American Institute for Bioprogressive Education

UNDERSTANDING THE VTO: ITS CONSTRUCTION AND MECHANICS FOR EXECUTION

VOLUME TWO

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by Dr. Robert M. Ricketts

UNDERSTANDING THE VTO:

ITS CONSTRUCTION AND MECHANICS FOR EXECUTION

Volume II

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CHAPTER FIVE
THE FORECASTING OF SOFT TISSUE

PROFILE FORECASTING

Introduction

The *major* desire of the orthodontist is for consideration of soft-tissue changes because **esthetics is a fundamental objective.** Soft tissue forecasts were therefore made together with the dental setups at the very start of the VTO exercise in 1950.

The nose, lips and chin were predicted on the basis of the original data produced on treated and non-treated subjects from 1947 to 1950. Soft-tissue measurements were verified in a second study of 250 subjects in 1960. They were further reverified in 1969 with computer work, and a complete review of the literature. They were finally "fine-tuned" again with 133 growing children in 1990. Thus **four different sets of data** have been obtained for reference of the soft tissue profile. The findings for development of the profile has changed very little for half a century (Fig. 5-1 and Fig. 5-2). The technique for forecasting the soft tissues of the profile with treatment has remained essentially the same. The sequence starts with the nose and proceeds to lips and the chin.

Semantics

Labels needed to be established for reference points for forecasting of the soft tissue components (Fig. 5-3). The bony parts were labeled in capital letters, and for the soft tissue lower-case letters were used:

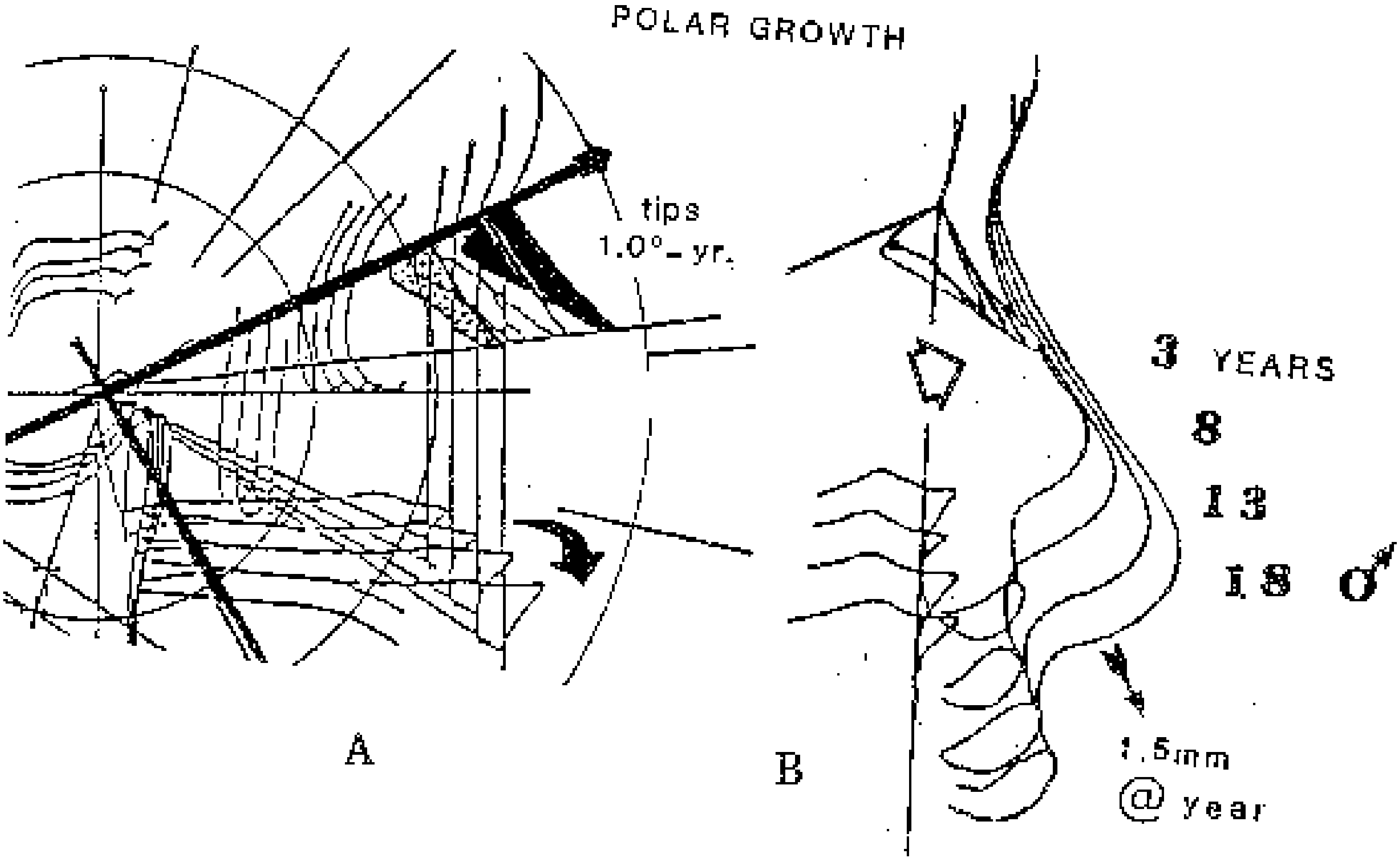


Fig. 5-1 **A.** The nasal bone tips forward with growth a mean of 1° per year and expresses vertical length as a polar phenomenon from Cc. Point A stays with N in forward development.

B. The nose grows concentrically downward and forward at a mean rate of 1.5 mm. per year. Both the nasal bone and soft tissue nose position can be altered with extraoral traction because the anterior nasal spine supports the septal cartilage.

