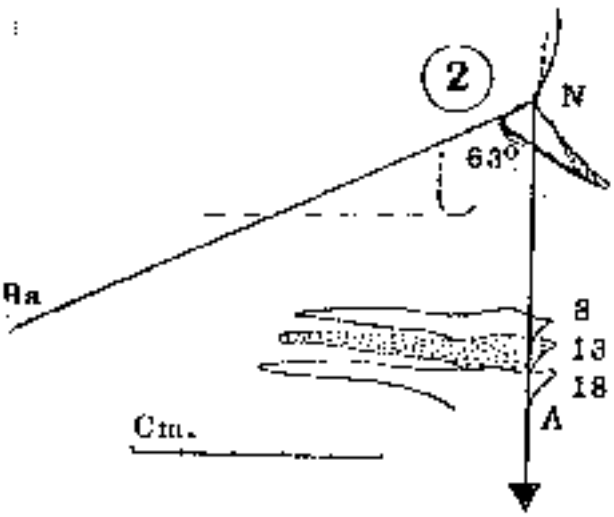
Possibilities were described earlier, but amounts should be recognized. Individual patients will show the extent of possibility. Composites of mean behavior will indicate practical expectancy. The extremes found so far are as follows:

Mandibular rotation (Facial Axis)	=	+ 7° to - 8°
Point A Reduction (BaNA)	=	- 12°
Point A Advancement (BaNA)	=	+ 7°
Forward movement of lower arch	=	+ 10 mm.
Intrusion of incisors	=	length of crown


1
N
Pt.
90°
Ba
5 Cm.
8 to 13 to 18 Yrs.


3
Pns
Ans
8
13
18
0.7 mm.
.3mm.
0.4 mm


4
18
13
8
XI
0.5 mm.
Cm.
Pm


2
N
63°
Ba
8
13
18
A
Cm.

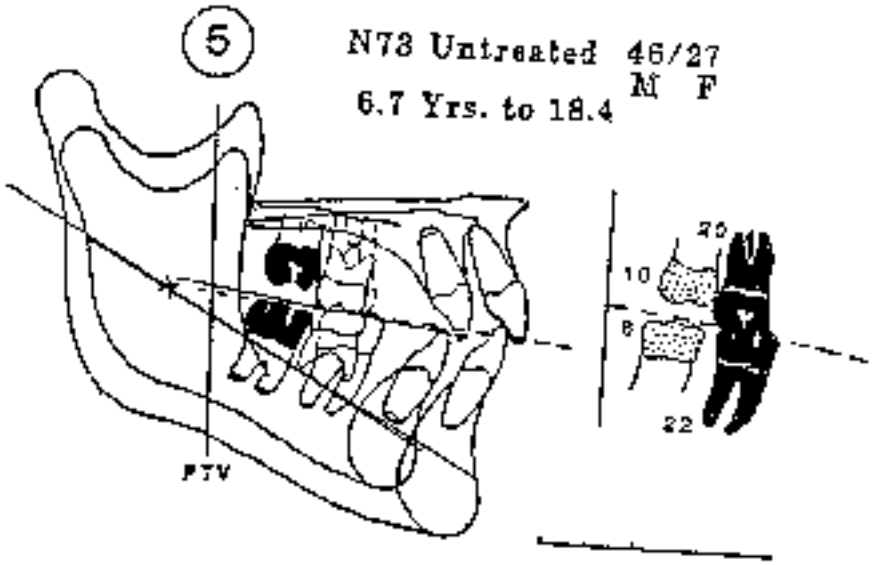

5
N73 Untreated 46/27
M F
6.7 Yrs. to 18.4
20
10
8
22
PTV

Fig. 5

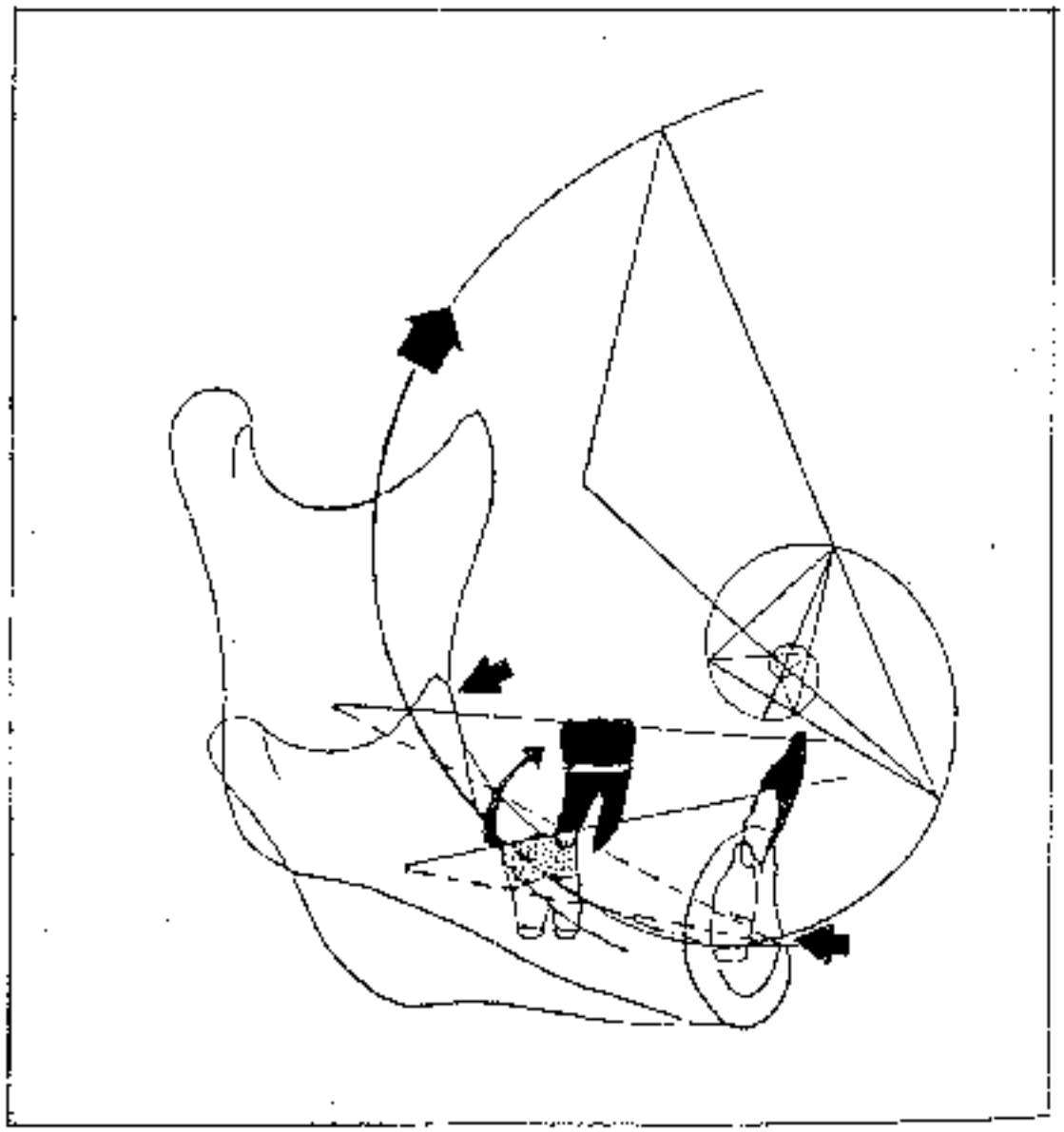


Fig. 6

Intrusion of upper molar	=	length of root
Intrusion of lower molar	=	4 mm.
Distalization of upper molar	=	10 mm.
Distalization of lower molar	=	4 mm.
Retraction of incisal edge of $\underline{1}$	=	20 mm.
Expansion (in adult)	=	14 mm.

3. Planning (First Objectives and Then Anchorage)

(12) Long-Range Forecasting

Like the stock market, which averages out over long periods, so does human growth tend to do so. The discovery of the arc of mandibular growth and the standardization of growth was a valuable adjunct. Correction for sex cut-offs, sexual dimorphism areas, skeletal age corrections, and adjustments for certain morphologic variables made individual forecasts surprisingly accurate. When the identification of disease states or accidents were added it made mandibular forecasting quite practical.

The growth and development of the skull base was more difficult, but maxillo-mandibular relations were found to be easier than anticipated. The long range forecast (to maturity) theoretically is a starting point from which to work backward in the decision-making process. In other words, it becomes the vehicle to see what remains to be corrected after growth has expressed its influence. Growth without treatment is termed simply a Long Range Forecast (LRF). Naturally, the termination or continuance of habits is a factor challenging the predictor (Fig. 7).

(13) Visualized Treatment Goal (VTG)

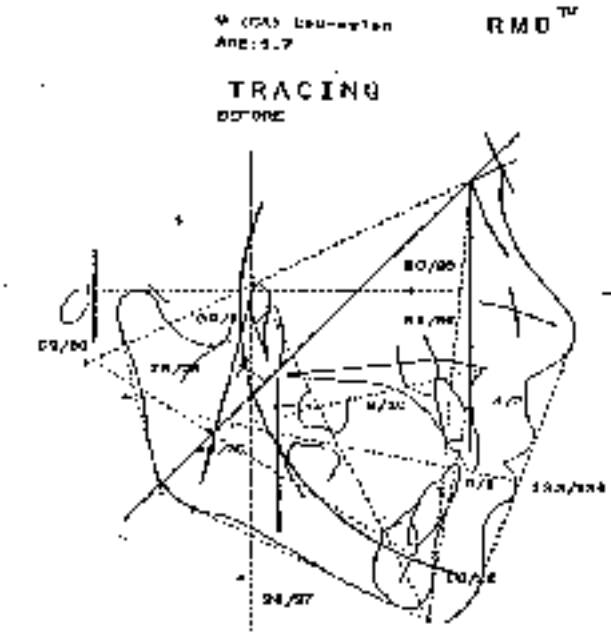
By using the nontreated forecast, as a matrix, convexity and vertical relations can be altered according to objectives of the individual clinician and the individual patient. The younger the patient the greater the possible extent of orthopedics. Therefore, objectives may differ with different ages. Individual types are to be respected, but esthetic and functional parameters may be employed to establish order for setting up objectives (Fig. 8).

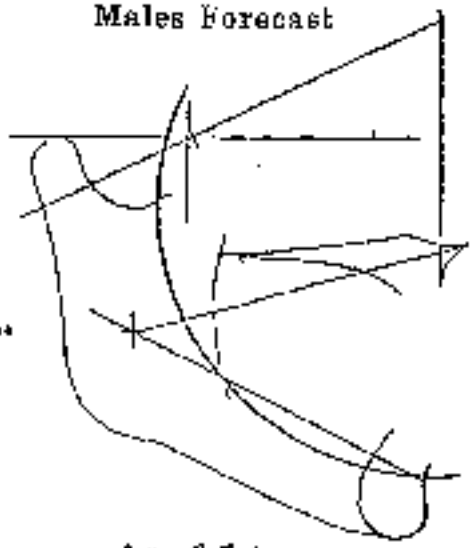
A goal is a long-term intent. Thus, when the forecast is corrected for optimal changes it is called the VTG or visualized treatment goal.

There is magic in the application of Xi point. Although when it was first proposed it met with great disfavor, it has proven to be a most welcomed point for astute clinicians with its eight applications (Fig. 9).

(14) Visualized Treatment Objective (VTO)

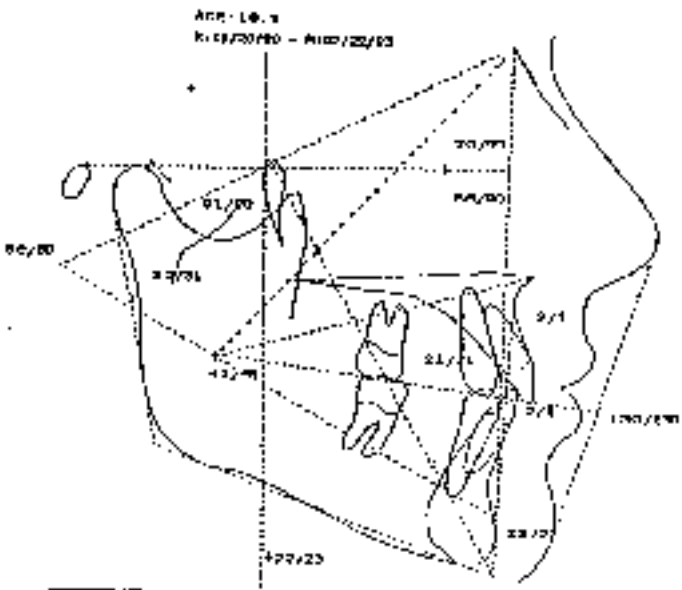
Before the arc was discovered the techniques employed were a





Age 6.7 to

18.1



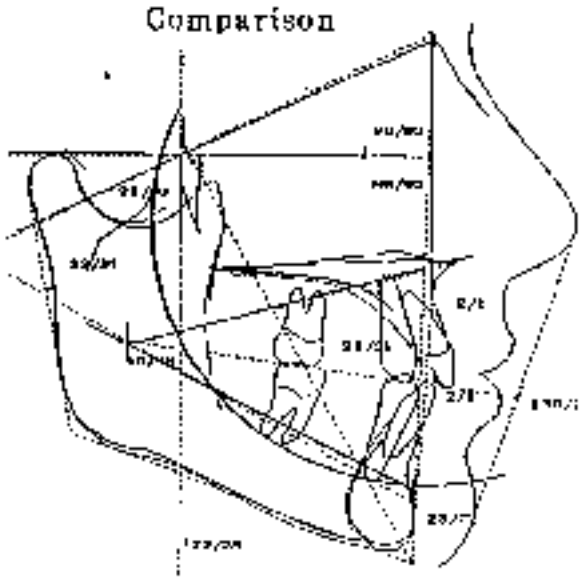


Fig. 7

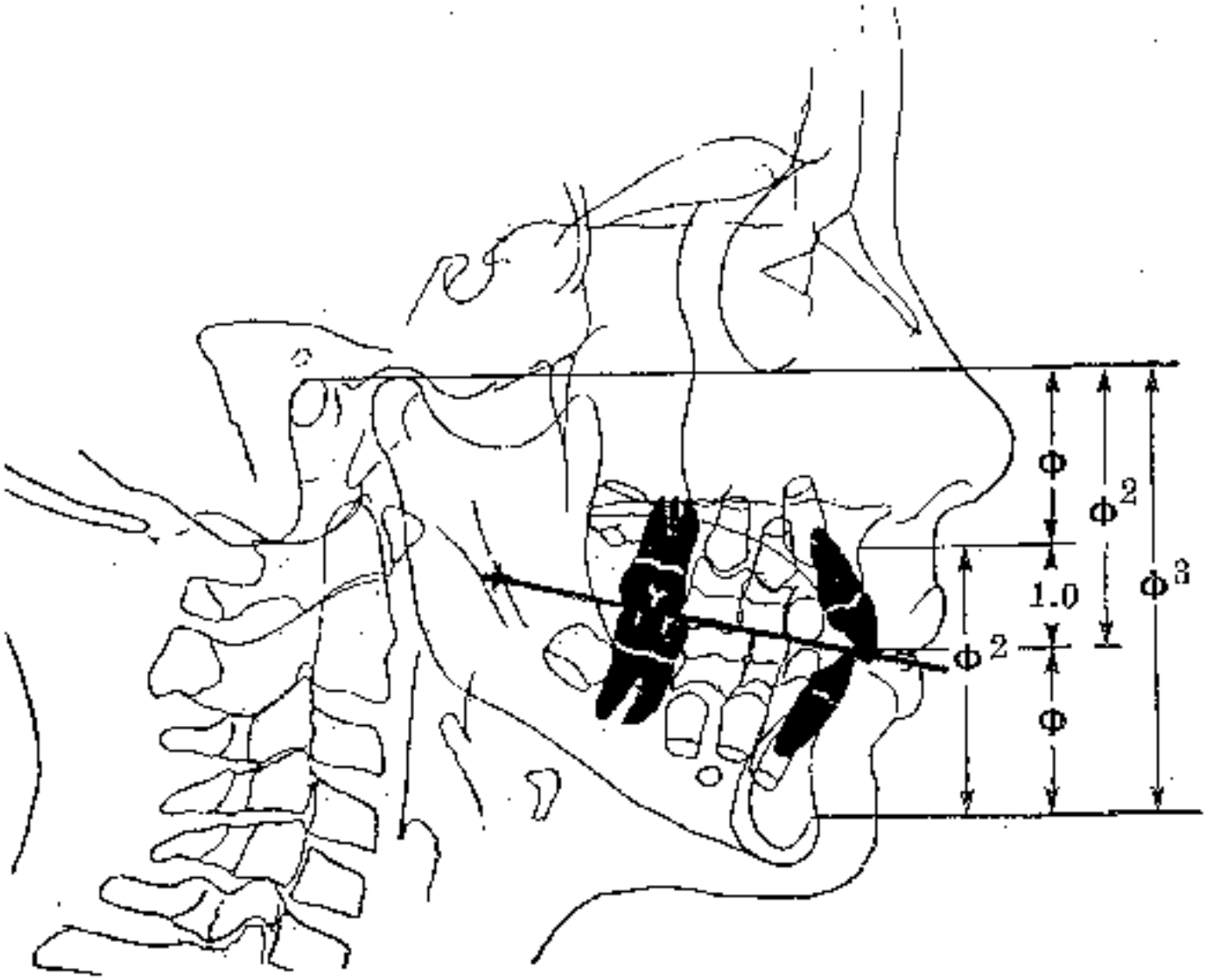


Fig. 8

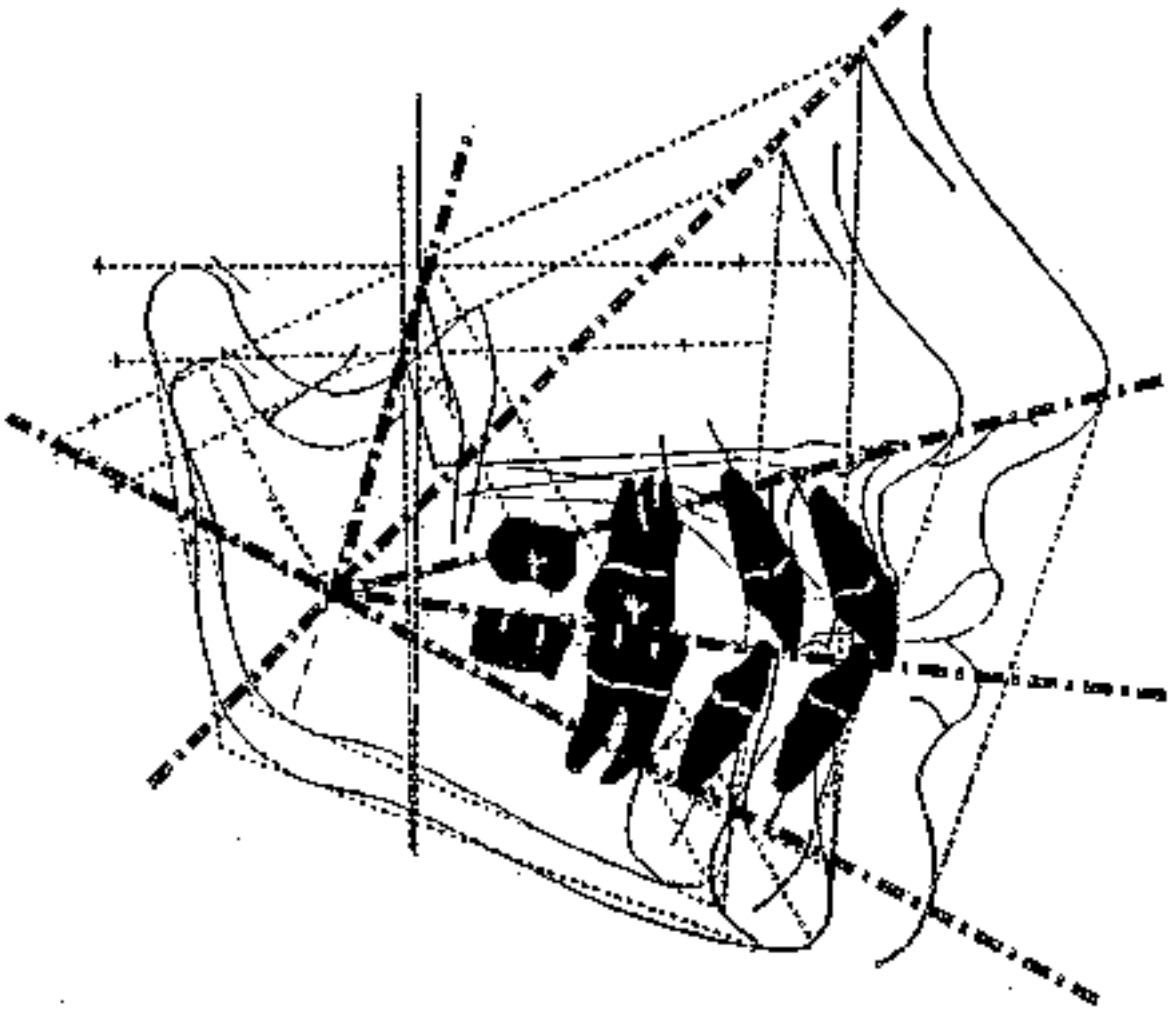


Fig. 9

combination of extensions and alterations of planes of reference. The cranial base, mandible and maxilla were set up on paper in that order. This served as a foundation on which the teeth were set up. This was followed by the soft tissue forecasts. The projections on that scheme were workable in short range or during the usual two-year experience. A modular concept was employed with typical growth for one year employed as one module.