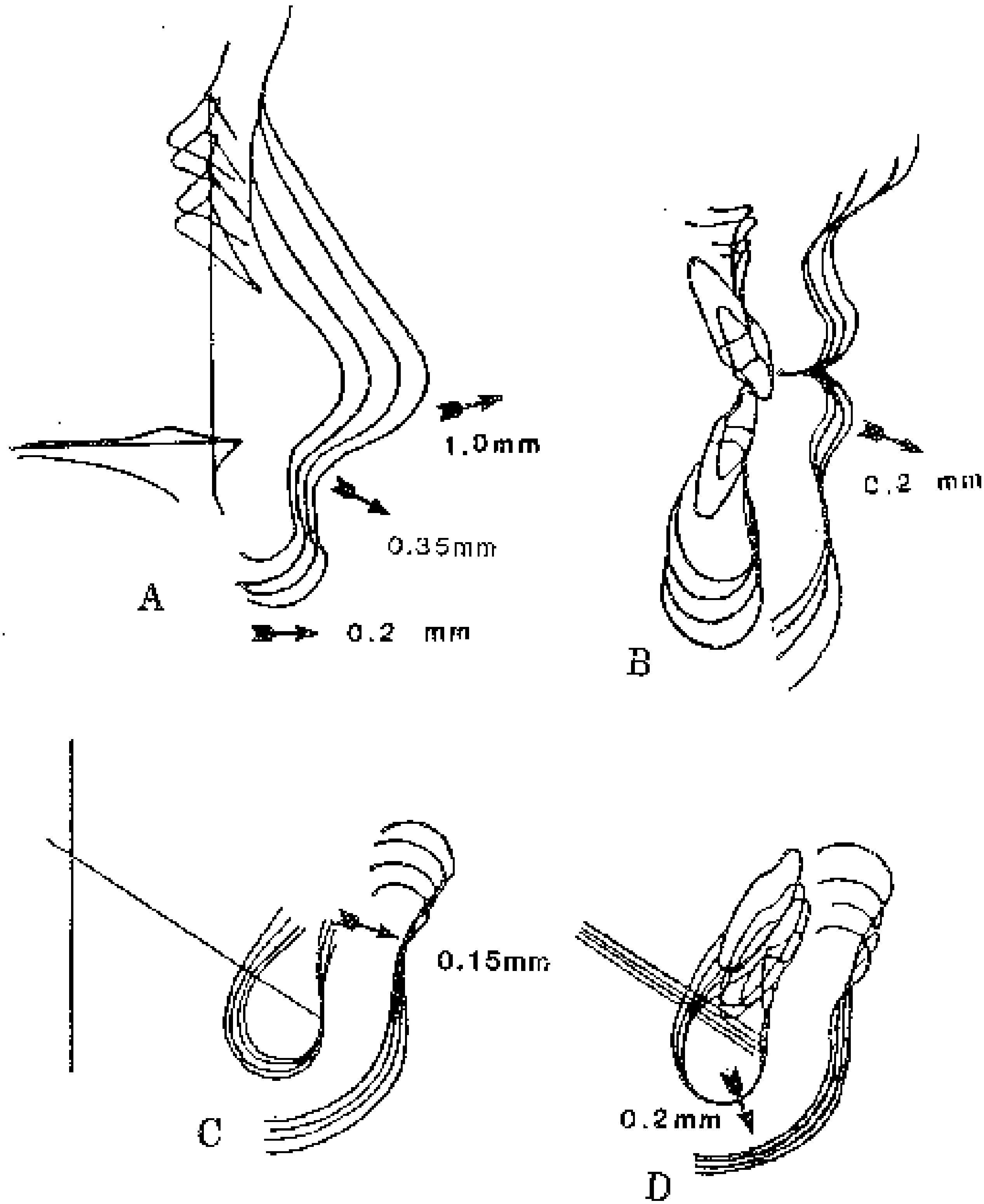


Fig. 5-2

A. Note the nose tip (pm) increases from Ans at a mean rate of 1.0 mm. per year. Subnasali (sn) increases downward and forward 0.35 mm. per year. From the labial of the upper incisor the lip thickens 0.2 mm. per year.

B. Stomion tends to maintain relative to the occlusal plane or drop downward with corrected function. The lower lip thickens 0.2 mm. per year.

C. Supramentali (sm) increases very little.

D. The chin thickens similarly to the lips, but increases more in many males.

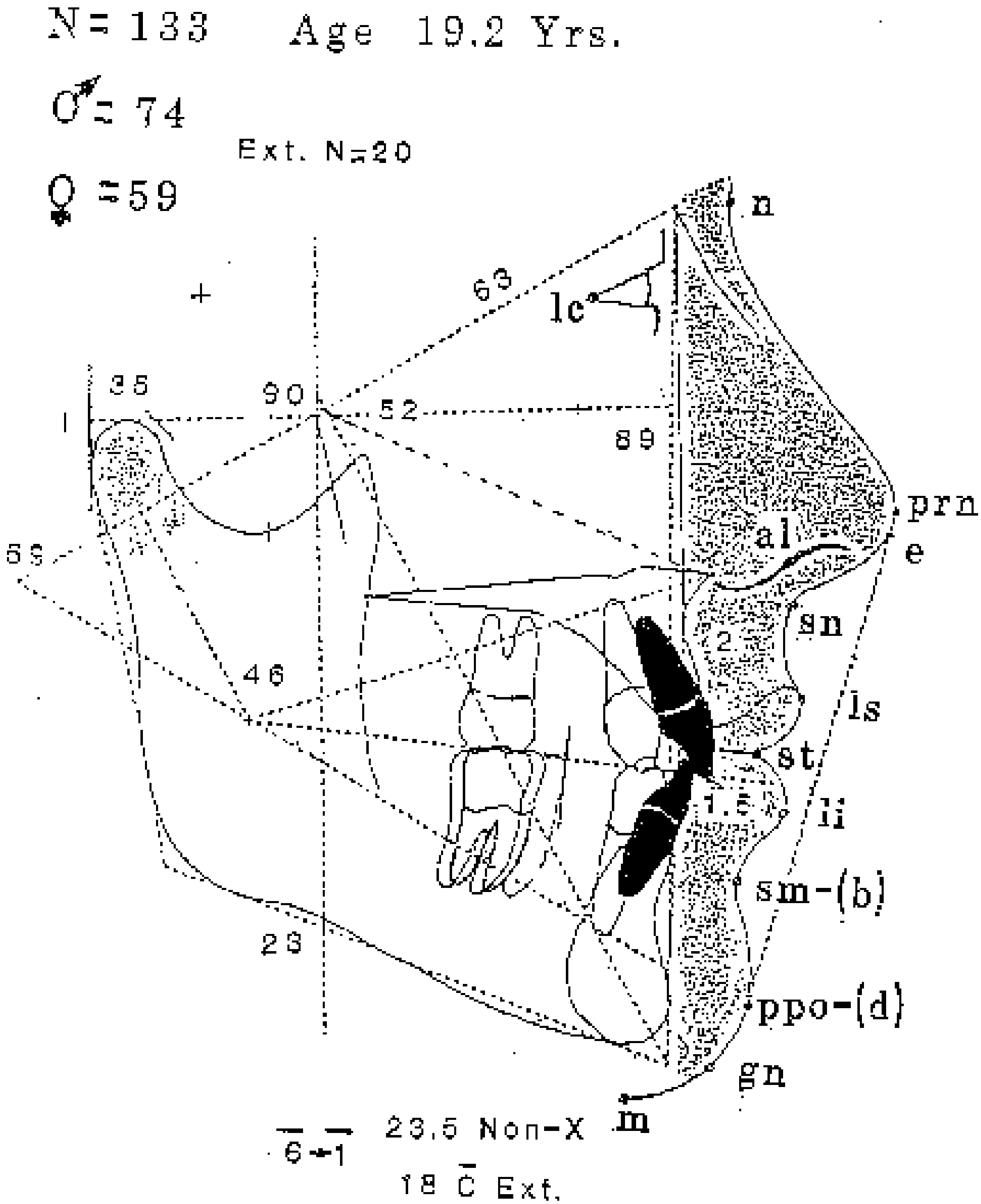


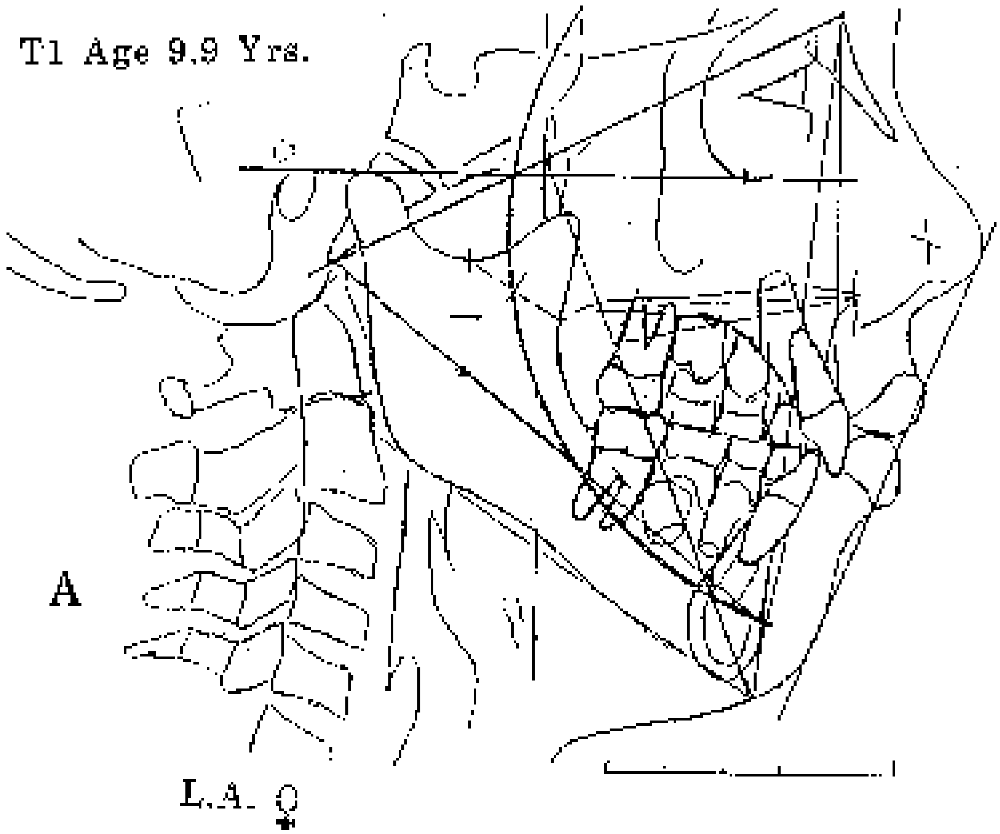
Fig. 5-3 Computer composites of 133 adult subjects; 83 had no orthodontic treatment, and 50 were out of retention. Cephalometric values are depicted. Lower case letters signify soft tissue points employed for analysis and forecasting. See text for definitions.

n	nasion
prn	pronasali (c) end of nose
sn	subnasali
ls	superior lip
st	stomion (lip embrasure)
li	inferior lip
sm(b)	supramentali
ppo	propogonion (d) -- chin dimple
gn	gnathion
m	menton
lc	lateral canthus
al	alar rim

* * * * *

The procedure as described covers seven general areas. It starts with the nasal bone covering and glabella area, and proceeds to the nose tip and subnasal area. The upper lip, the location of stomion and the lower lip are then considered. Finally, the sublabial area and the chin complete the exercise.

The two patients employed for demonstration in Volume I are continued here in Volume II. These are the female Laurie (L.A.), age 9.9 years (Fig. 5-4), and the male Nicholas (N.N.), age 12.5 years (Fig. 5-5).



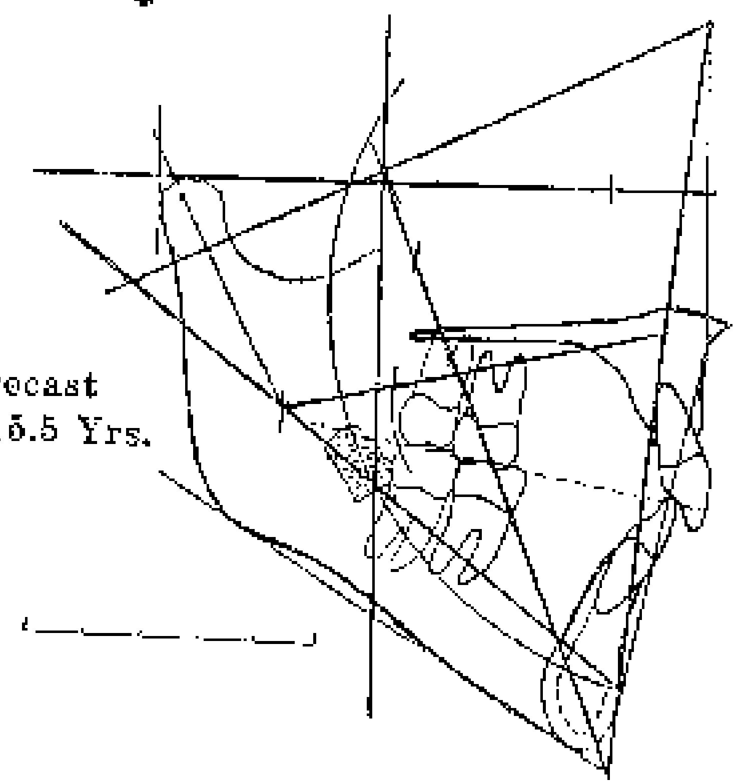


Fig. 5-4 A. Beginning tracing (T1) on female (L.A.) At age 9.9 years.
B. Skeletal and dental forecast to final X-ray at 15.5 years.

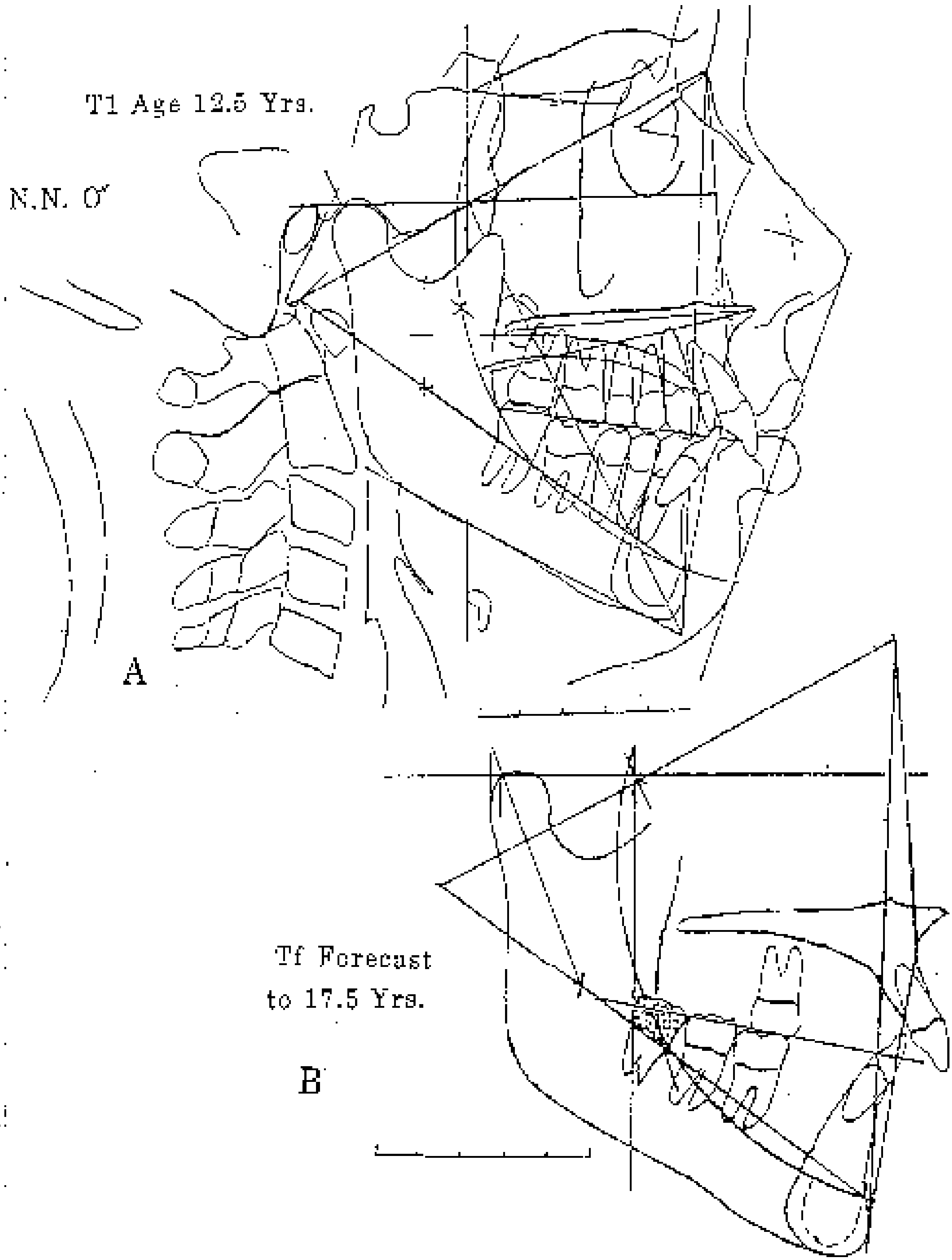


Fig. 5 5 A. T1 tracing on male (N.N.) At 12.5 years
B. Compare to the forecast of N.N. untreated at age 17.5 years.

Technique for the Nose

Step 1: On the T1 (original) extend a line from Cc through the end of the nasal bone. The nasal bone tips forward 1° each year. Place the end on the projected line (Fig. 5-6 [1]).