The VTO worked for those having mechanical knowledge and skill to produce it. The VTO will not work unless it is employed to plan anchorage or if by chance the technique employed yields results consistent with the design. This is such a simple fact it is amazing it is so misunderstood.

Certain factors such as disease states, psychologic states, and pain thresholds need consideration. Rare cases with extreme, unusual behavior may be experienced. A 90% accuracy is routinely anticipated. Orthopedic changes in the palatal plane were not visualized until the misses were observed in that study in 1955.

(15) The Sequence in the Cybernetic Circle

For explanation of the steps to follow in making a treatment design (VTO), the logic was drawn in a circle. Each component was related to each other component as a feedback or cybernetic element. For instance, the placement of the lower incisor would affect arch depth, which affected arch length and hence the position of the lower first molar (Fig. 10).

Skeletal

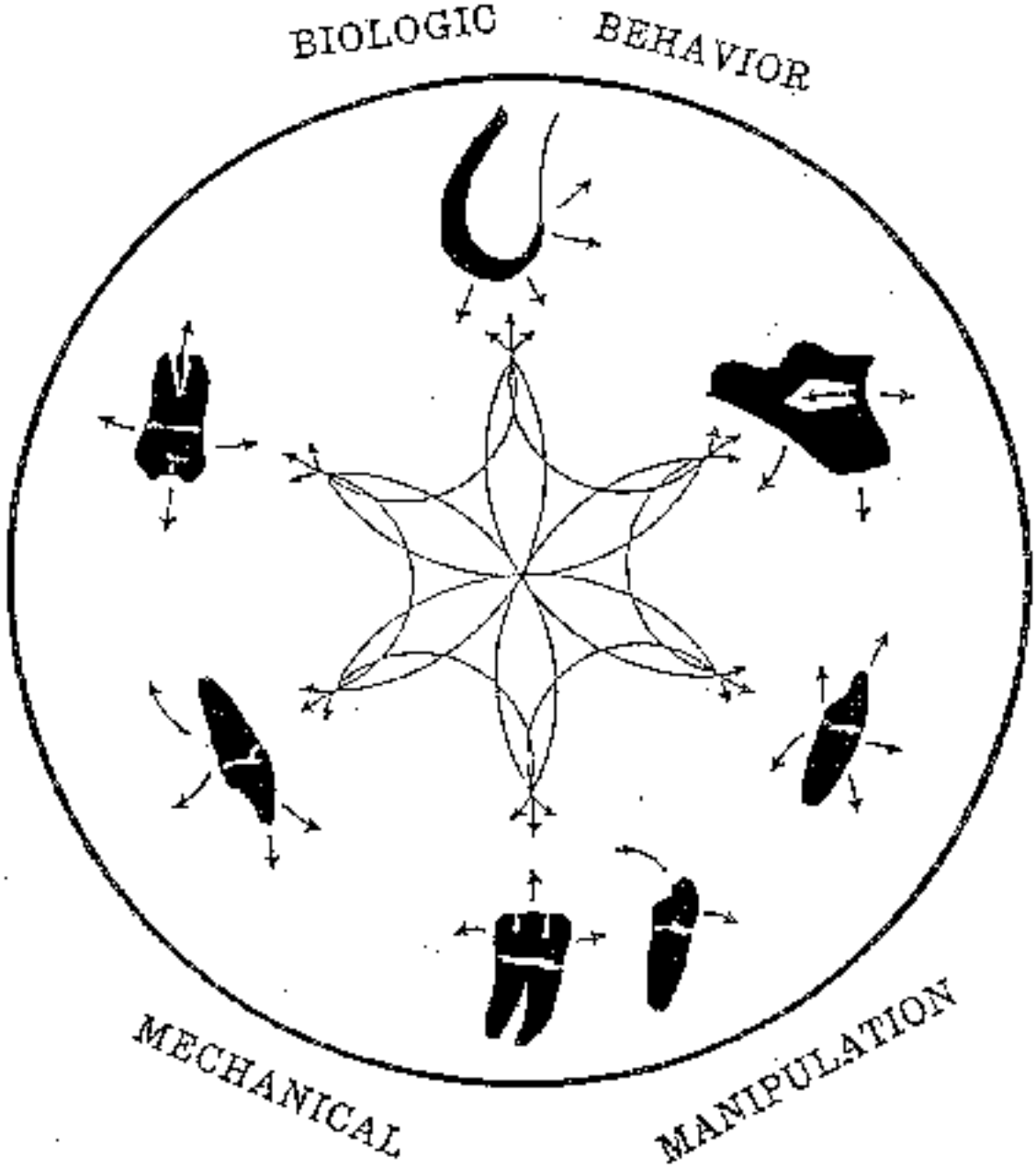
The procedure in "setting up a case" on paper is first skeletal and then dental. The position of the chin that will be present as a result of growth and the treatment itself is the starting base. Traditionally, Pogonion was used, but Pog can be used for the vertical.

The second issue is, then, where the maxilla will need to be because this can be controlled in the young patient. Even Point A alone can be retracted slightly as alveolar modification is accomplished in corrective and rehabilitative cases, but for total facial esthetics the nasal floor may need to be modified.

After skeletal change is designed, two references are employed for the dental planning. These are the **APo (or APm)** and the true buccal occlusal plane (Fig. 11).

Dental

The lower incisor is the key to denture emplacement. The horizontal and vertical positioning of the lower incisor is the most controversial issue in all of orthodontics. Racial type, ethnic type, facial type, lip tension, tongue position, and even personality constitute factors for concern.



CYBERNETIC CIRCLE

FOR PLANNING

Fig. 10

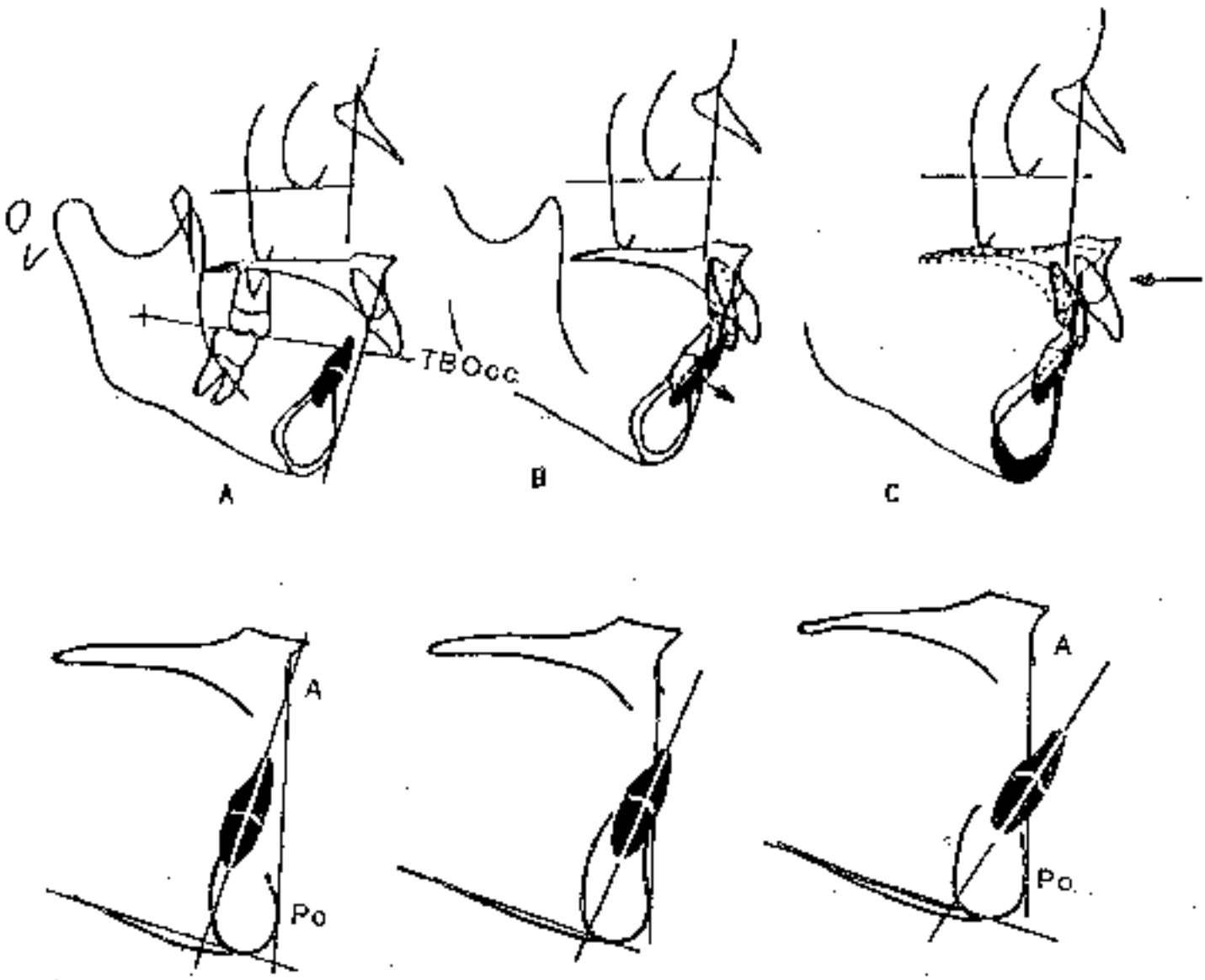


Fig. 11

A sample of beautiful young mixed dentition children in Chicago in 1948 displayed the mean lower incisor to be +1 mm. at 22° to the APo plane. This was originally held to be the objective if the environmental factors was managed. In loose, flaccid lip cases it could be placed at +3 or +4 (to the chagrin of some traditionalists). Later a sample of 83 normal subjects gathered by the Foundation for Orthodontic Research revealed a mean of +2.4 mm. ±2.0 mm. Black and oriental samples of normal adult males both yielded mean values of essentially +5 mm. In addition, the incisal edge of the lower incisor vertically in all races was found to be in the divine proportion to APm 1.0:1.618. Thus, once the skeletal framework was established the teeth could be set up.

The sequence after the lower incisor involves placement of the lower molar. Average arch depth cephalometrically is 23.5 mm. ± 1.4 mm. Extraction of premolars reduces that to 18 mm.

The lower arch then becomes a reference for the upper arch. The long axis upper incisor is then arranged at a mean of 126° to the lower as a mean objective, but is again modified by type. The upper molar is then related to the lower.

As stated before, practical and feasible considerations are made -- hence cybernetics.

(16) Analysis of the VTO for Calculations of Anchorage Required

This procedure employs the same four-position analysis described in (9) of this series. However, it depicts the movements of the jaws and the teeth that are the objective. **If the VTO is accepted the movement of the molars and the control of the mandible becomes the concern. If the VTO is rejected a modification is necessary.**

Thus in the Bioprogressive philosophy the orthopedics (skeletal change) becomes the first factor for anchorage. Studies have shown that the maxilla is capable of being changed in three dimensions in the young patient. The mandible is temporarily affected, but studies suggest that in long **range it is not capable of being increased but that maybe it can be inhibited.** The second in order in anchorage is control of the vertical position of the chin (orthopedics) so that **normal growth can be utilized** for Class I and Class II correction.

When skeletal modifications are made the whole arch is affected in maxillo-mandibular relations. Thus needed tooth movements and the anchorage required is the third in the order of anchorage evaluation.

Stated again, the foundations of the denture are the molars. The lower comes first and when these are established drift of premolars and position is

the fourth order. These are the walls of the denture. The upper incisor comes last as the ceiling on the denture. The amount of this movement and torque needed is the final calculation (Fig. 12).

(17) **Selection of Treatment Modalities to Execute the Plan**

There are essentially 20 options for mechanics or procedures available in orthodontics. For Bioprogressive philosophy, a format was established as a "Staging Matrix". Priorities are selected as determined by the goals for the individual patient. Essentially three treatment stages and a retention stage is employed.

An individual plan may be selected for each patient. A hierarchy of needs is determined, and appliances are selected in a sequence. It was recognized that attempts to accomplish orthopedics and fixed orthodontics simultaneously has complicated treatment and restricted the possibilities.

"Unlocking" of the conditions is a first priority. This means the bite, the teeth within the arch, the breathing apparatus and even psychologic factors. Thus the "forces of occlusion" are turned to favor correction rather than rigidly locking up normal biologic actions.

V. The Divine Proportion (Harmonic Equation)

There were several observations that led to the search for basic mathematical and biologic principles which terminated in the so-called "Harmonic Equation" theory, as mentioned before (see Fig. 3).

1. Certain proportions seemed to be consistent in humans with normal morphology, suggesting a deeper organization of structure.