Step 2: Superimpose Tf on T1 nasal bone at Nasion, and copy the contour of the upper half of the nose followed by shifting to the contour of the glabellar area (Fig. 5-6 [2]).

Step 3: Superimpose Tf on T1 on the Org line, with Ans registered, and add 1.0 mm. directly forward, and mark a point of reference (Fig. 5-6 [3])

Step 4: Back up the Tf to the established mark, keeping the Org lines parallel to each other, and copy the lower half of the nose and inferiorly for the anterior one-half of the columnela (Fig. 5-6 [4]).

Step 5: Superimpose the Tf Ans on T1, and add 0.35 mm. per year at subspinali area (Fig. 5-6 [5]).

The nose to the base of the upper lip is completed (Fig. 5-6 [6]).

Conditional Factors for the Nose:

There is an old slang saying: "them that has gets". This has been interpreted in orthodontics to mean that a large structure will grow more than a small structure, and has often been thought to pertain to the nose. However, the child's nose by age 4 years is either large or small when compared to other children their age. As the child becomes older or into adulthood a large nose becomes further magnified. But **the nose does not usually tend to grow proportionally more** than that of the patient starting with a smaller nose unless an injury or defect is present.

Some late growth of noses is noted after adult skeletal facial growth has been achieved. This is often a drooping of the nose tip as stasis occurs in many facial tissues as well as body tissues.

Nasal cartilage may continue to grow, and further increases are noted in the cartilage of the ear. Thus, **continued growth and "nose drooping"** and **upper lip drooping** are some of **the characteristics of facial aging** together with sagging and wrinkling of the superficial tissue.

Interestingly, during development of the nose, the contour or form of the

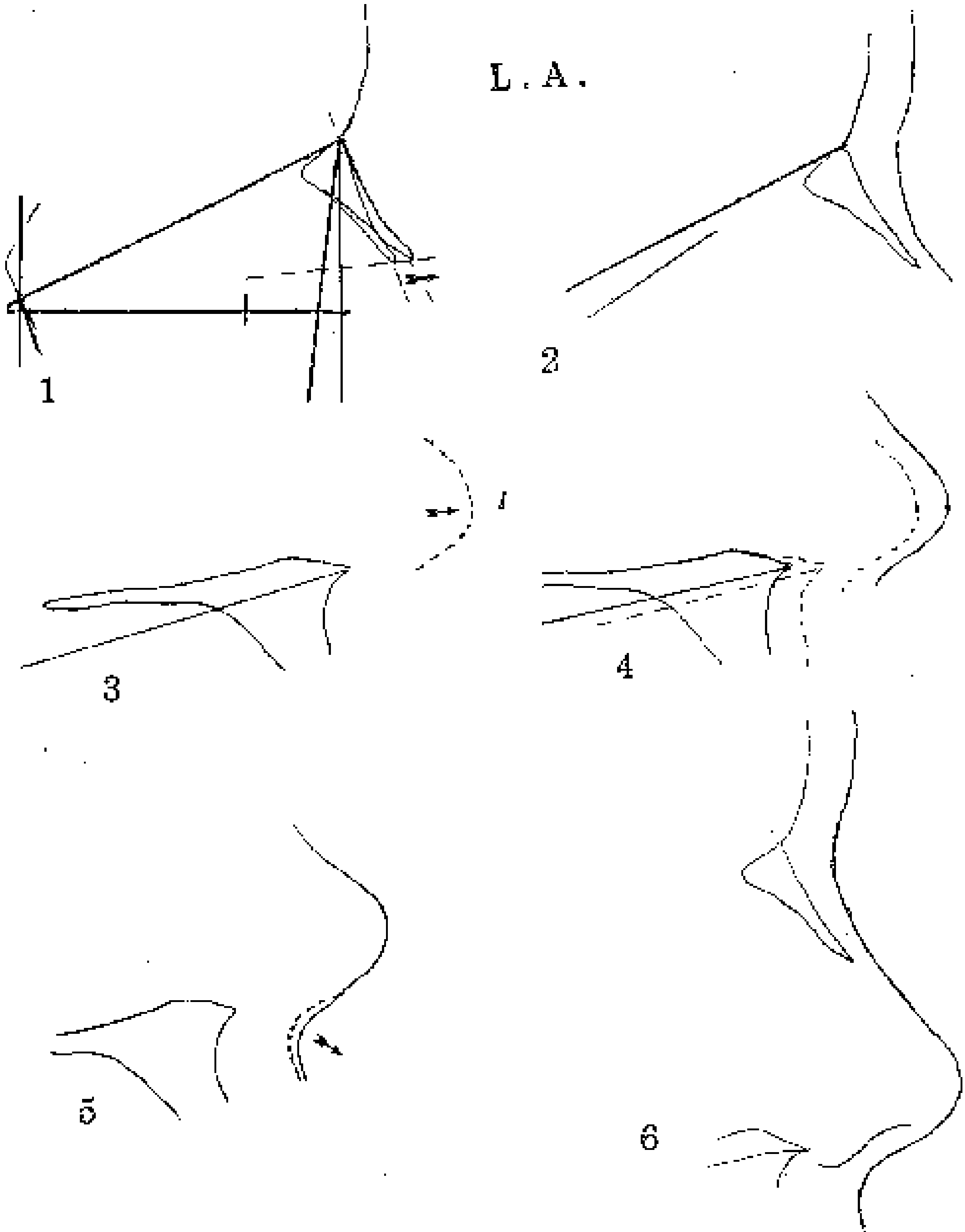


Fig. 5-6 See text.

nose tip tends to be maintained after age 6 to about 2 cm. above and 1 cm. below the end of the nose. Lip tension further can cause a slight change in the nose tip position.

Humps in the nose develop with the nasal forward tipping of the bone. The angle of the nasal bone increases 1° yearly, and its length is gnomonic to the polar phenomenon (see Fig. 5-1).

The prediction of the end of the nose is a problem in LeFort surgery. The anterior nasal spine is retained (by surgeons) together with the septum in patients having maxillary impaction in order not to distort the nose.

Forecasting the Lips

The Upper Lip and Stomion

Step 1: Superimpose Ti and Tf on the predicted upper incisor and, at the vermillion border of the upper lip, add 0.2 mm. per year for natural development. Select a point for the future Stomion relative to the upper incisor (Fig. 5-7 [1]).

> **Note:** Stomion tends to remain at the same level to the occlusal plane in a short-range prediction, but in long range **Stomion tends to drop with age about 1 mm. each five years.**

Connect the lip contour to subnasali and to Stomion (lip embrasure).

Conditional Factors: The lips are controversial in terms of instructions given to patients for the X-ray procedure. Some clinicians prefer the lips at repose, but the author requests lips together for assessment of strain in function. The pursed lip is thinner and the reposed lip may be more flaccid.

The Lower Lip

Step 2: Superimpose at the Inter-incisal point (Ii) between the **upper and lower** incisor. In a **downward and forward** direction mark a point at 0.2 mm. per year for the lower lip increase in thickness (like the upper). Fill out the contour of the lower lip from that point to about 5 mm. below the vermillion border (Fig. 5-7 [2]).

> **Note:** More will be explained later regarding lip change with treatment.

Conditional Factors for the Lower Lip: A problem in forecasting occurs with lip change resulting from correction of a malocclusion. There is also a

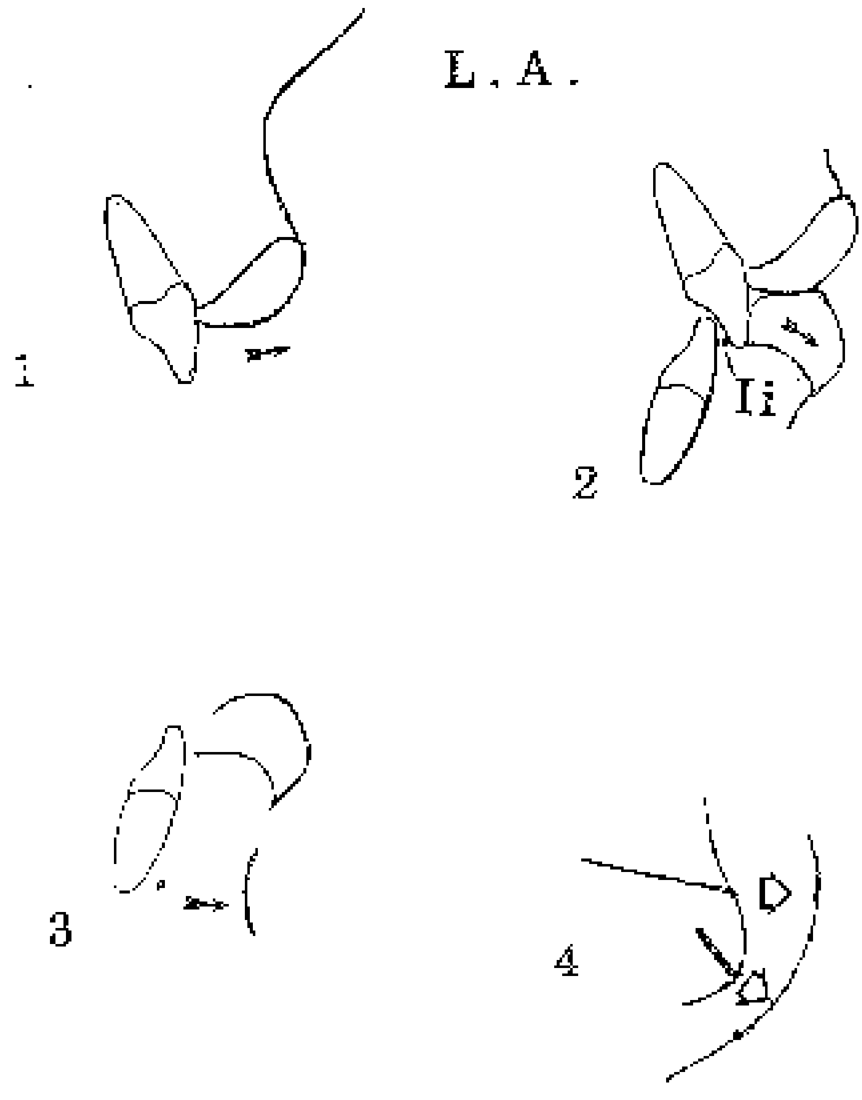


Fig. 5-7 See text.

problem concerning **the manner in which the mouth is held for the taking of the original headplate**. From the start the author preferred to measure lips and forecast them from the closed lip position, as seen in the function of deglutition, which was found best for the diagnosis and the prognosis.

Supramentali (Sublabiali)

Step 1: Superimpose T1 and Tf at B Point or at the apex of the lower incisor root. Increase the thickness of the soft tissue at only 0.15 mm. per year (1.0 to 1.5 mm. in ten years). This variation depends on vertical increases in denture height.

Step 2: Fill in the contour in the sublabial fold (Fig. 5-7 [3]).

Technique for the Chin

Step 1: Superimpose T1 and Tf on the Corpus Axis at Pm (Fig. 5-7 [1]).

Step 2: Add 0.20 mm. per year at Pm for **females** and 0.25 mm. for **males**.

Step 3: Superimpose on the Facial Axis at Gnathion.

Step 4: Add the same 0.20 mm. per year in females and 0.25 mm. per year in males to the soft tissue chin at Gnathion (see Fig. 5-7 [4]).

Conditional Factors: Some males, the types yet to be determined, will develop significant soft-tissue chins. Also, Stomion in some males in particular tends to drop significantly with development.

The complete soft tissue is now forecasted (Fig. 5-8). The same sequence of steps are demonstrated for the male N.N. in Figures 5-9, 5-10, and 5-11.

Summary of Soft Tissue Behavior

After the teeth are placed in the forecast the soft tissue is added on the profile according to reconfirmed data since 1950. Quite often the soft tissue is thought to be the most difficult portion to "predict". However, to our great surprise it is much more regular than would be expected. (The accuracy of prediction of soft tissue is

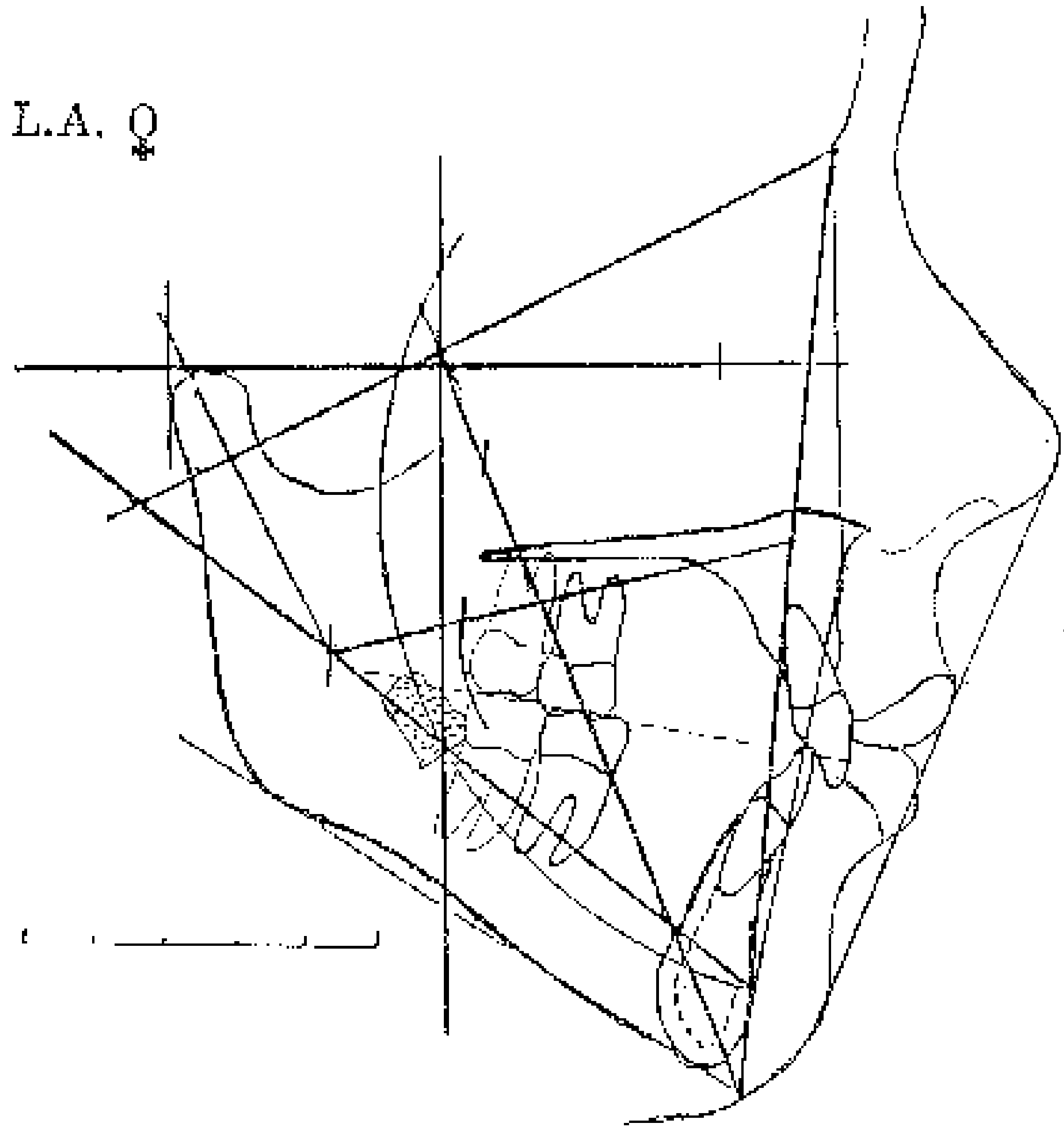


Fig. 5-8 The completed forecast, including the soft tissues, for female patient L.A.