2. The Polar Growth Phenomenon was orderly and in uniformity (Fig. 13).

3. Frontal perspectives had proportional relationship in the growth of the facial cavities resembling Fibonacci numbers.

4. Certain parts had proportional behavior such as the corpus axis and condylar axis of the mandible.

5. An arc of growth of the mandible resembled a logarithmic spiral.

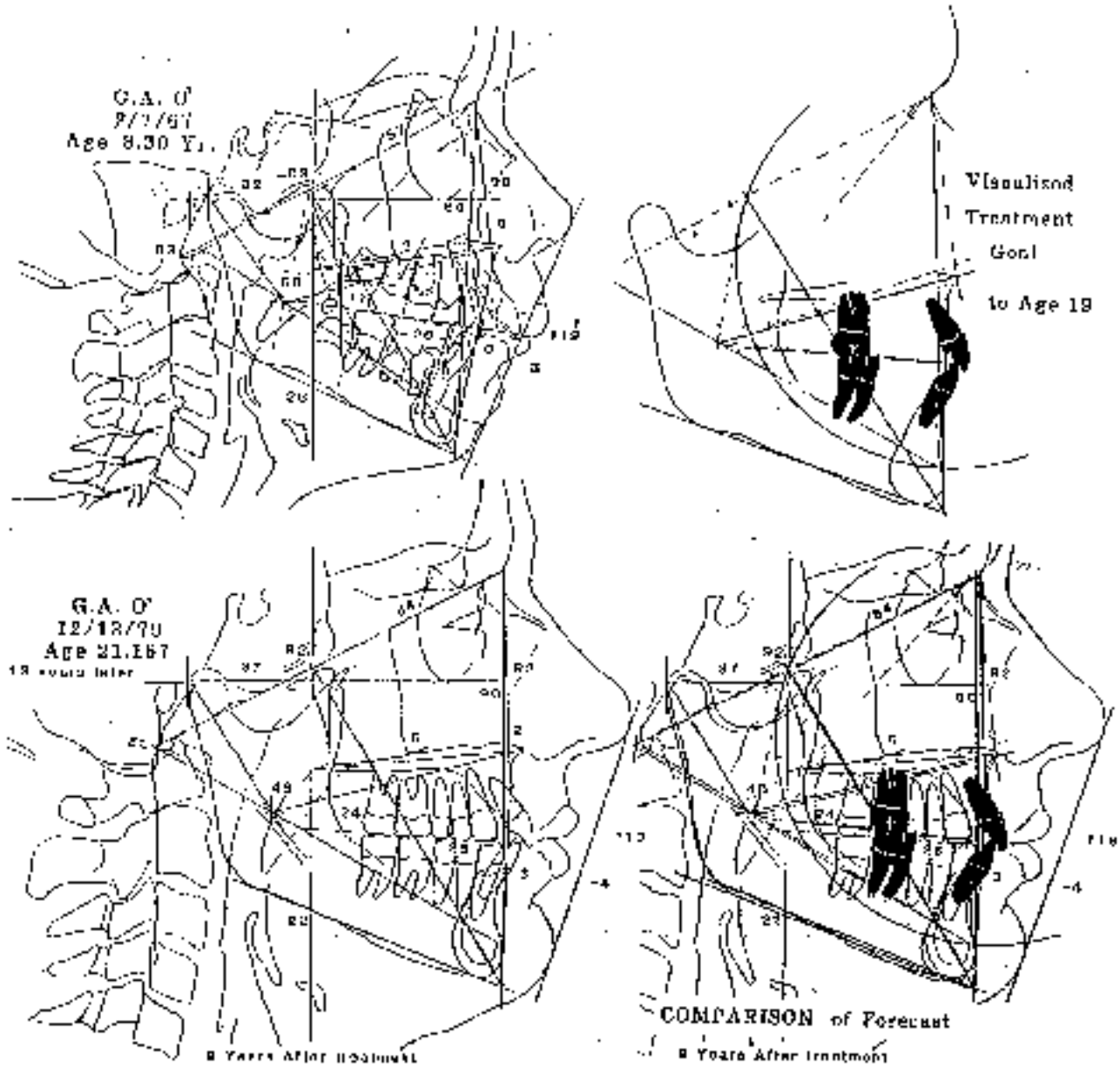
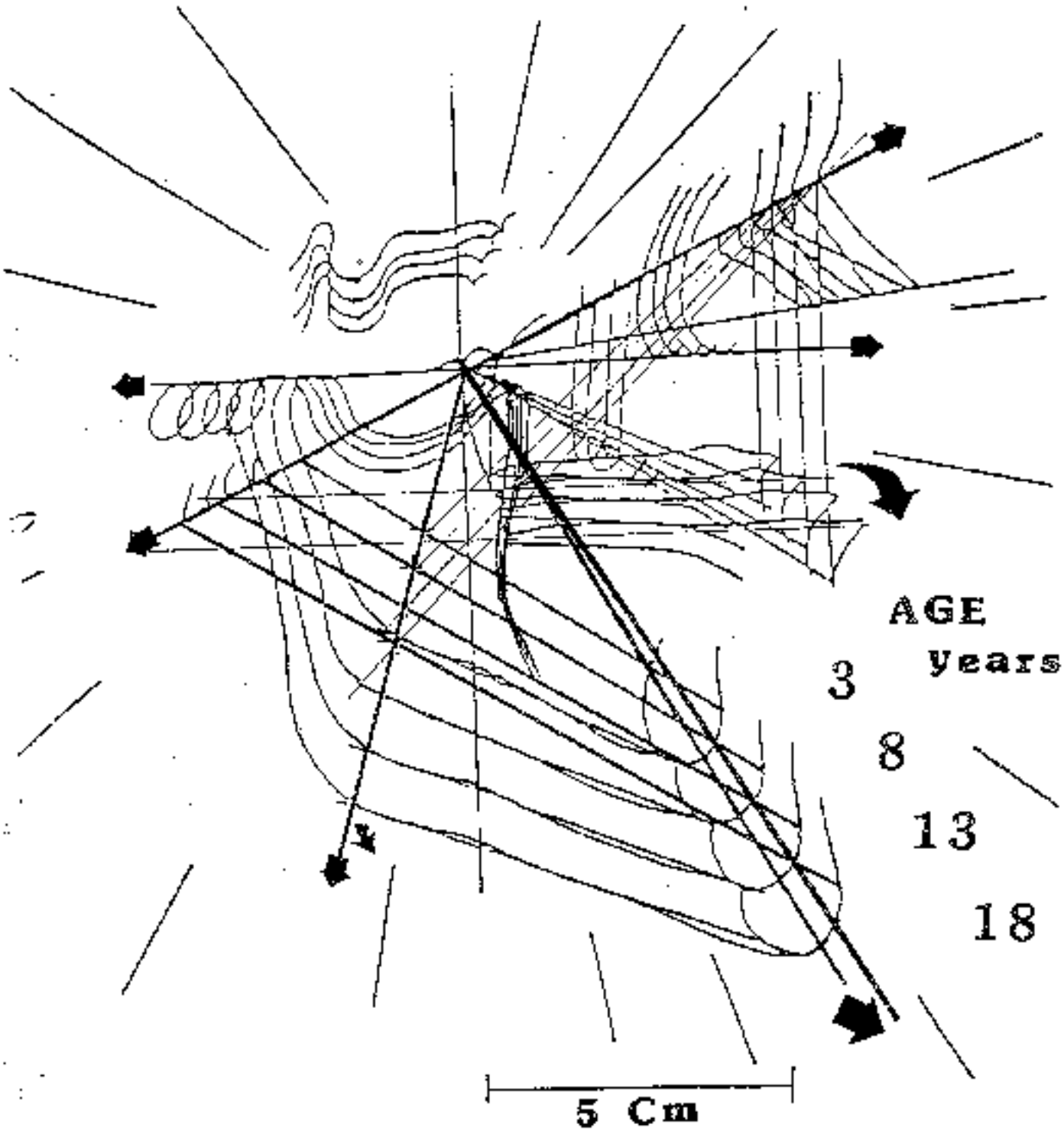

G.A. O'
Age 8.30 Yr.
Visualized
Treatment
Goal
to Age 18
G.A. O'
12/13/79
Age 21.167
COMPARISON of Forecast

Fig. 12



POLAR

Fig. 13

6. A neural bed for the face was recognized at the entrance of nerves into the cavities which explained asymmetries.

7. Patterns were identifiable as unity amid diversity.

With the recognition that proportions existed, some traditional points such as Nasion lost value and others gained in importance for diagnosis. Sensory input seemed also to be of more morphologic significance than formerly conceived. After age six there was more uniformity than expected in the structures of the head and neck.

The divine proportion worked well for surgical planning or in patients with severe dysplasias for whom orthopedics was planned. The analysis worked in both lateral and frontal perspectives. Space will not permit a review of the details of this new development.

VI. Patterns

In the past there has been some confusion regarding the concept of "patterns". The face itself is made up of parts which, as they are organized for the individual, may be referred to as that patient's pattern: For example, mesofacial, brachyfacial, or dolichofacial and extents of convexity. In other words, these are morphologic types, which were classified based on cumulative extents of clinical deviations (Fig. 14).

Also referred to are "growth patterns" which is more confusing. Semantically, this refers to the direction and amount of change in the chin as the primary factor in growth behavior. Direction is further confused by auto rotation (muscular) or growth rotation (change in form).

We therefore offer the following for communication:

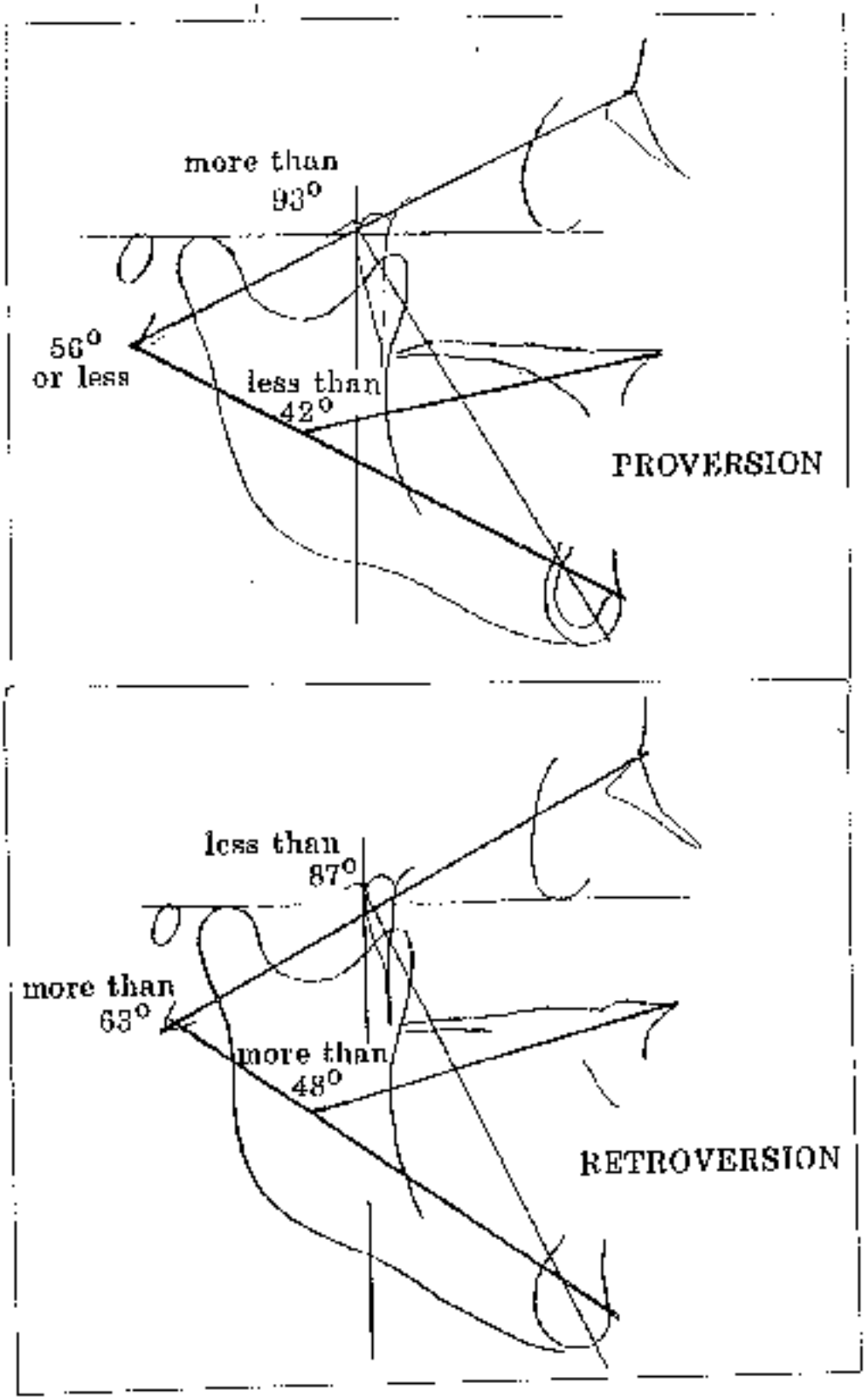

more than
93°
56°
or less
less than
42°
PROVERSION
less than
87°
more than
63°
more than
48°
RETROVERSION

Fig. 14

Rotations of the Facial Axis:	(Direction)	Positive	$< 1°$
		Neutral	$0 \pm 1°$
		Negative	$> 1°$
Magnitude on the Facial Axis:	(Amount)	High	2.7 < mm.
		Neutral	2.4 to 2.6 mm.
		Low	2.3 > mm.

These ideas are helpful for communication regarding patients during the course of growth and the effects of treatment.

SUMMARY

Treatment planning is based on known possibilities. Skeletal and dental limits were established based on a career of clinical findings. After each plan is made the PPF test is recommended, which means a consideration of **Possibility, Practicality** and **Feasibility**. Twelve real possibilities were established as principles to be employed as guides for planning.

Cephalometrics is a key to detailed anchorage planning. Its complete use was briefly described as a reference for anchorage determination for skeletal and dental change. Analytic functions and serial application helps to establish limits. Planning is the third level, and the VTO and VTG are the basis for determining the sequence of mechanics.

Since morphologic patterns and growth patterns are not the same, parameters were established for purposes of communication.

THE LOGIC AND KEYS TO BIOPROGRESSIVE PHILOSOPHY AND TREATMENT MECHANICS

CHAPTER THREE

MECHANICS FOR EXECUTING THE VTO

I. Introduction

Whether performed manually or by computer, the VTO is based on demonstrated possibilities. Specific mechanisms and modalities are employed to execute the VTO. If the VTO calls for extreme action, then the aim of treatment is to attempt to reach it to the degree that practical circumstances will allow. Remember, it is an objective. Thus, the modalities available need to be reviewed and options need to be considered.

Physical forces are employed in essentially all mechanics. Removable mandibular activating appliances are estimated to exert 300 grams of force. Shielding mechanisms hold the lip and cheeks away from the teeth and change the environmental factors acting upon the teeth and possibly pull on the periosteum.

Almost every malocclusion is in a general state of physical equilibrium when the patient presents to the orthodontist. Any treatment is therefore involved in, first, disturbing the original biologic balance and, second, hopefully creating a new equilibrium for ultimate stability after the correction.

The laws of physics do not directly apply in a biologic application. Increased force in the usual physical sense will increase acceleration. However, in the teeth and the jaws opposite actions may be encountered. Thus, a new set of principles and laws need to be developed for clinical application.

II. Anchorage Sources

In orthodontics four essential sources of anchorage are available. These are:

1. Local
    a. Dental -- roots, fluid mediums, ligament, bone, connective tissues.
    b. Musculature and soft tissue.
2. General
    a. Extraoral -- cervical, parietal and facial,
    b. Growth as an adjunct or hindrance.

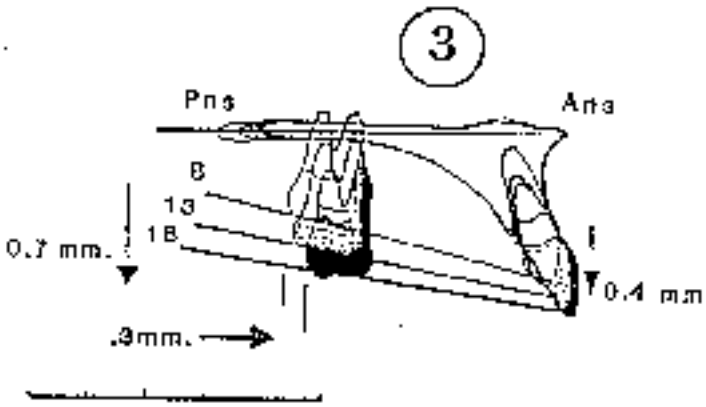
Because fixed appliances occupy such an important place the anchorage factors within and around the oral cavity are of interest first.

Anchorage Values from Roots Against Bone

Orthodontics is a science and art of anchorage. Anchorage by definition means to hold fast or to resist a drag. Because orthodontics is involved with living tissue, anchorage is relative. The most stable and practical available points are needed for references in order to evaluate changes. Newton's third law, concerning action and reaction, applies to the ends of force mechanisms, but as biology becomes involved differential pressures become a necessary consideration for clinical application. Displacements or movements from the original position of equilibrium are calculated relatively. Hence, the Four-Position Analysis becomes a useful clinical tool (Fig. 1). Any movement of teeth or jaws differing drastically from the predicted would be interpreted as treatment induced.

Mesio-distal or sagittal change attracts attention because of arch length and arch corrections to each other horizontally. Tooth-root anchorage becomes the question.

Considered from the biological viewpoint, one of the older doctrines held that because bone resorption was allegedly more rapid than bone apposition, anchorage



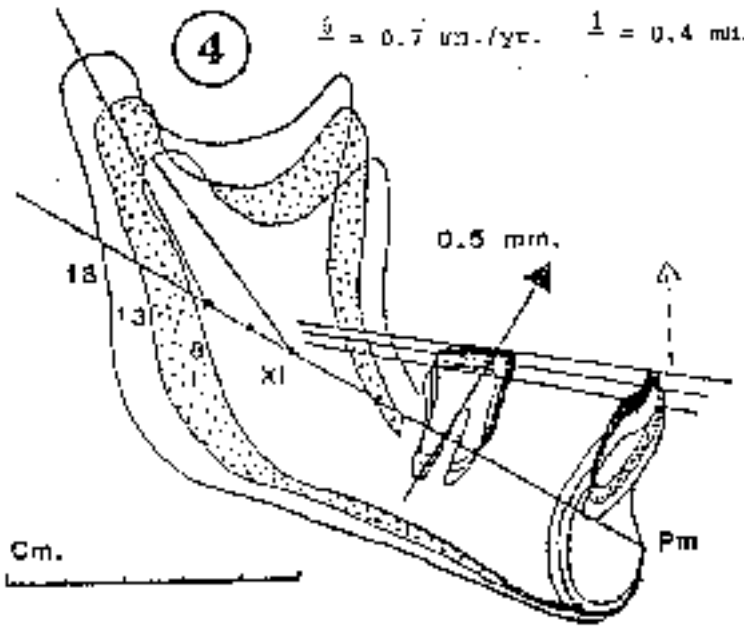
POSITION 3

Factor: Palatal Plane (ANS-PNS) at ANS
For Reading of Incisor - Molar + Occlusal Plane

Function: Indicator for Maxillary Denture Change

Change Values: Forward: 0.3 mm. each year. S.E. - 0.1 mm.
Occlusal Plane - drops at molar more
0.6° each year, S.E. 1° at 5 years,
6° at 10 years

$\frac{6}{}$ = 0.7 mm./yr. $\frac{1}{}$ = 0.4 mm./yr.



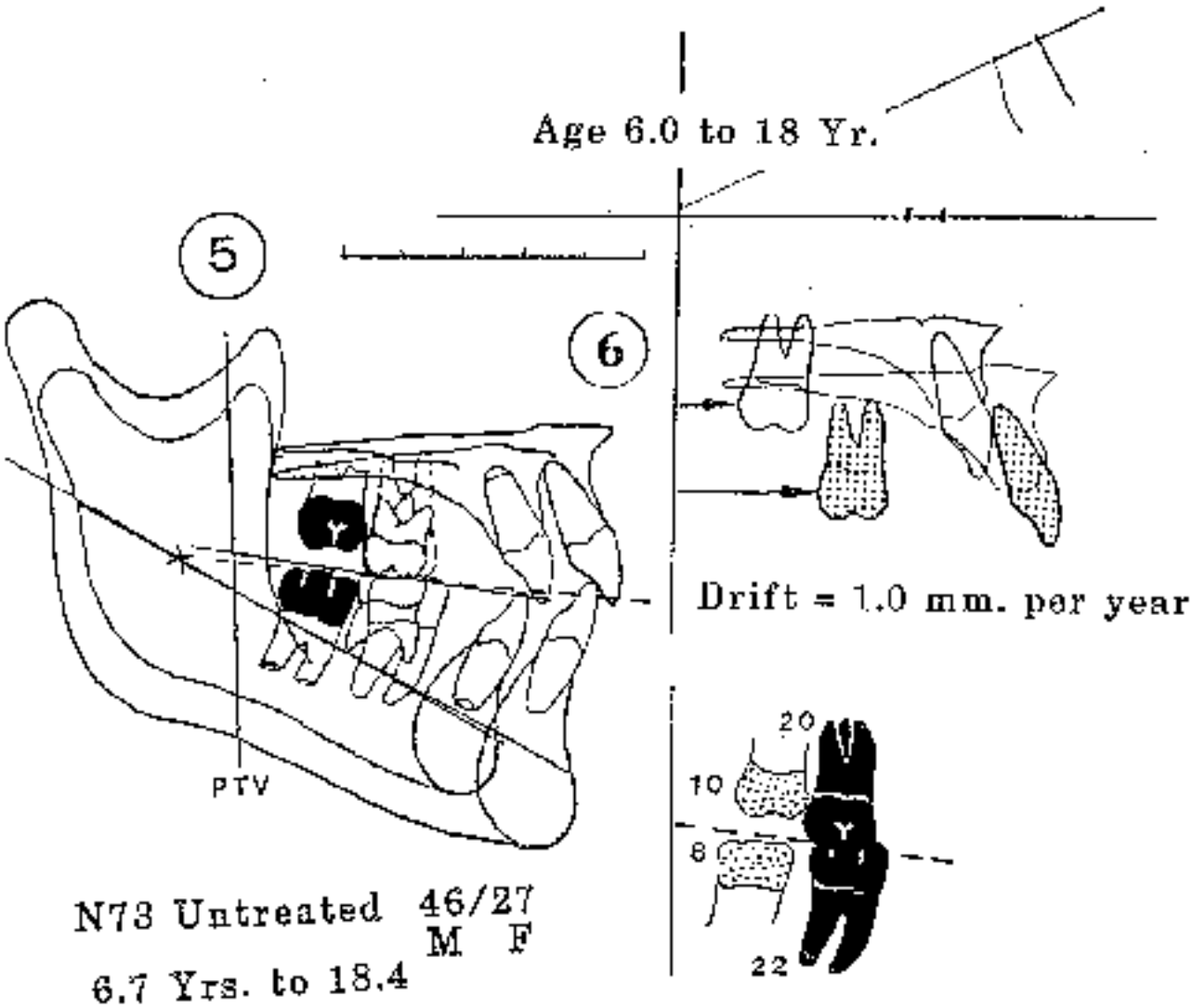
Position 4 shows the lower first molar to erupt straight upward from the original corpus axis. The occlusal plane tends to remain level. The lower incisor erupts slightly upward and backward from Pm.