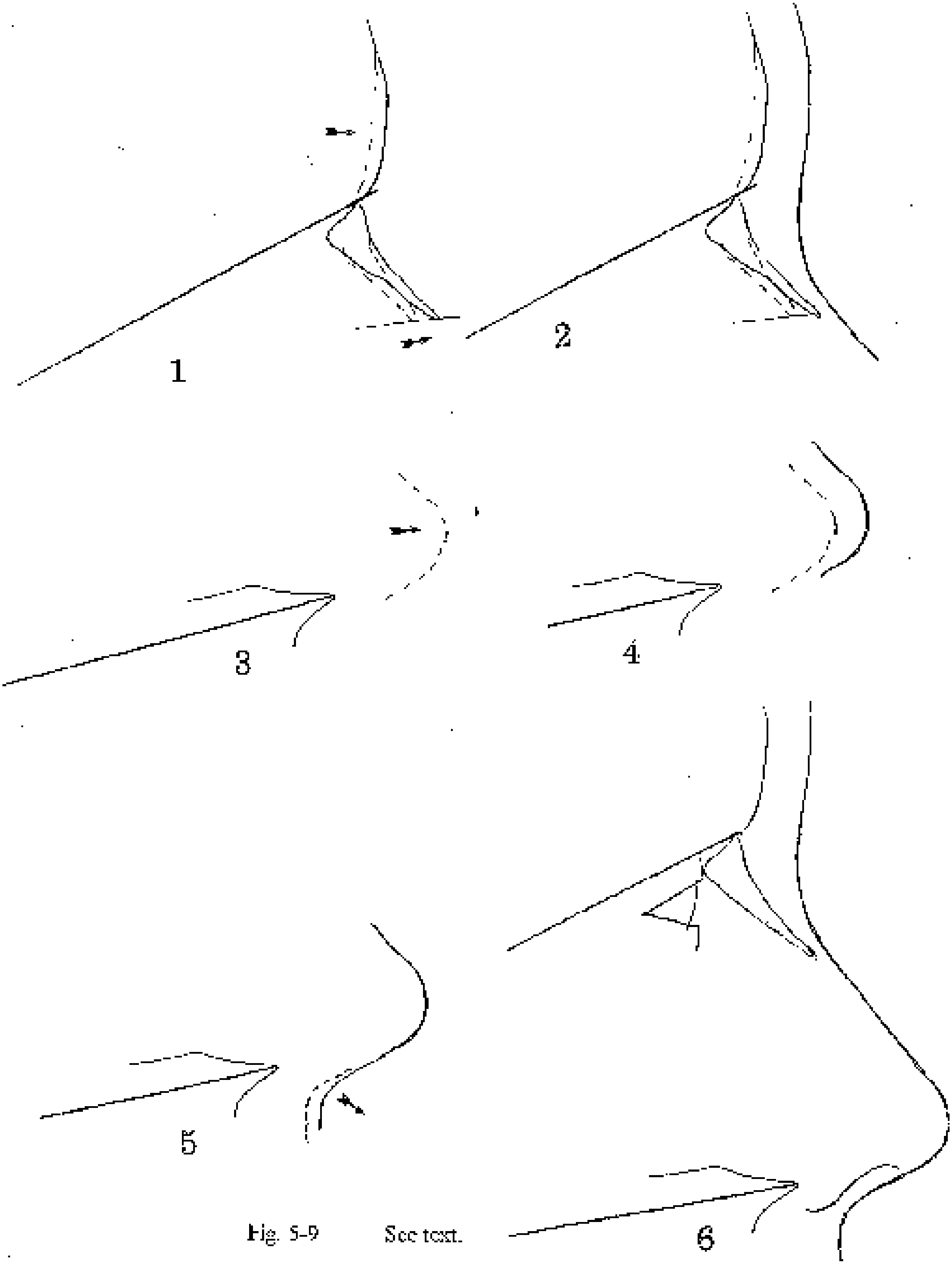


Fig. 5-9 See text.

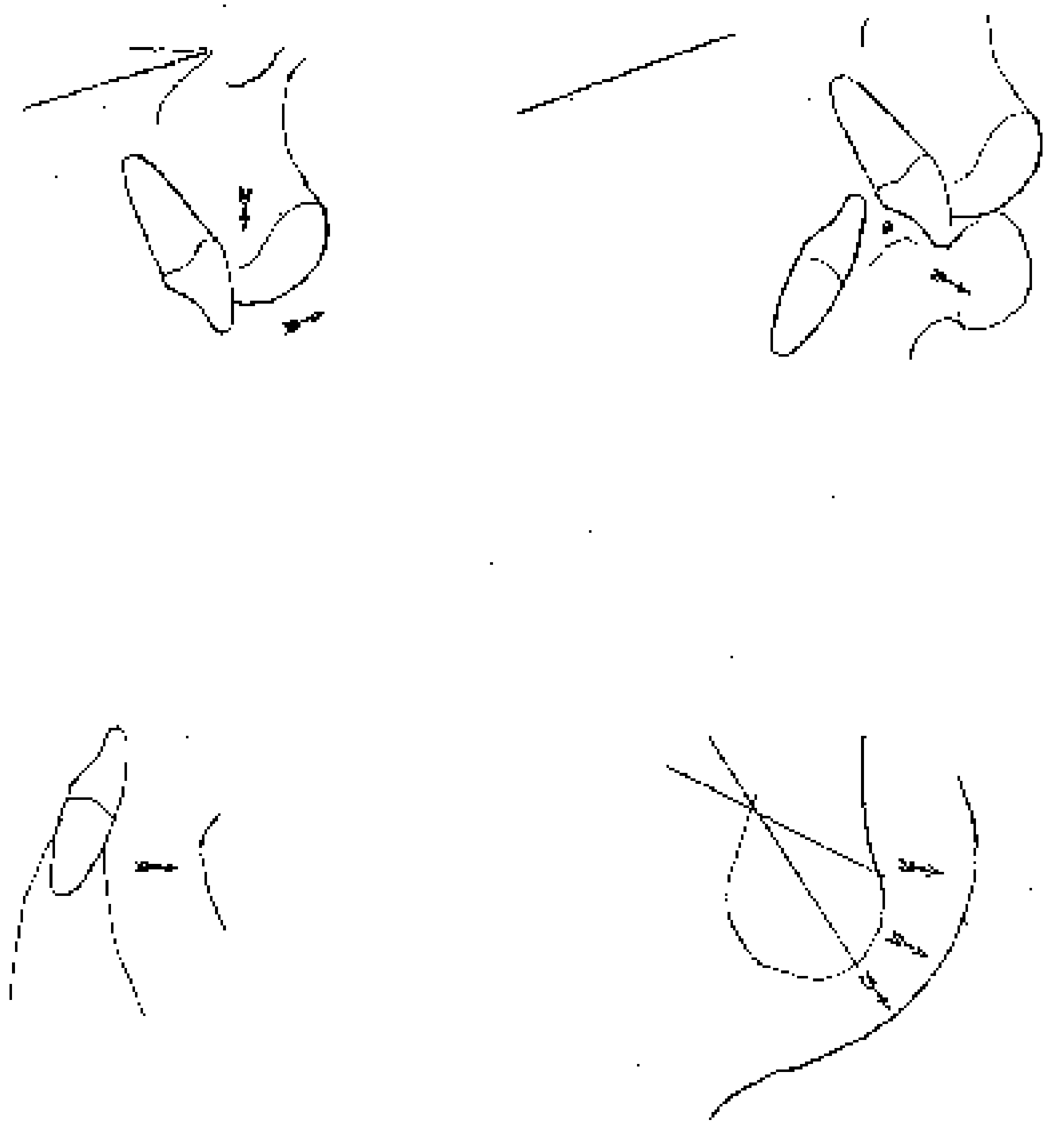


Fig. 5-10   See text.