Factor: True Occlusal Plane to Corpus Axis at PM point

Function: Indicator for Change in Lower Denture

Change Values: 0° change in Occlusal Plane
Eruption from Corpus Axis 0.5 mm. each year.
Lower Incisor + 3.0 mm.

Fig. 1A



POSITION 5

Factor: Pterygoid Vertical Plane at Crossing of Buccal Occlusal Plane

Function: Indicator for relative position of molars from a terminal reference

Change Values: Once erupted the upper molar moves forward 1.0 mm. per year. The lower molar moves forward 1.4 mm. per year.

Fig. 1B

was gained from the pull of the periodontal ligament. Mesio-distal "Toe-hold" positions were set up as "anchorage preparation" with the idea also of producing osteoid tissue which is claimed to be less resorbable. Yet at the same time, ironically, ease of movement was taught to be gained by keeping the teeth in the "trough" between the outer and inner alveolar plates; hence the concept of "cortical avoidance and cortical anchorage". It was clear that roots engaged in the compact bone delayed action and "burned" anchorage. Why someone earlier didn't think to use compact bone plates to enhance anchorage is a mystery.

Even more confusing is the fact that few clinicians or researchers in the 1940s were measuring the actual forces used clinically. Vague parameters were set for light, medium and heavy force, and the measurements at that time were made in ounces or pounds! What is even more provocative is that force was studied instead of pressure. Concentration on following rules in techniques was more common than asking questions about the forces and pressures being applied.

Pressure Values

After the early work of K. Reitan in 1950 and A. Storey in 1952, certain other clinicians such as B. Lee tried to establish optimal values for pressures (or force per unit/area). Laboratory work by Mulra and clinical measurements by Ricketts converged in hypothesis for a safety level of about one gram per square millimeter of root enface bony resistance for tooth movements. This permitted the construction of a tooth rating scale (Fig. 2).

The one-gram value was to be modified for orthopedic objectives (where it is doubled or tripled) or for adults where it is cut in half. For modification of the alveolar plates (or ridge, because of compact bone), one-half to one-fourth the values are indicated theoretically.

ROOT RATING SCALE

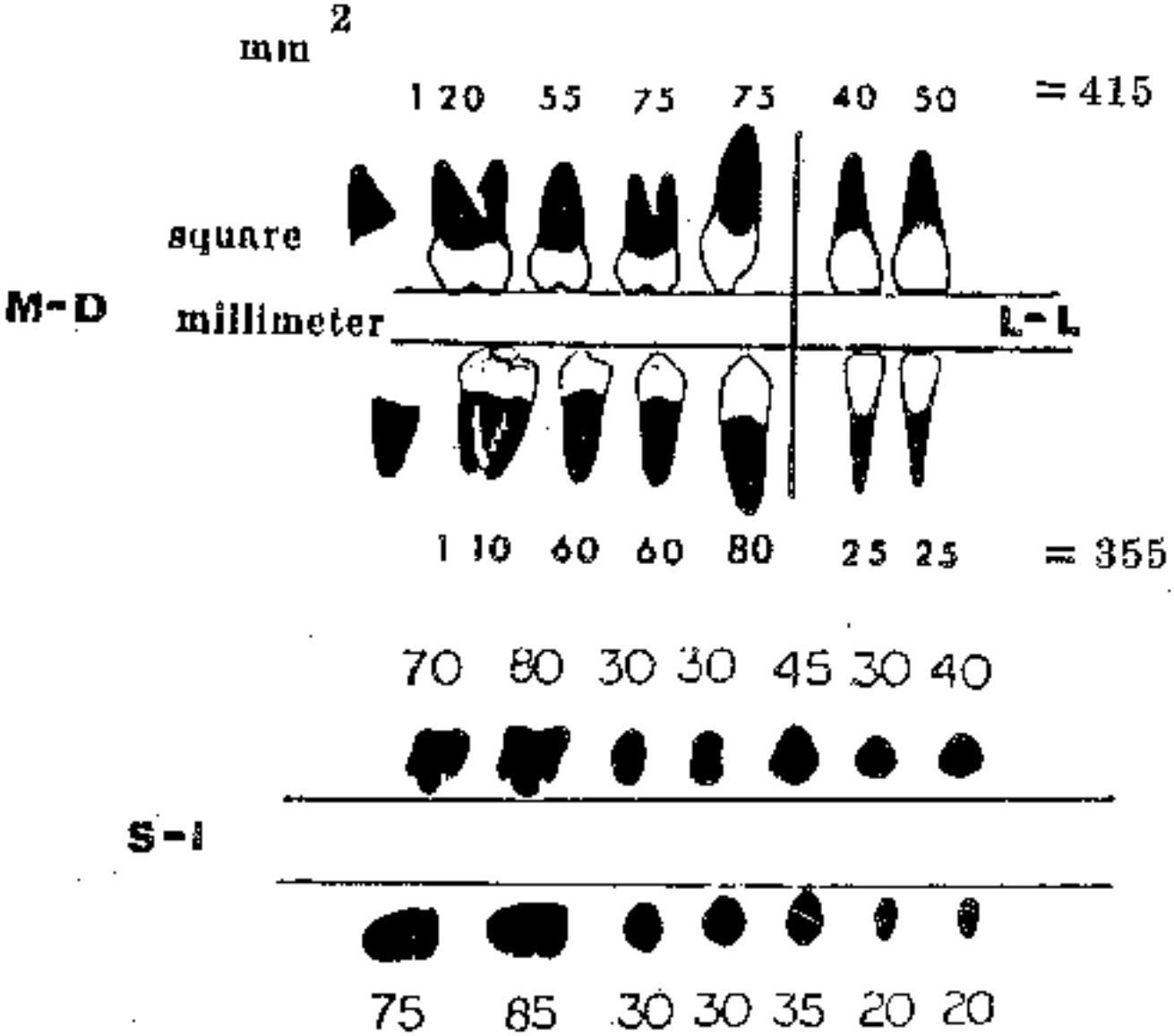


Fig. 2A

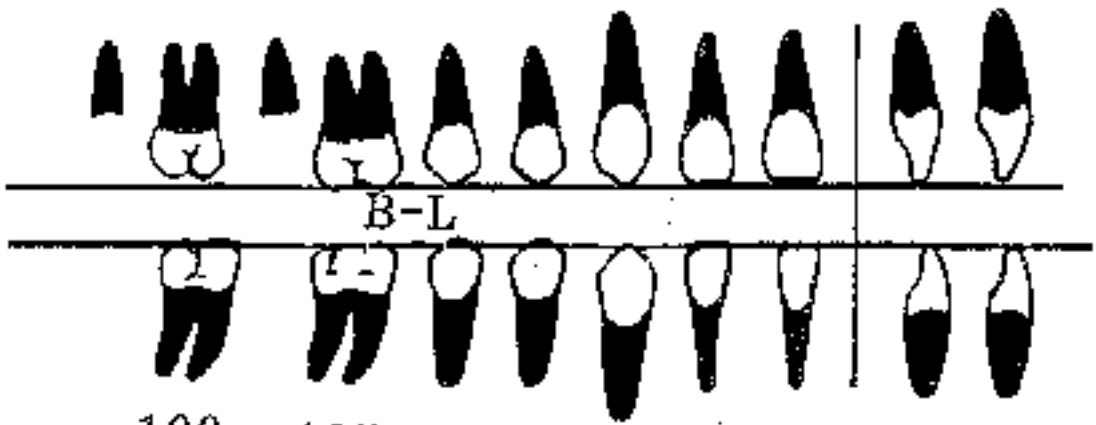
SQUARE MM. OF BONE ENGAGEMENT

For cortical change 1/2

200 300 150 2 to 3 grams

50 75 25 25 40 20 25 1/2 gram

105 135 50 50 70 40 50 65 70 1gram



100 105 60 60 70 25 25 50 50

50 55 30 30 35 15 15

200 200 150 per mm.^{2}

For Sclerosis × 2 or × 3

Fig. 2B

III. Hierarchy of Resistances

With root ratings as a guide, the levels of local tissue resistance need to be a further consideration.

For Bioprogressive therapists, a hierarchy of tissue resistance was thus envisaged and is taught. **Ultimately bone resorption was thought to be the key** as the following levels of anchorage were theorized:

A. Fluid in the membrane (interstitial) (Fig. 3).

B. Ligament pull -- periosteal pull -- soft tissue atrophy (ligament stretches within 8 minutes) (gingiva atrophies).

C. Pressure against Lamina Dura (thin and semi-corticated for initial resistance).

D. Cancellous bone of the alveolar plates (anchorage needed is lowered after the tooth enters cancellous bone).

E. Compact bone of the basal bone (External Oblique Ridge, Key Ridge, and outer or inner cortex of the alveolus) (Fig. 4).

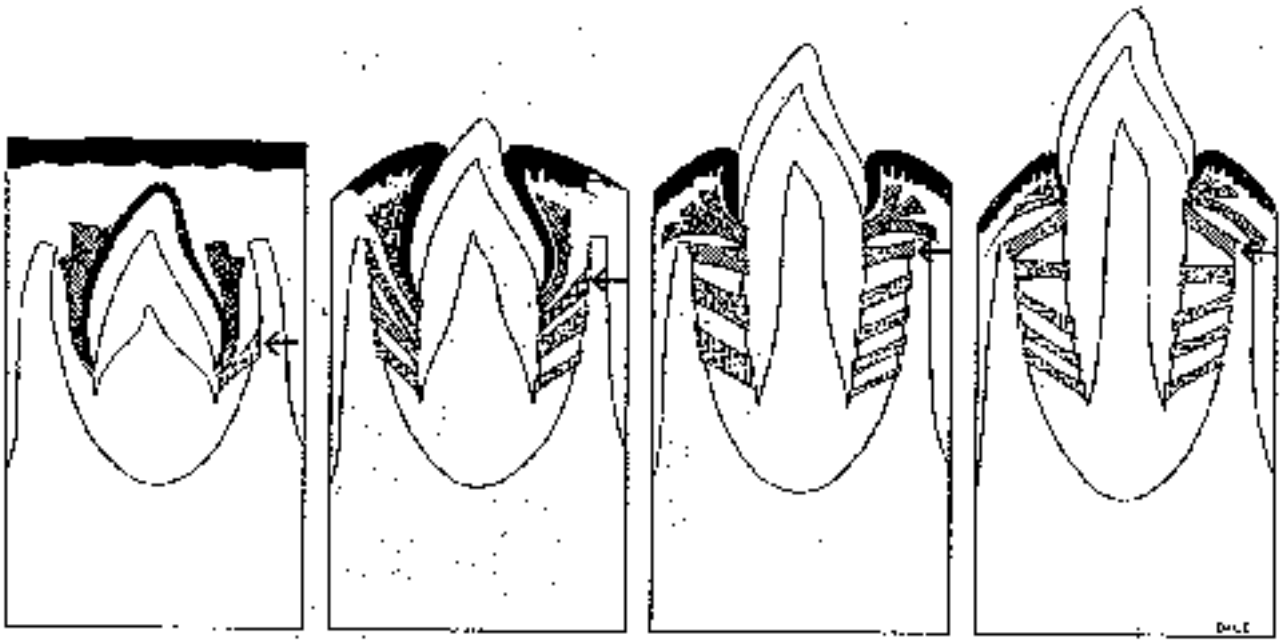
F. Tension converted to pressure at spikes of the maxillary complex sutures and periosteum.

G. Muscle resistance -- oral and circumferential chain.

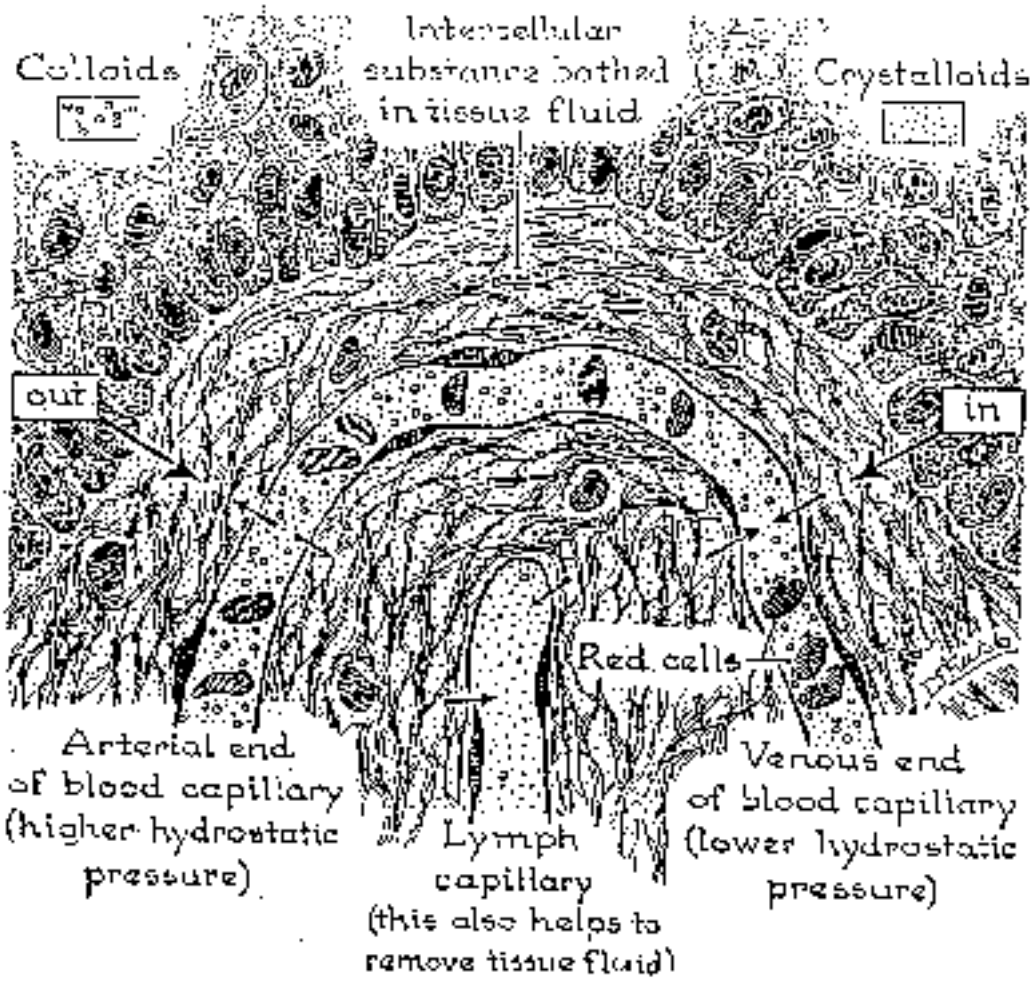
H. Soft tissue of the palate (for holding arches).

I. Extraoral growth.

In the final analysis the cortical bone and muscle became the dominant factors in anchorage consideration. Extraoral force and growth are other factors at the disposal of the clinician. **Extraoral traction even when only the molars are employed can alter the entire palate and nose.** Three planes of space are utilized. Growth and development dominate over the long range of time.



From TenCate



From Ham

Fig. 3A

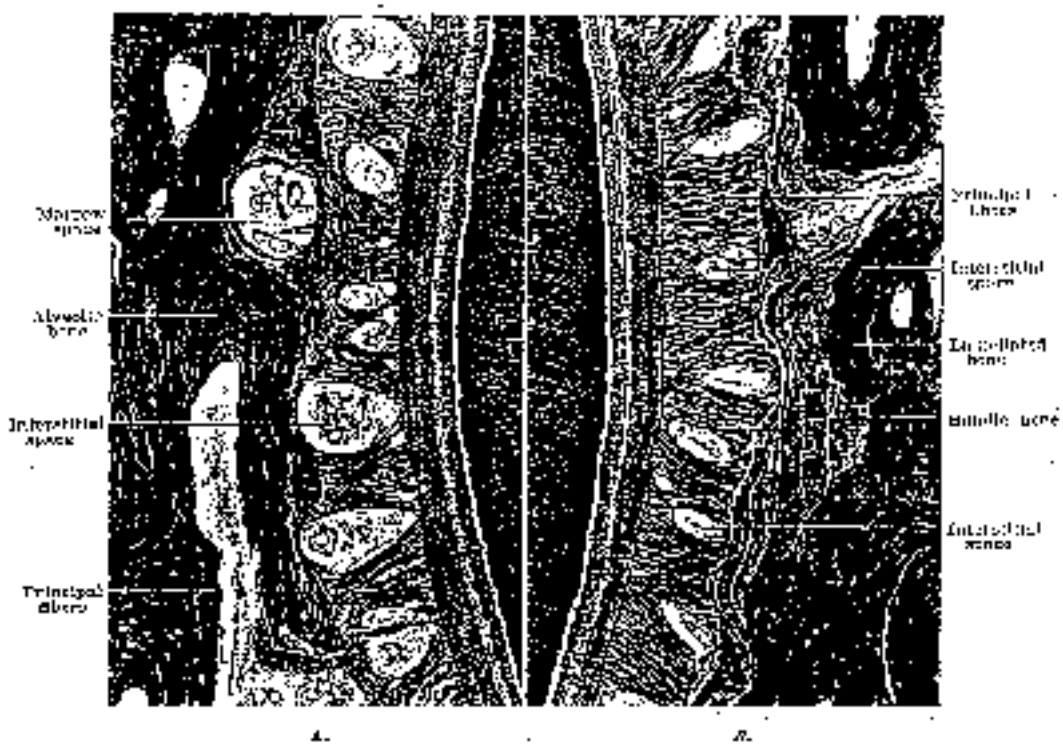


Fig. 142.—Interstitial spaces between the principal fiber bundles are found on the pressure side (A) and elliptic on the tension side (B). Marrow spaces open up on the pressure side and become interstitial spaces.

From Orban

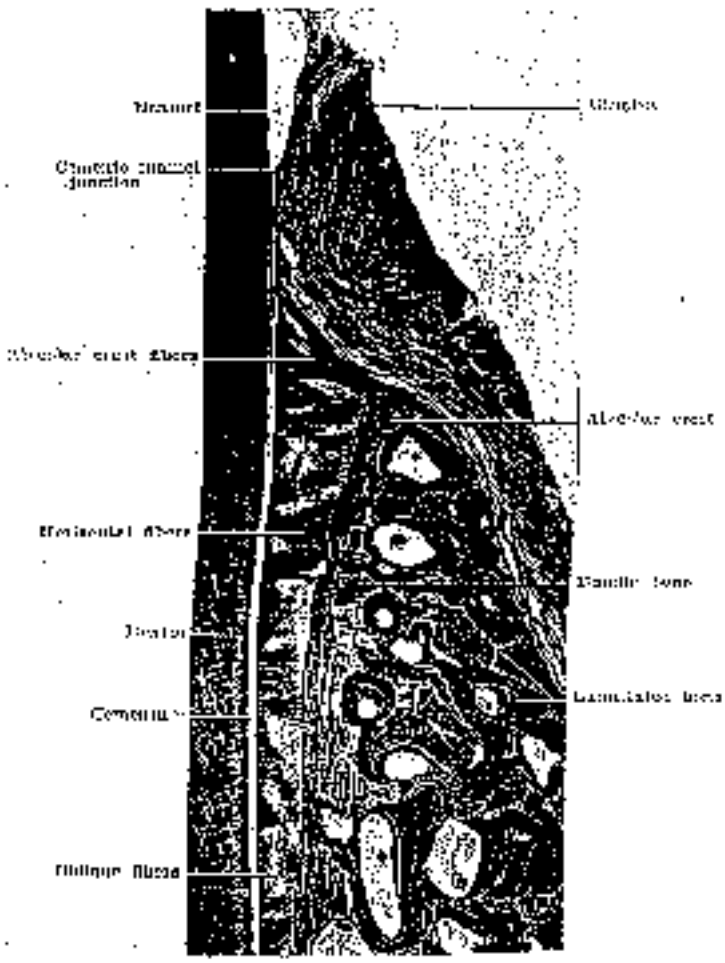


Fig. 3B

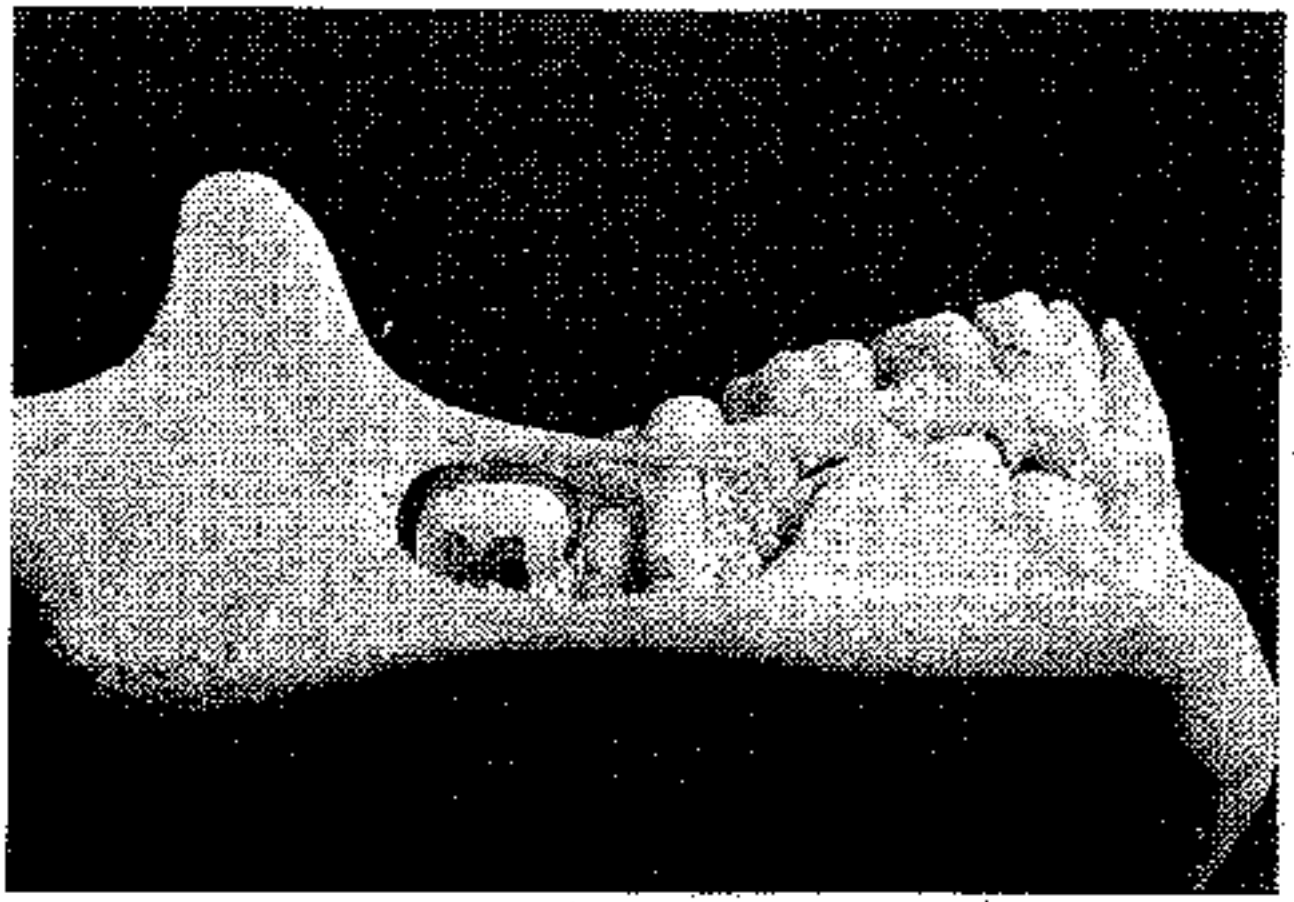


Fig. 4

IV. The Evolution of the Mechanism

Several steps were involved in the gradual development of the Bioprogressive armentarium. These can be divided into the **fixed apparatus** and **activating mechanisms.** But because they were simultaneous -- one affecting the other -- they are cited together in order that the reader may comprehend the logic involved.

The developments and mechanical innovations will be taken up in semi-chronological order in an abstract manner.

The keys are represented in 130 innovations:

[* = of special significance]

A. First Era - 1947-1952 (Research Fellow, University of Illinois)

1. * The perception of unlocking -- a needed hierarchy of movements -- the use of drift.
2. * Application of the "W" Pollack palatal appliance for cleft palate (juvenile stage).
3. Maxillary orthopedics.
4. Arnold split lingual for mandibular arch.
5. Progressive space opening with appliances (to replace separators).
6. Influence of bite opening on the mandible (environmental influences).
7. * Progressive banding (by-passing).
8. Smaller three-dimensional control wire -- .021" X .021" gold -- adaptation principle.
9. Adult treatment – TMJ Second stage.
10. * Neck strap (to replace headgear).

11. Lower molar intrusion.

12. Effects on lower arch development from upper arch (Klochn).

13. Length of outer bow (to tragus of ear).

14. Night wear (14 hours).

15. * Loops (open and closed) bent in square wire for lighter "force" and more continuous action.

16. Tissue sense (Wright).

17. * Treatment of overbite first and maintenance of incisal freedom (to prevent distal displacement).

18. Trauma to premolars lessened.

19. Danger of canting of occlusal plane (molar height and dumping of incisors).

20. Bands driven to firm fit (foil mallet).

21. Molar rotations and angulations in both arches.

22. * Two brackets (to eliminate staples).

23. Sliding mechanics (sliding hooks and push coils).

24. Intraoral adjustments (experimental).

25. Cervical traction with isolated molar (no arch -- no plate).

26. Change in direction of eruption of permanent teeth.

27. Fixed obturators (speech appliance) on deciduous teeth.

28. Sequence in finishing.

29. Progressive debanding (all but canines and molars) (tucking of canines).

30. Surgical squeeze (forced inclines).

31. Dietary control programs.

- - - - - - - - - - - - - - - - - - - -

B. Second Era (1952-1962)

1. Tubes premounted.

2. * Angulations of brackets and tubes standardized.

3. Progressive canine by-pass.

4. Progressive canine control (2 X 2).

5. Bumper (.045) lower (shielding).

6. Removable E arch (.045) upper.

7. Ribbon arch experience upper and lower (2 X 4 - A + B).

8. * Cortical anchorage -- recognized lower molar torque.
   Pull of elastics analyzed (Fig. 5).

9. Torque on upper incisors determined.

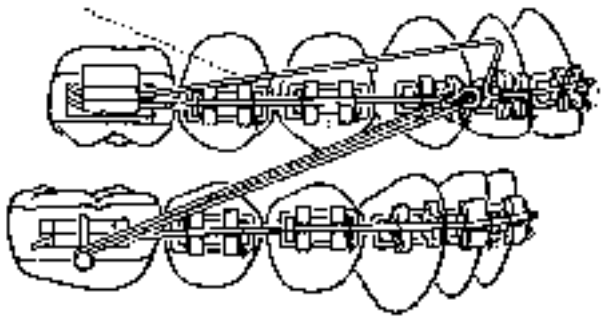
10. Headgear modifications --
    Tube gingival -- Bayonet stop
    Buccal shielding -- Periosteal
    Pull -- Buccinator traction.
    No bite plates

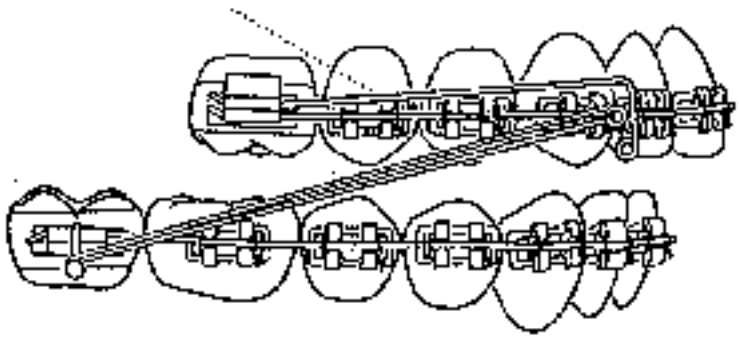
11. * Siamese gold brackets (Swain) (Fig. 6).

12. Development of typical arch form.

13. Narrow bands (gold).

14. Change in ideal arch steps.





A - DISTAL UPRIGHTING

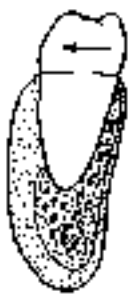
The uprighting action and distal tipping of the lower molars is affected in the reciprocal action of the lower utility arch. This allows for the maintenance of the E space.

B - DISTAL LINGUAL ROTATION

Distal lingual rotation of the lower first molar positions it to properly receive a well rotated upper molar.

C - BUCCAL ROOT TORQUE

The buccal torquing of the lower molar roots under the cortical bone of the oblique ridge is a basic movement in mandibular anchorage.



D - BUCCAL EXPANSION

A slight buccal movement of the lower molar roots helps to keep the arch from crowding inward anterior to the second molar.

Fig. 5

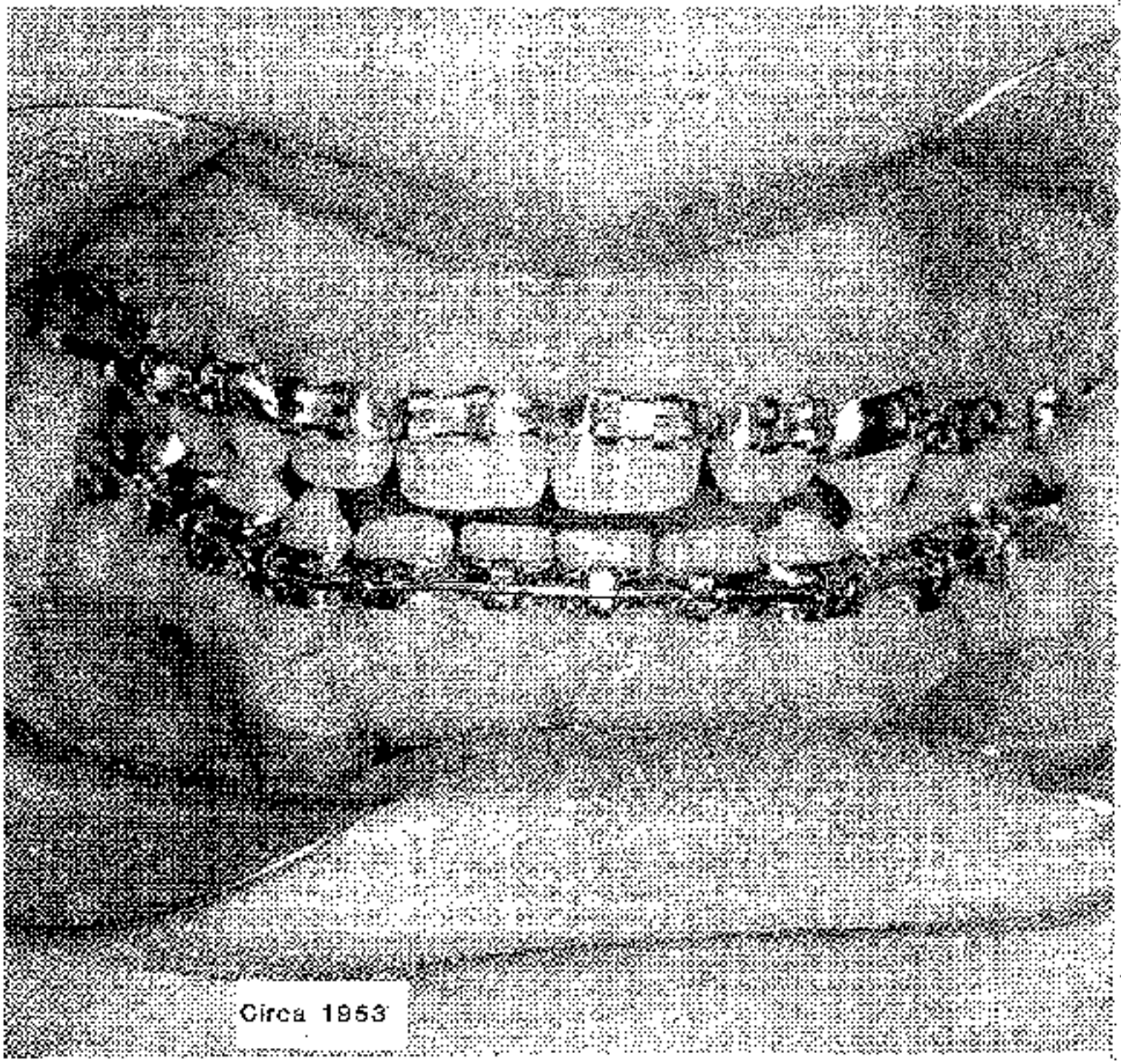


Fig. 6

15. Standardization of band-bracket height.

16. Ricketts retainer design.

17. Bi-Helix developed for lower.

18. Sectional retraction of canine (push coil section).

19. Maxillary orthopedics verified.

20. * Segmented sectional (buccal) for Class II intermaxillary traction.

21. Segmented anterior for midline (transverse elastics).

22. Canine impaction technique.

23. * Biotemplate perfected (for TMJ conditions).

24. Intra-arch elastic traction.

25. Transfer to base metals.

26. Preformed bands developed for all teeth.

27. First recall study -- overtreatment need.

28. Bracket position on band standardized at 1.5 mm. from margin.

29. * Posterior bands standardized to marginal ridges (not cusps) (Fig. 7).

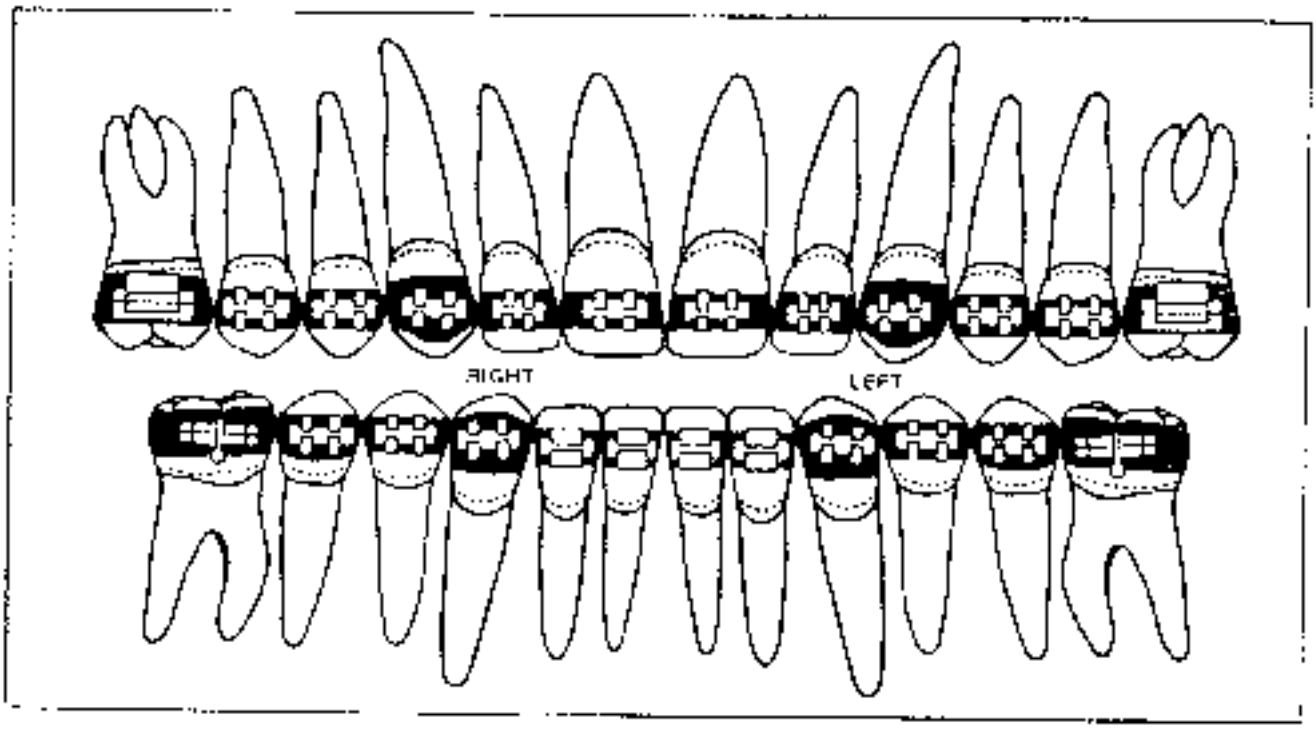
30. Quick-wing Siamese brackets in four widths for different teeth.