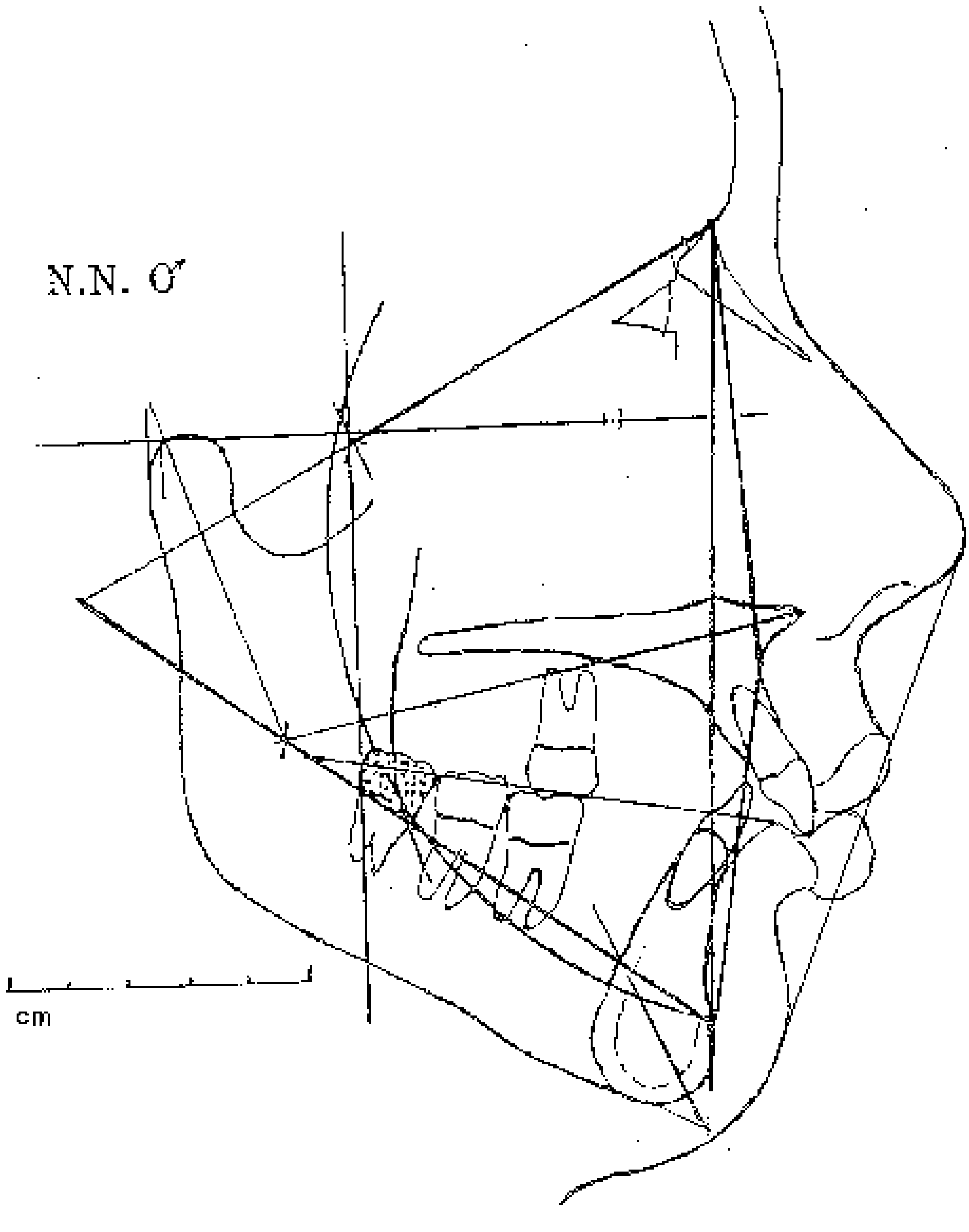


Fig. 5-11 Full forecast for male patient N.N.

better than most clinicians would assume.) The problem often lies in the vertical and horizontal behavior of the underlying skeletal parts. Thus accuracy rests with the basic structural accuracy. (If the basic parts are incorrectly forecast, the end product -- the profile -- will also be affected.)

The integument consists of the nose, both lips, and the chin, and the forecast can be made without treatment of the skeletal and dental parts.

However, a more difficult problem lies in the changes in the soft tissue associated with both orthopedic and orthodontic corrections. These will be addressed in Chapter Six.

SUMMARY FOR CHAPTER FIVE

This chapter has dealt with soft tissue growth behavior and forecasting.

Until 1954 no method of appraisal of soft tissue relations was available. From challenges by Dr. Charles Tweed the author founded the "Esthetic line". This was a line from the nose tip (Pronasali prn) to the anteriormost contour of the chin at the area of protuberance menti (Ppm). Later the "pupil planes" were employed for relative mouth width assessment. The "cheek plane" was later employed to add to the "esthetic balance" concept.

The Divine Proportions were rediscovered and instituted in about 1980. Thus, the objectives in esthetics and concern for the future face have steadily grown. This interest marks the last half of the 20th century in the profession. Growth of the soft tissue and its prediction has been a basic challenge to the clinician and surgeon.

Techniques for the soft tissue forecast were described in a sequence consisting of the nose, the upper lip, stomion, the lower lip, the sublabial area, and the chin. Conditional factors were described. It was pointed out that soft tissue projection was based on the accuracy of the underlying hard tissues on which the integument is based. The effort was made, as a starting point, to first describe growth in the absence of treatment. A more detailed forecast will be necessary as the two patients chosen for demonstration will be planned for treatment objectives and will be compared as treated to the forecast in later chapters.

PREDICTION, PLANNING, CONSTRUCTION and MECHANICS

CHAPTER SIX
FORECASTING IN THE FRONTAL
(The Vertical and Transverse Dimension)

INTRODUCTION

Application of the frontal headplate* has been hampered by the lack of consistency in the positioning of the patient in the cephalometer. One problem was the variation in ear cartilages which made the external canal inconsistent. Also, the tipping of the head downward makes the face appear longer and a tipping upward gives an image of shortness. However, if a standard and careful technique of orientation is followed routinely a better consistency should result.

The method for the positioning of the patient for the frontal was improved by Dr. Ruel Bench. He oriented the head to the lateral canthus of the eye to a standard mark on the ear rod holder placed at 15 mm. above the top of the ear rod as the patient was "suspended" in the ear rods (Fig. 6-1).

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*Note: The frontal forecasts have been developed more recently and require more research. However, the techniques employed todate are offered here for consideration as a reasonable teaching method for transverse dimensional consideration.