31. Standardized base thickness at 0.7 mm.

32. Tooth stripper developed.

33. Square wire reduced to .019" X .019" blue Elgiloy.

34. .022" bracket box reduced to .016"



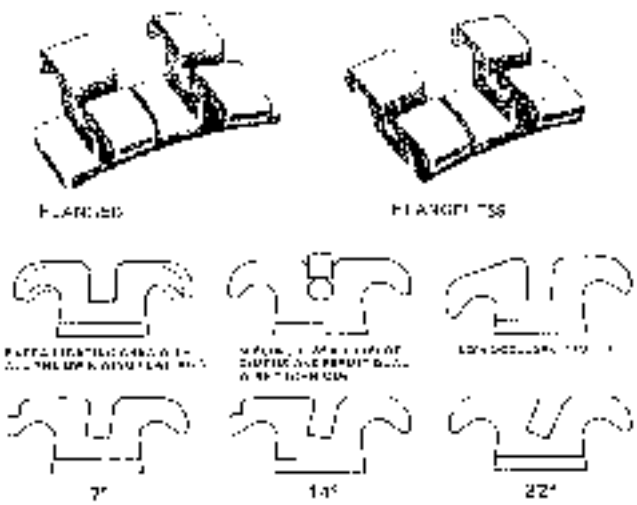


Fig. 7

35. * .018" bracket standardized.

36. Experiments with .018" X .022", .017" X .022", and .016" X .022" Elgiloy.

37. Torque of upper anteriors (22° and 14°) (Fig. 8).

38. Standard Bioprogressive formulation.

39. Contraction headgear design.

40. Expansion headgear design.

41. Wire size .016" X .016" dominates (Fig. 9).

42. Loops designed and studied for force delivery.

43. Utility arch developed
    modifications
    sizes (Fig. 10).

44. Quad Helix in .038" blue Elgiloy.
    assorted sizes (Fig. 11).

45. Lower premolar to premolar retainer blanks.

46. Double Delta arch (Fig. 12).

47. Cinching arch.

48. Closed helix arch.

49. Maxillary canine retractor (Las Vegas) (Fig. 13).

50. Mandibular canine retractor.

51. Torquing utility arch.

52. Non-surgical squeeze treatment for open bite.

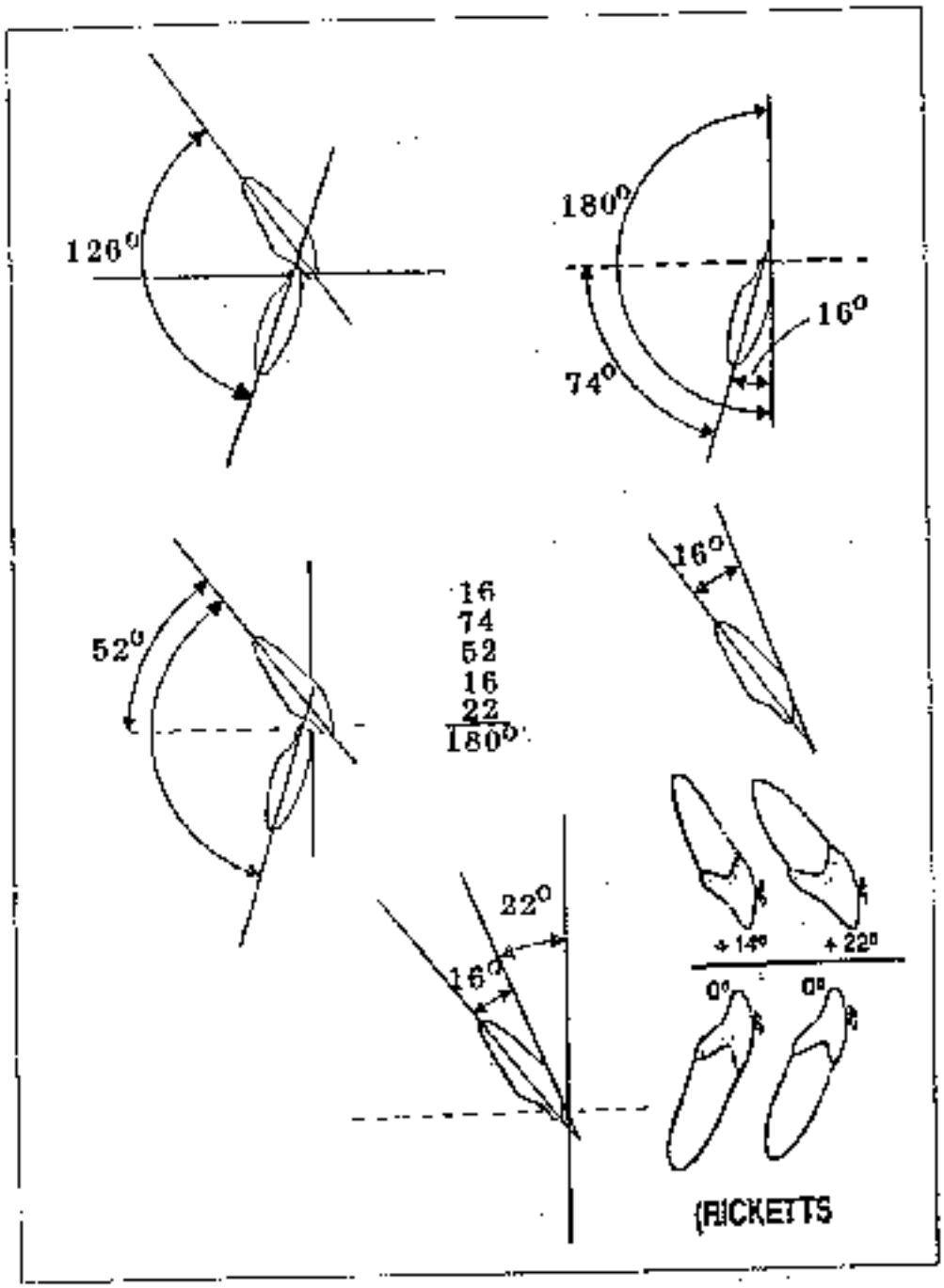


Fig. 8

C O N C L U S I O N :

AROUND 2,000 GRAM-MM. OF MOMENT

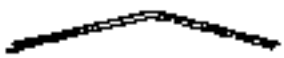
.016 X .016 BLUE ELGILOY WIRE

LENGTH	FORCE OF BENDING
@ 30 MM.	± 66 GRAMS
@ 25 MM.	± 80 GRAMS
@ 20 MM.	± 100 GRAMS
@ 10 MM.	± 200 GRAMS
@ 5 MM.	± 400 GRAMS
@ 4 MM.	± 500 GRAMS
@ 3 MM.	± 600 GRAMS

ROUNDED OFF FOR CLINICAL ESTIMATES

(A)  SIMPLE STOP. SIMPLE BENDS

(B)  FIRST ORDER BENDS

(C)  SECOND ORDER BENDS

(D)  THIRD ORDER BENDS

Fig. 9A

SIMPLE LOOPS

RIB BACK

DELTA

OPEN HORIZONTAL
BOOT LOOP

OPEN LOOP

OPEN

OPEN T LOOP

CLOSED

COMPOUND LOOPS

HELIX

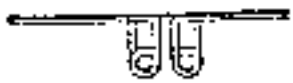
BACK ACTION HELIX

OPEN HELIX

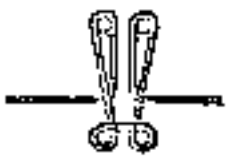
CLOSED HELIX

CROSSED T

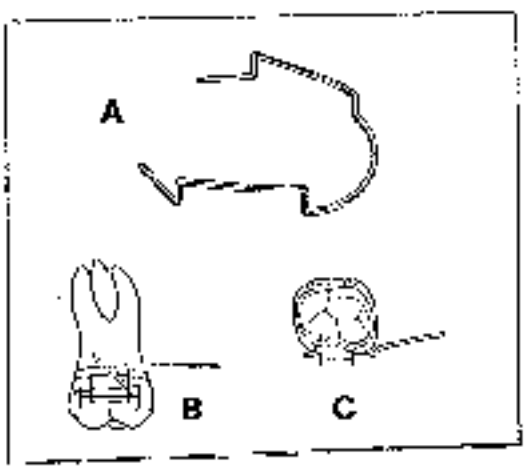
DOUBLE DELTA



DOUBLE CLOSED HELIX



DOUBLE CLOSED
HELIX CROSSED T

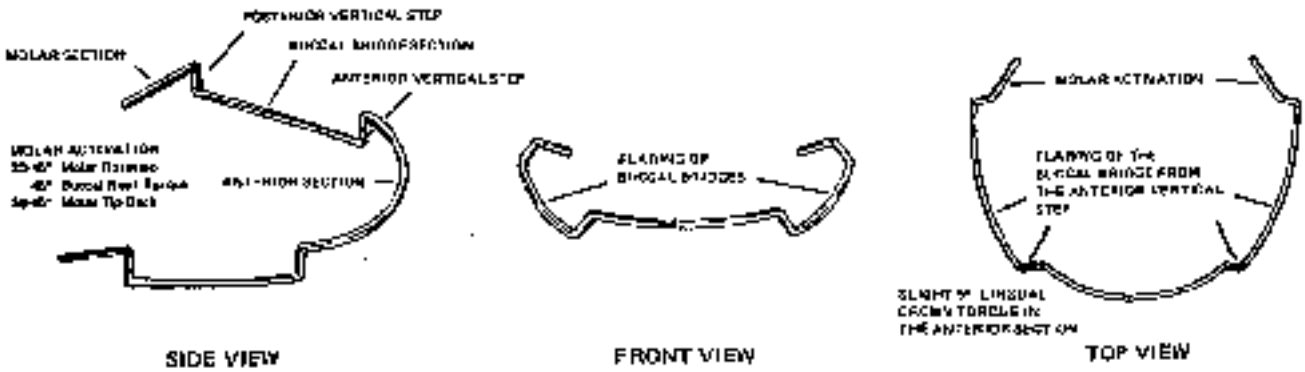


Maxillary Utility Arch (A)

Fig. 9B

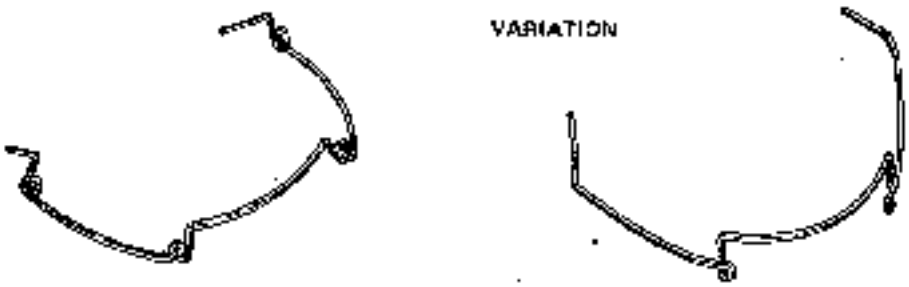
.016 x .016 BLUE ELGILOY®

mandibular utility arch



SIDE VIEW FRONT VIEW TOP VIEW

VARIATION



CROWN TORQUE OR LINGUAL RETRACTION
(Torn plier over)

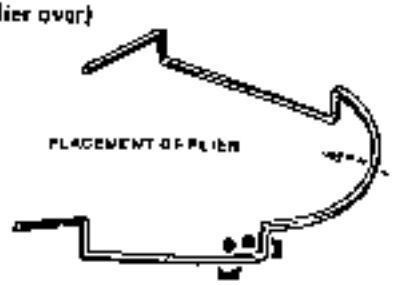
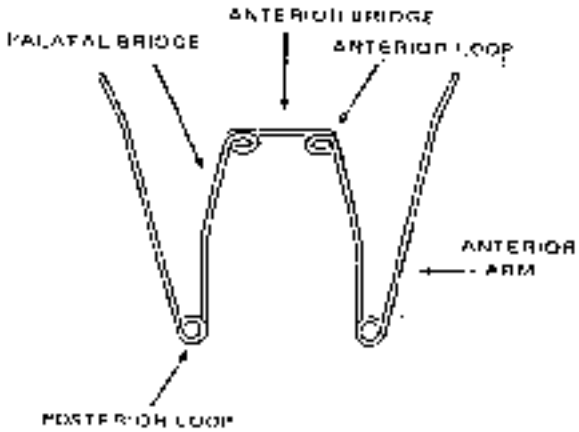
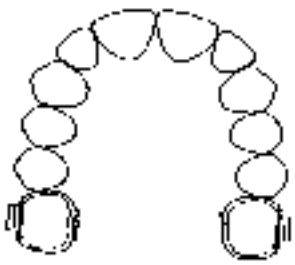
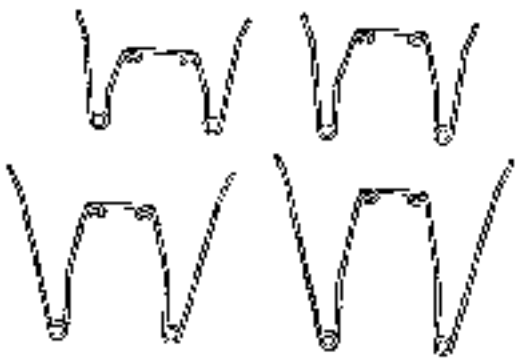


Fig. 10





A. FIT BANDS



B. SELECT FROM FOUR SIZES, AND FORM TO PATIENT NEEDS

C. MARK FOR SOLDERING

D. SOLDER TO BAND

ACTIVATION (INTRA-ORAL)

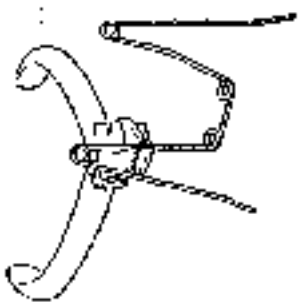


Fig. 11

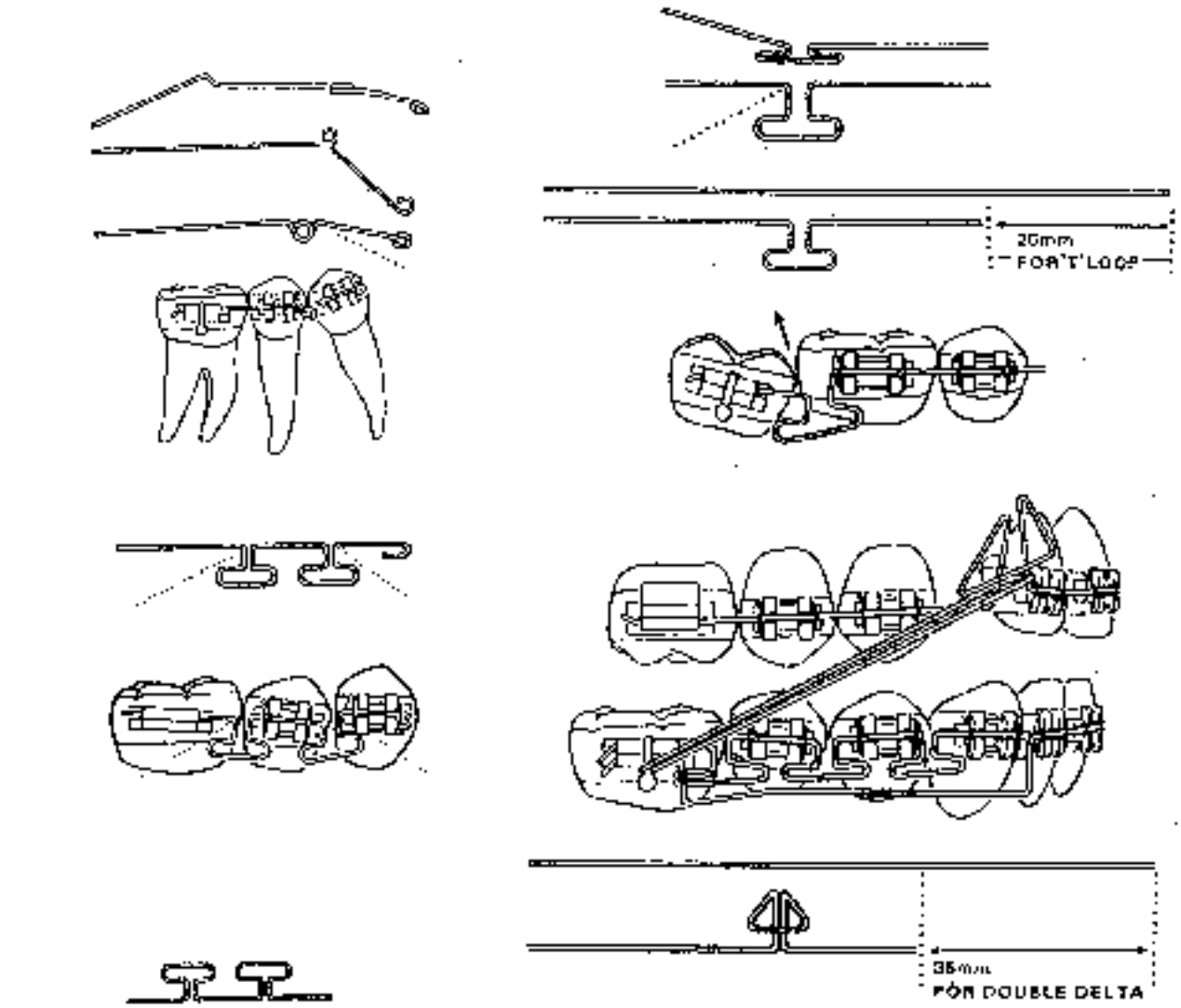
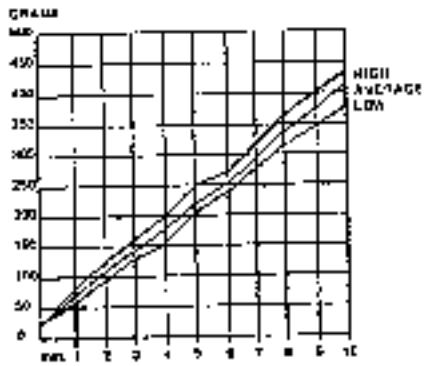
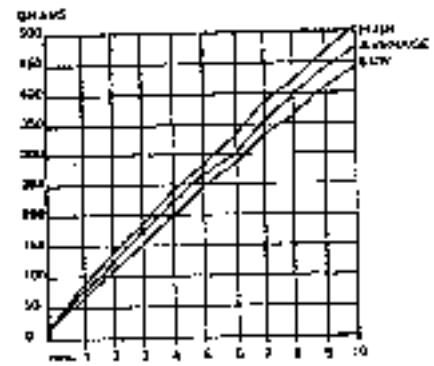
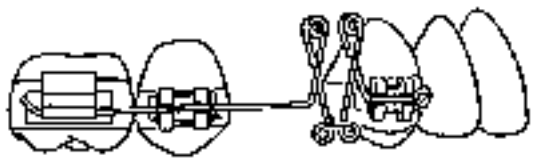


Fig. 12



LOAD DEFLECTION RATE
MANDIBULAR CUSPID RETRACTOR





Do not open more than 2.0 mm.

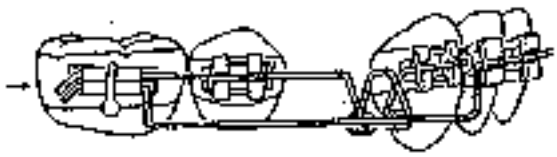


Fig. 13

C. Third Era (1982)

1. Splint retainers.
2. Canine lingual root torque.
3. Xi Point and occlusal plane control.
4. Full torque design -- lower buccal second premolars and molars reciprocal to upper incisors.
5. Double tubes (lower).
6. Triple control design.
7. Inverted "L" for mandibular surgery.
8. Ricketts template for crown and root sizes.
9. * Long range recall (PS study) -- mandibular pattern dominance.
10. Overtreatment re-emphasized.
11. Three-plane maxillary orthopedics (Fig. 14).
12. Triple tubes (upper).
13. Anterior intrusion for all deep bites.
14. Concept of force reduced to pressure.
15. * Root rating scale.
16. Arcial growth and forecast.
17. * Computer composites of treated samples.
18. Mandibular bending with mandibular posturing and vigorous elastics.
19. Respiratory obstruction syndrome.

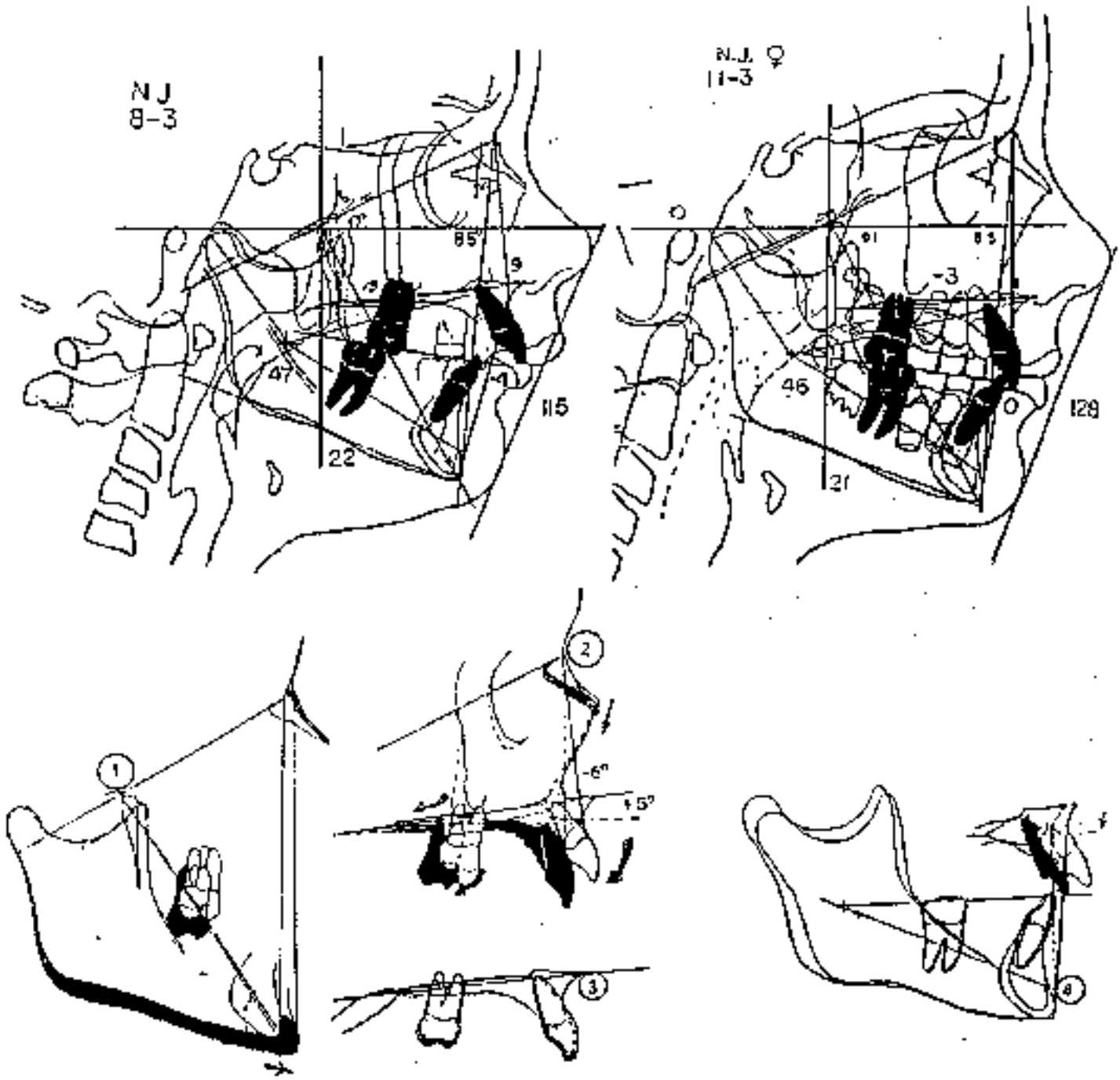


Fig. 14

20. Classification of lip problems and anchorage considerations.

21. Third molar gemectomy.

22. Transfer of banding to bonding technique (Fig. 15).

23. * Therapeutic ideal occlusion (Fig. 16).

24. Crickett appliance.

25. Growth contribution to correction. (Fig. 17).

26. Dangers of mandibular rotation in Class I and Class II.

27. Advantages of rotation for Class III.

28. Pentamorphic arches.

29. * Deflection rates for .016" X .016" blue Elgiloy wire.

D. Fourth Era (1982-1996)

1. Psychologic profiles.

2. Pain control modalities.

3. Metapositioning planned.

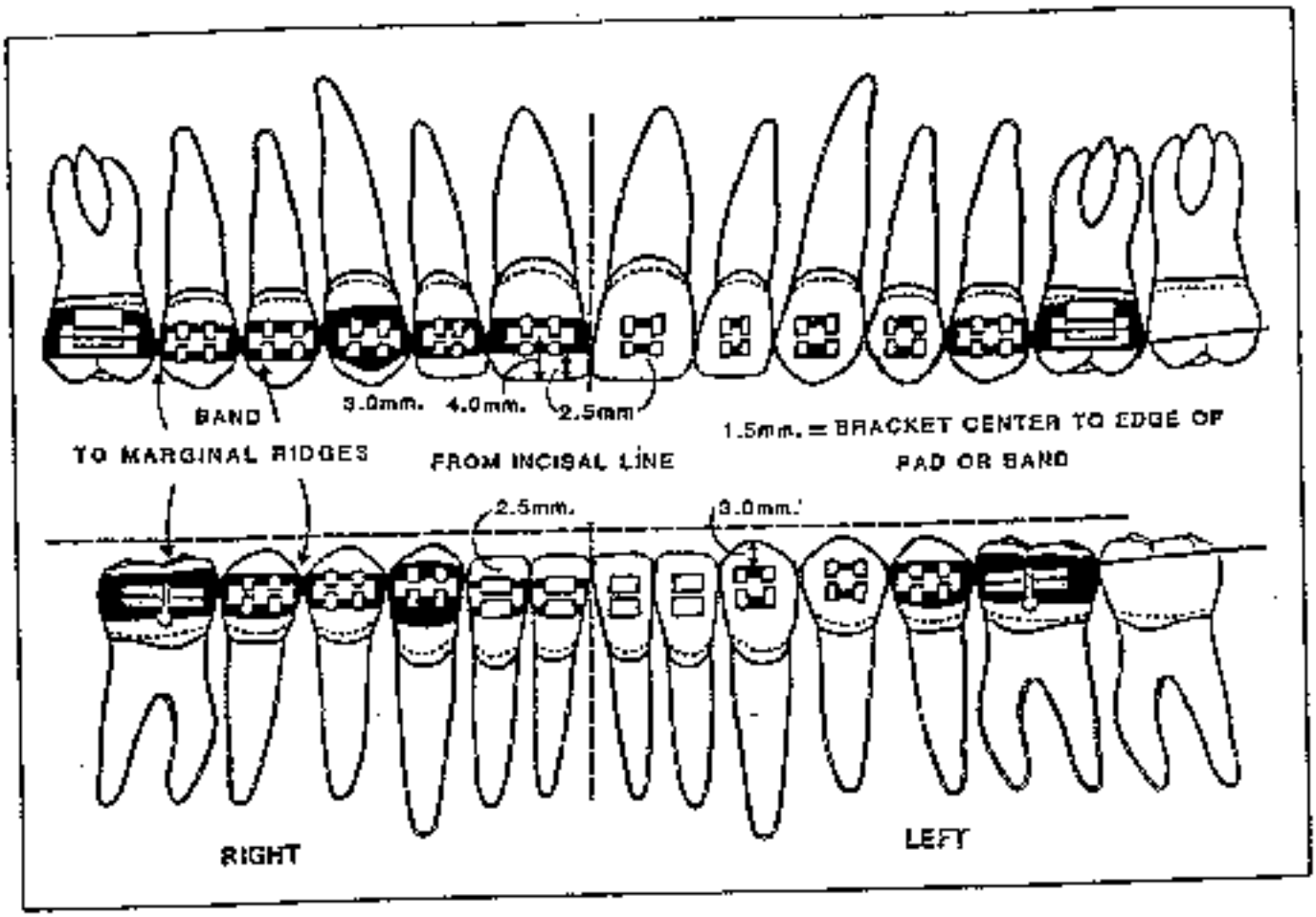
4. Head manipulations (neck adjustments).

5. Confirmation of incisor torque.

6. Alternative methods for TMJ cases.

7. Molar intrusion for open bite.

8. Lower lip release surgery. (Fig. 18).



Heights recommended for the Bioprogressive formulations. The center of the bracket is 1.5 mm. from the band or pad edge. The bracket or tube edge is oriented to the tooth rather than the bracket center. Note posteriors are placed precisely to the marginal ridges and the anteriors are measured from the incisal edge. The lower incisors are placed more gingivally 0.5 mm. for overtreatment of open bite.

Fig. 15

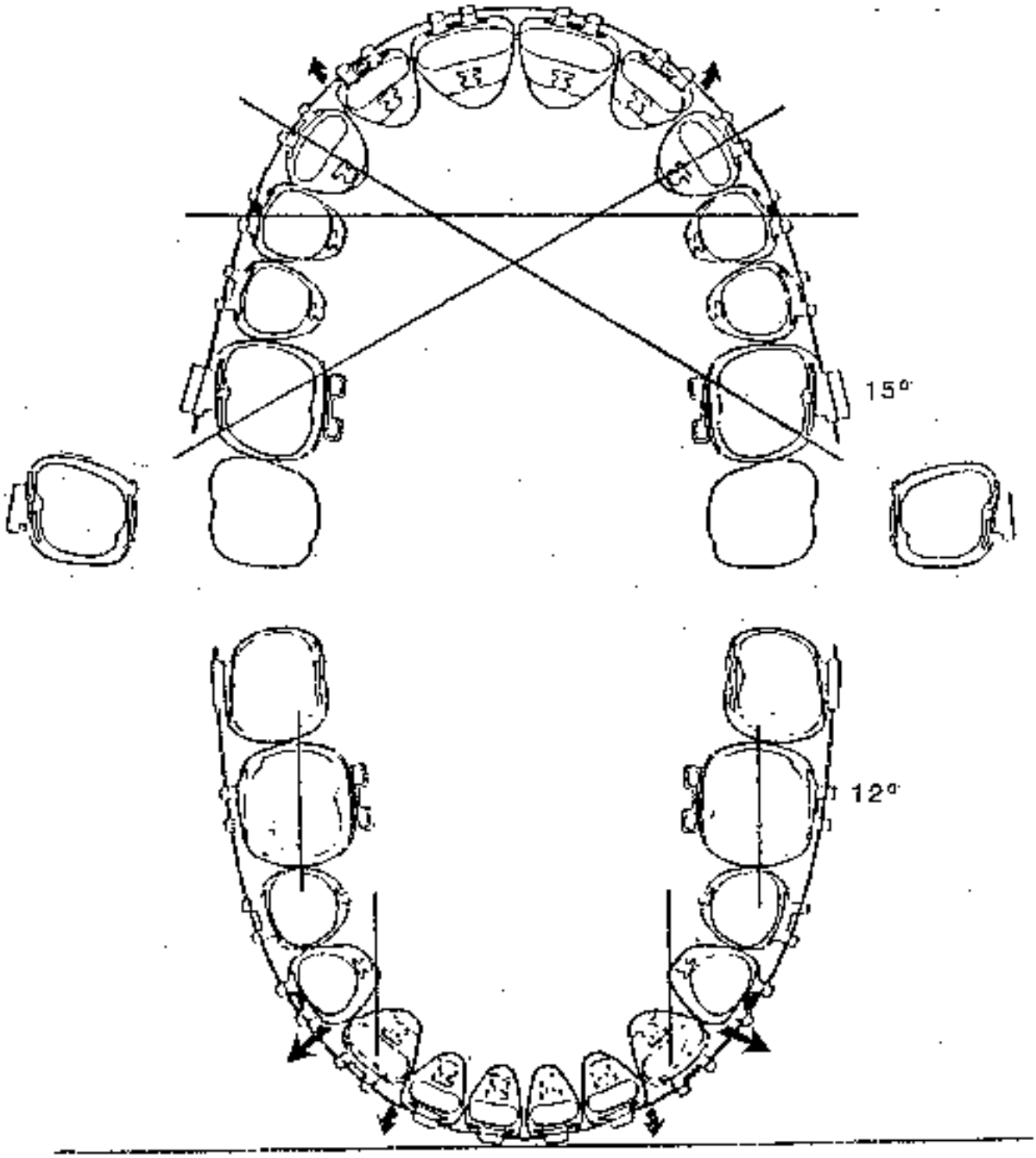
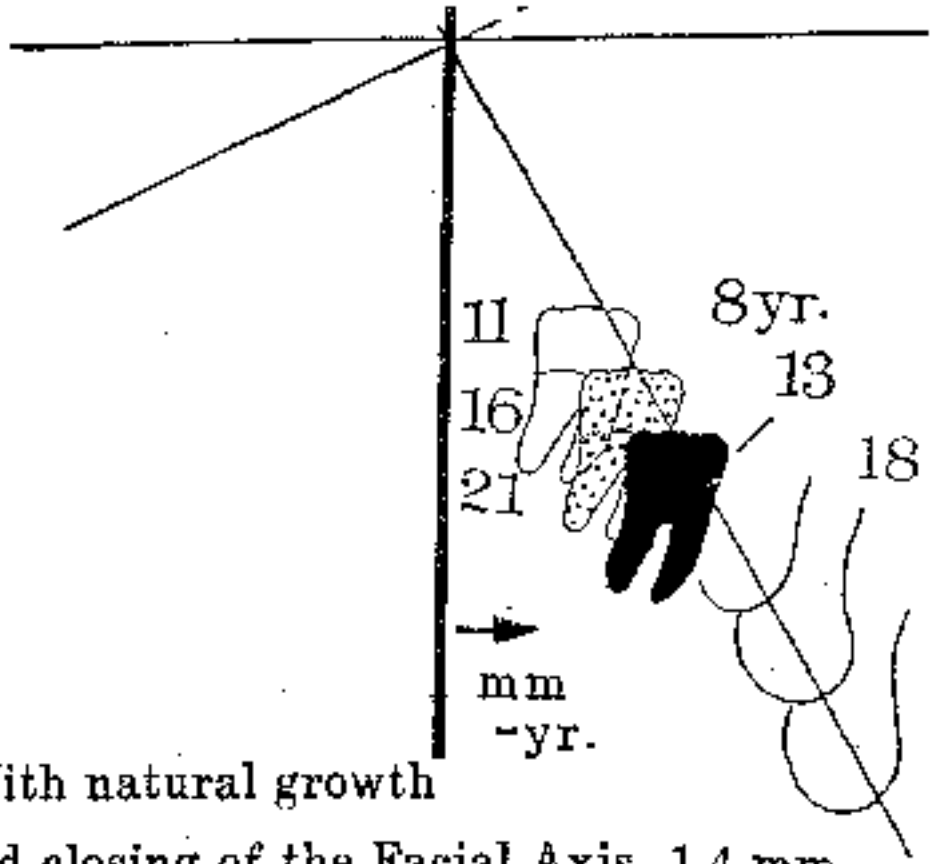


Fig. 16



With natural growth
and closing of the Facial Axis 1.4 mm

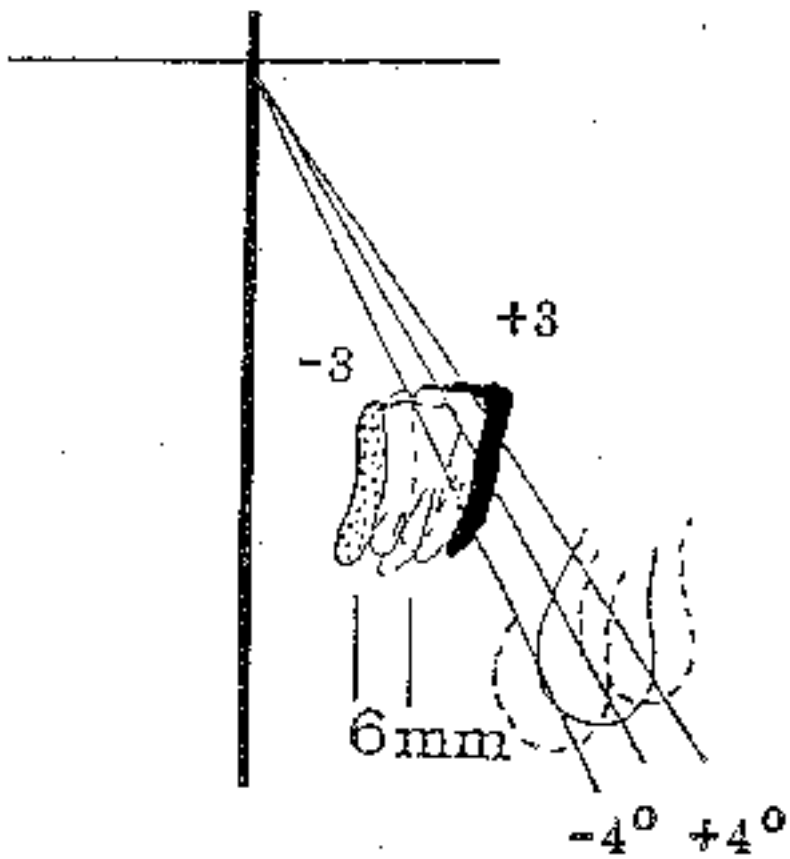
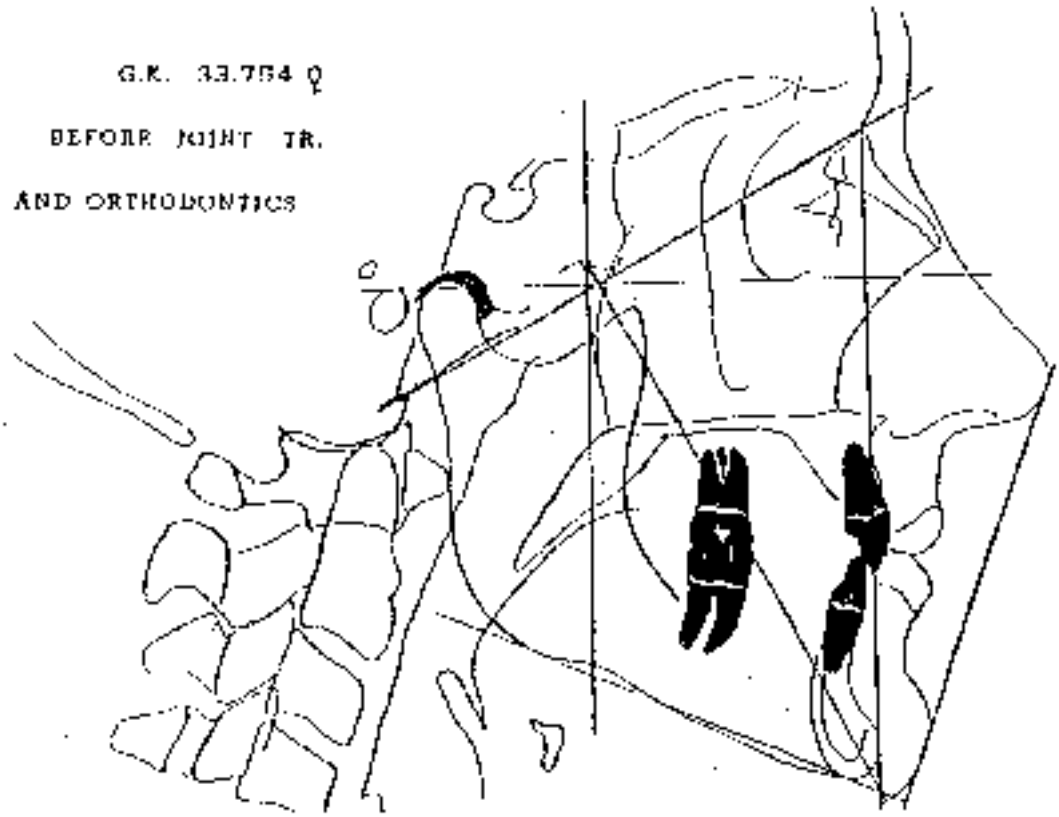


Fig. 17


G.K. 33.754 ♀
BEFORE JOINT TR.
AND ORTHODONTICS

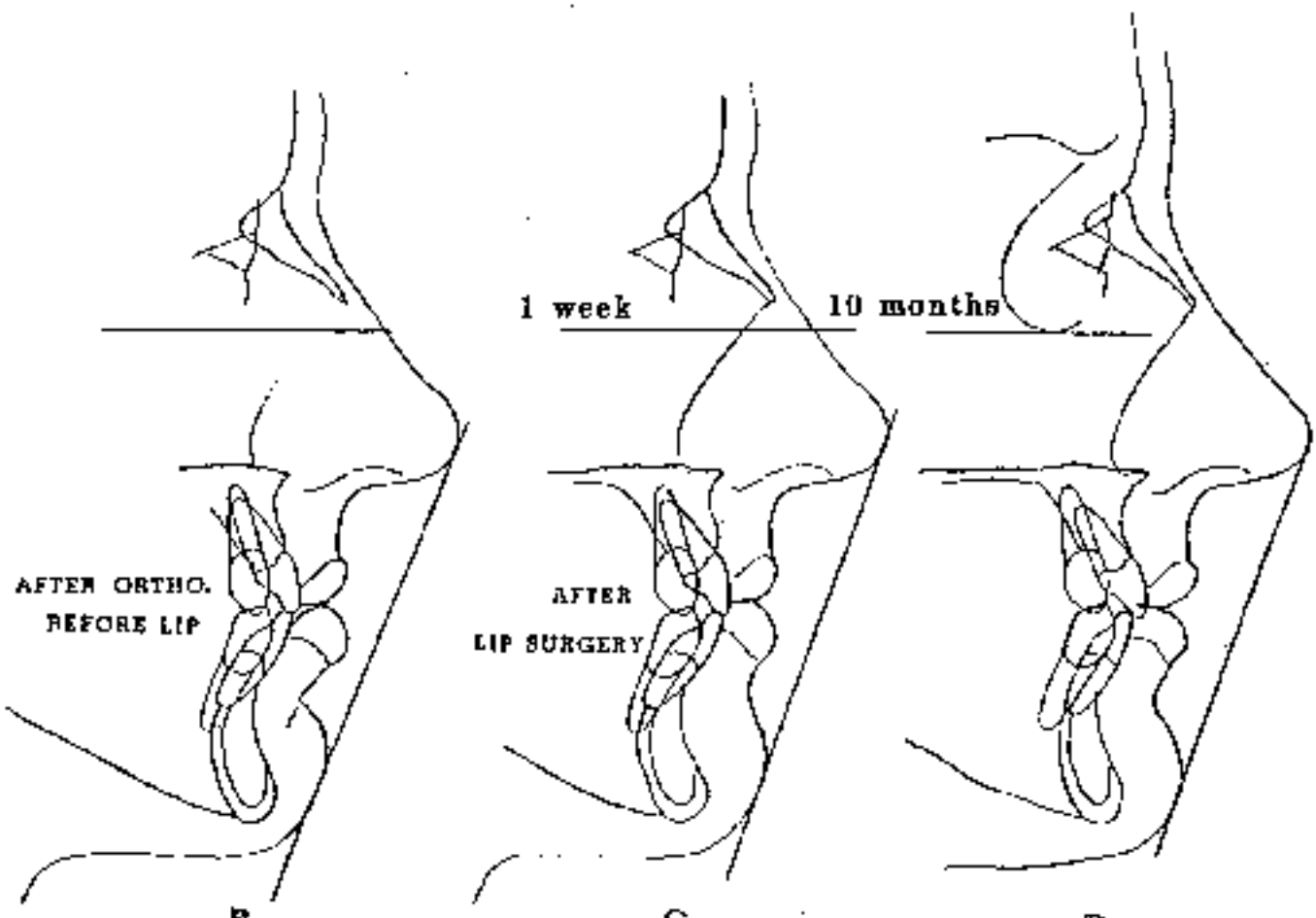

1 week
10 months
AFTER ORTHO.
BEFORE LIP
AFTER
LIP SURGERY
B
C
D

Fig. 18

9. Confirmation and proof or arcial growth

10. Long-range permanence of maxillary orthopedics.

11. Fourth Dimension formulas.

12. Divine Proportion phenomenon and esthetics

13. Magic of Xi Point and occlusal plane (Fig. 19).

14. Synergy bracket.

15. Tri-morphic formulation -- Fourth Dimension Plus.

16. Dream bracket.

17. Modification of root rating scales for buccal expansion or for cortical anchorage.

18. New computer planning.

V. Sequences and Segmentation

A chronologic development of the details of mechanics which make up the Bioprogressive arsenal would be too involved to describe. It should be borne in mind that **procedures were developed in order to fulfill the diagnosis and the objectives of the VTO.**

The Armamentarium

The following fifteen general or main types of appliances are employed:

1) Head gear cervical -- no high-pull off molars

2) High-pull anterior

3) Face mask

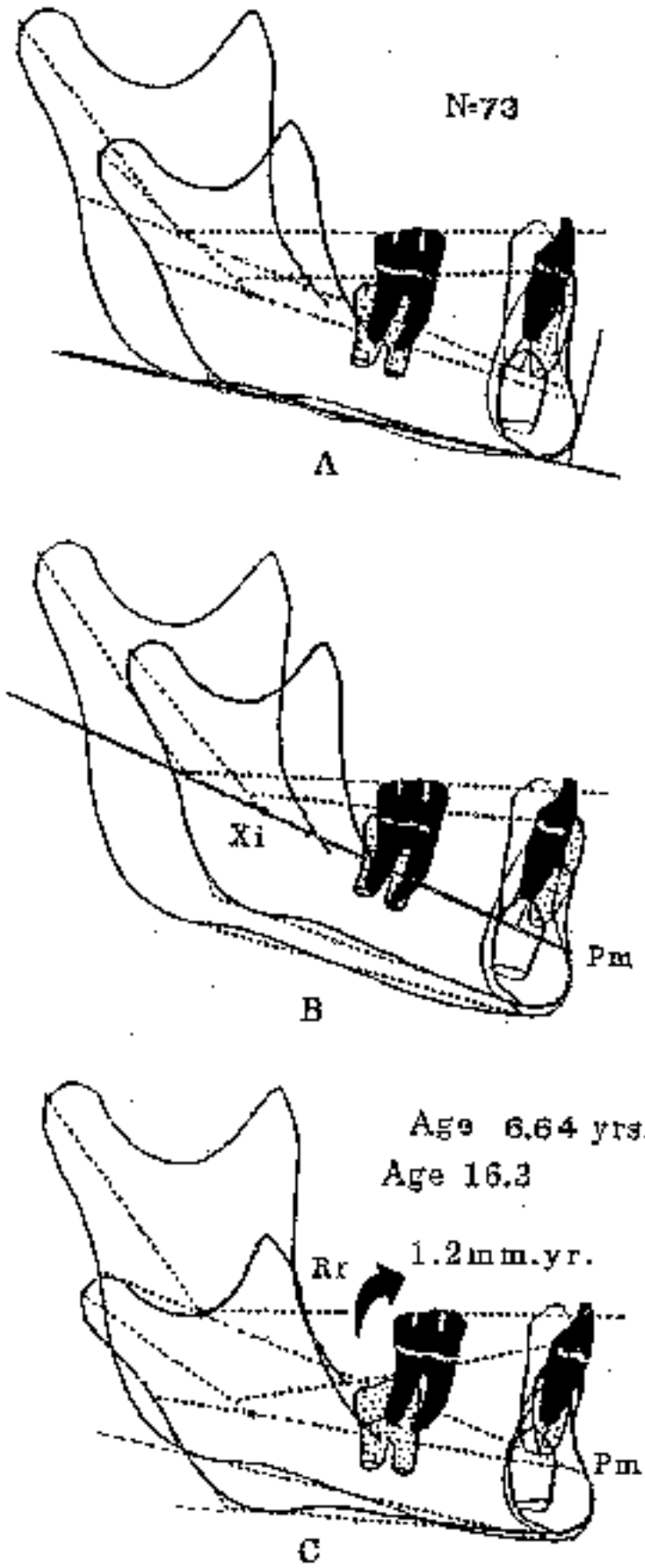


Fig. 19

4) Quad Helix
5) Utility arches
6) Intermaxillary traction
7) Sectional mechanics
8) Retraction modules
9) Straight-line and looped continuous modalities
10) Bumper-bars
11) Mandibular posturing devices
12) Lingual arches
13) Crickett-clasped appliances
14) Squeeze treatment
15) Myofunctional approaches

VI. Essential Basic Principles

In order to indicate some uses of these modalities, certain basic principles will be discussed with a view to answering needs for certain problems.

Problem with control of Mandibular Rotation

* Keep incisors out of interference (treat overbite before overjet).
* Prevent extrusion of lower molars and forward tilt of the occlusal plane (cortical preparation with lateral toe-hold).
* Prevent pain and/or proprioceptive inhibition.
* Prevent tongue cushioning.
* Open up airway.
* Reduce lip strain.

* Overintrude upper and lower incisors in deep bite before finishing.
* Encourage vertical-anterior condyle growth.

Gain arch length by controlled expansion.

* Avoid expansion with straight wire (tip teeth).
* Use Quad Helix or Bi Helix.
* Use Klochn face bow and cervical traction for upper arch change.
* Use Crickett appliance.
* Use lingual arches.
* Use shielding.
* Use shielding of the utility arches.
* Use bumpers or bars

Orthopedics in three planes of space.

* Maxillary

  Quad Helix

  Klochn headgear

  Bars and shields

  Palatal dysjunction (slow preferred)

  Sectioning and intermaxillary traction

* Mandibular

  Mandibular posturing devices

  Vigorous intermaxillary traction (200 grams per side)

  Cervical traction on upper molars (vertical condylar growth)

  Overlay posterior appliances

The Unlocking Principle

* Unlocking of bite -- utility arches
* Unlocking of arch -- utility arches -- looped continuous (concatinated) to control site
* Progressive engagement
* Unlocking of condyle -- incline plane

  Elastics -- bite jump
* Impacted teeth -- Headgear A, Quad Helix

  Utility (opening), Bumper, Crickett
* Unlocking condyle growth -- posterior support -- Headgear A
* Unlocking breathing

Sectioning Mechanics

Transformo anchorage preferred to proximal anchorage

* Continuous straight wire (proximal)
* Continuous loops -- concatinated designs
* Segment units (buccal or anterior) variety of utility sections, straight sections.
* Isolate molars -- headgear -- bumper
* Isolate with secondary action -- Quad Helix

  Lingual Arch -- Crickett

Forward emplacement of the Lower Arch

Light round wire -- keep molars contracted

* Intermaxillary elastics

Prefabrication and Therapeutic Ideal Occlusion

- Standard .018" brackets (1958)
- Fourth dimension formulation for angulation, torques, raises and rotations -- selective placement for overtreatment (1980)
- Common use of .016" X .016" blue Elgiloy (1960)
- Standard modules and arches (1959)
- Pentamorphic arch forms (1975)
- Trimorphic anterior formulation (1988)
- Line and emplacement of occlusion (1976)
- Occlusogram analysis (1965)
- Physiologic Centric (1949)
- Finishing sequences (1948)
- Stabilization and guidance of metapositioning (1990)
- Myofunctional application (1950)
- Fractional surgeries (1980)
  - Impactions (corticotomy)
  - Third molar enucleation
  - Lowerlip release (buccinator)

SUMMARY

Experiences with either computer-generated or manually performed renderings of VTOs have been shocking to many orthodontists. Some openly stated that they could not achieve the objectives with the techniques they employ. Many questioned the possibility of the changes. Yet the changes drawn were based on demonstrated past achievements in clinical practices and were real. On the basis of such experiences it is obvious that possibilities with specific modalities need to be communicated.

Orthodontics is a game of anchorage and differentials of pressure. The sources of resistance to a push or a pull were listed in two categories. First was local, meaning in and around the oral cavity from bone, connective tissue and muscle. The

second source was general, which included extraoral traction and also feedback from the growth factor.

The main issue in understanding mechanics is, of course, force -- but it must be reduced to the unit area it is pitted against, which means pressure. Force cannot be differential but pressure can be, depending on the surface area on which it is distributed.

Our working theory is that one (1) gram per mm.^{2} is the safe starting point. The issue further is movement of intended teeth rather than alteration of anchor teeth or anchorage force. An alternative answer to anchorage reinforcement is **reduction of the drag.**

When cancellous bone is to be modified the 1-gram-per-mm.^{3} applies. When anchorage is desired the root is directed against compact bone and increased two to four times that. However, if modification of the ridge (cortex) is expected, the pressure is cut in half (0.5 gram per mm.^{2}) and the operator needs patience. A hierarchy of resistances was described for consideration by the clinician.

It was thought best to communicate the mechanics of Bioprogressive to describe the changes made in the evolutionary process of its development. Hence, from a mechanical view (not theoretical per se), 130 keys were listed as they came to mind. These were divided into the first five years, the next ten years, the following twenty years, and the last fourteen years.

Fifteen main appliances or procedures were listed as imperatives to the understanding of the Bioprogressive Philosophy. Following that a few basic principles were abstracted to suggest where and for what purpose they can be applied.

The goals in orthodontics have not changed. They are esthetics, optional function, and health and stability. Efficiency and security in treatment is also a practical goal for the clinician. Possibilities are based on demonstration of successes. The Bioprogressive approach offers satisfaction of all these goals.

THE LOGIC AND KEYS TO BIOPROGRESSIVE PHILOSOPHY AND TREATMENT MECHANICS

CHAPTER FOUR

GENERAL SUMMARY

The philosophy labelled Bioprogressive, by students in 1972, probably had its beginnings with studies of joint and skeletal behavior by means of tomography. With this, employed together with central sagittal cuts, a new analytic approach emerged. Findings on growth and treatment behavior offered a data base. It was immediately recognized that analysis from the anterior cranial base alone was insufficient. The joint is located in the middle base and the head is supported from the posterior base. The Basion-Nasion plane and true Frankfort were employed as a base of reference, and the lower mandibular border was connected with a "condyle plane".

After data had been accumulated the analysis was reversed for trials of growth and treatment forecasting, which were successful in 1950. As clinical treatment experiments led to new techniques, new results were found which in turn were programmed into the "planning on paper" procedure.

As a dearth of enthusiasm for the method was witnessed, short-cuts were tried with more limited clinical success but with more professional acceptance in 1959. The idea of a visualized treatment objective (VTO) caught on, as opposed to "Synthesis" or "Treatment Design". Simultaneously, the STO (surgical treatment objective) received excellent support.

The search for improvement and simplicity led to the use of foramen rotundum (Pt), ramus centroid (Xi), and protuberance menti (Pm). Thus the Facial Axis was established as the central axis of the face which improved the accuracy of chin

analysis. The Xi Point directed the way to eight uses as the Corpus Axis (Xi-Pm) became a foundation for treatment analysis and planning.

Further investigation with the computer revealed a bending upward of the mandible with normal growth which resulted in the development of a growth arc. In addition, the computer precipitated factors for a practical Frontal Analysis, which when combined with the Lateral Analysis offered a three-dimensional program for analysis and projection.

With the confidence of new, trustworthy methods and with the availability of computer composites for direct visualization of results of typical treatment modalities, a scientific comparison could at last be made. However, the new techniques were not embraced by the mainstream of the profession. Several speculations were offered concerning the possible reasons why the profession in general has hesitated to accept such developments.

Chapter Two concentrated on the doctrine of possibility as opposed to the concept of limitation prevalent from the 1940s through the 1960s. Because cephalometrics is the main source of communication its several uses were reviewed. The thrust was on the construction of the VTO and on the analysis of the forecast which is employed for anchorage planning and technique application.

Chapter Three focused on anchorage. A hierarchy of resistances was discussed. In order to mitigate the reluctance in the profession toward the philosophy of Bioprogressive, the evolution of mechanisms (fixed and activating) was listed according to the author's experience in four time periods.

On the one hand, the Bioprogressive philosophy employs the most sophisticated state of the art for diagnosis, prognosis and planning objectives. On the other hand, there are essentially fifteen modalities as options to select from in order to execute the objectives. All appliances do not render similar results, and even the same appliance is used differently by different clinicians.

Simple principles were pointed out as an abstraction to indicate the possibilities of orthopedics and orthodontics on a contemporary basis.

Thus, it is up to the clinician to put the two parts of the philosophy together. If the principles are formulated on science and are accepted, and the reasons are understood, the way will be found to select and employ the proper mechanics.

Bioprogressive -- like any mechanical tool -- is simple when it is understood. If each technique is mastered independently first, it becomes an easier task for them all to be put in sequence or combined.

In conclusion, there is logic and reason for each appliance and step to be employed in the Bioprogressive philosophy. Biology is always a basic factor, and progression to a goal is the path to a successful production. There is no mystery. In the end everything is based on common sense.