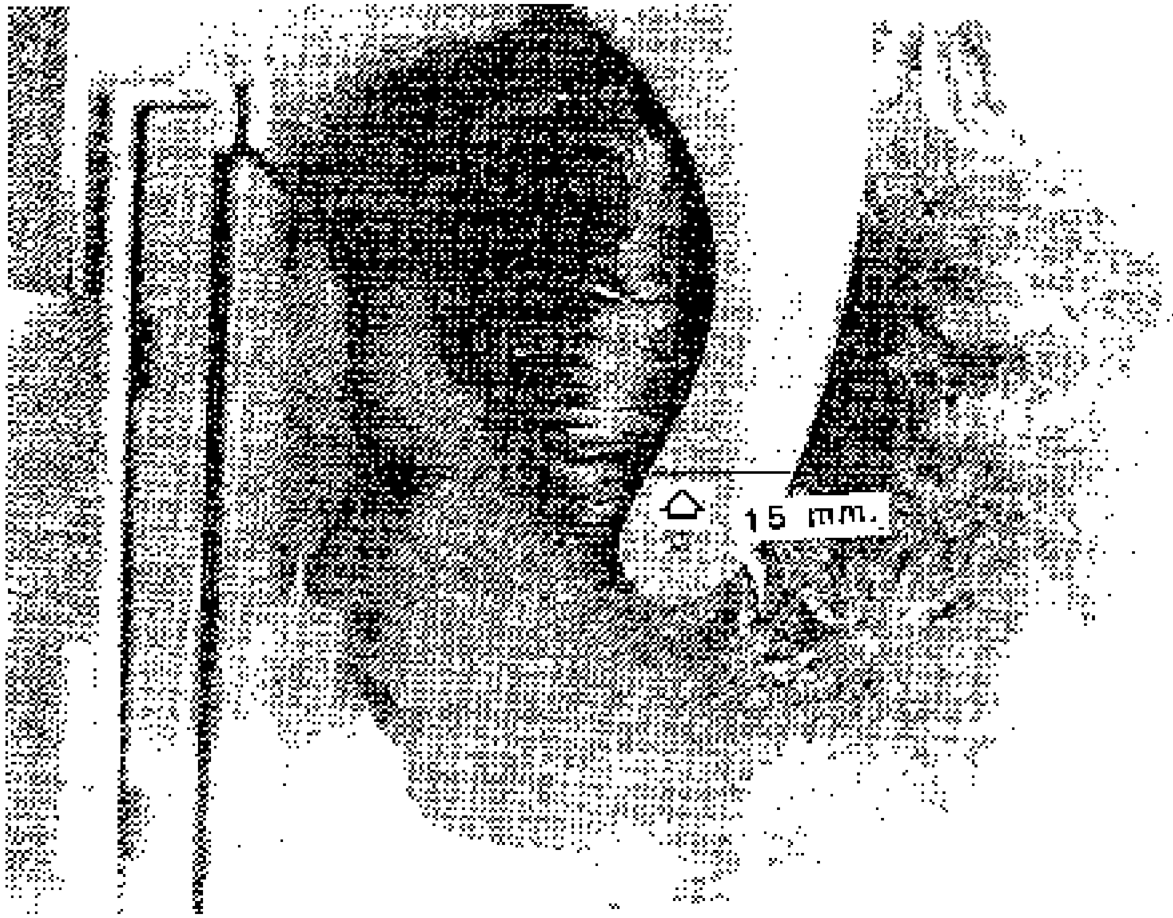


Fig. 6-1 Orientation by Dr. Ruel Bench for the frontal exposure. A line is placed 15 mm. above the ear rod and while the ear rod is seated superiorly in the ear canal the head is tipped to align the line with the lateral canthus of the eye. This "standardizes" the process.

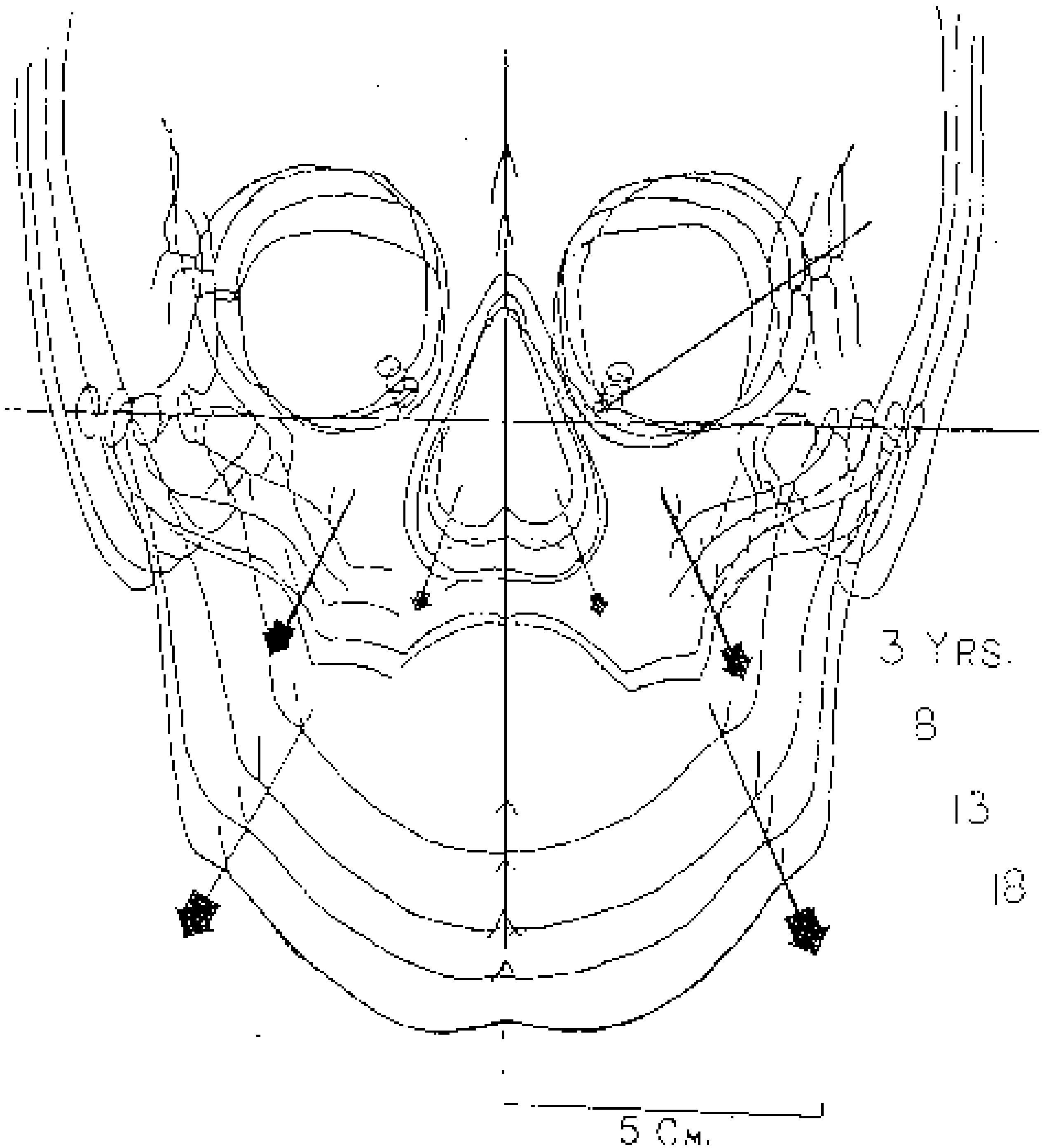


Fig. 6-2B Superimposed composites with growth increases for the nasal cavity, maxilla, mandible, and orbits.

Planes of Reference

Ten planes were developed for the Frontal Analysis and for future comparisons (Fig. 6-3). These planes were for the transverse:

(1) Frontal Frankfort (Z - Z),
(2) Cranial (Zf - Zf),
(3) Maxillary (J - J),
(4) Mandibular (Ag - Ag),
(5) Palatal (Nc - Nc) and
(6) Occlusal (6⌉ - ⌈6).

For the vertical (Fig. 6-4) these were:

(7) Midsagittal (perpendicular to FH from nasal septum),
(8) Fronto-facial each side (Zf to Ag),
(9) Maxillo-mandibular (left and right) (J - Ag), and
(10) Maxillo-mandibular (central) (Ans - Pm).

A comprehensive analysis emerged, and a summary analysis of fifteen measurements became practical. The patients (L.A. and N.N.) employed for analysis and forecasting in the previous chapters are displayed with the measurements posted appropriately (Fig. 6-5 and Fig. 6-6). As in the lateral analysis, the order for the comprehensive analysis was the "fields" or "families" of measurements for the teeth, the skeletal face, and the cranial base.

The frontal measurements were (top to bottom):

the nasal cavity,
the maxilla,
comparative maxillary concavity (R & L),
Ans symmetry,
buccal molar relationship (R & L),
first molar width,
comparative molar position (R & L),
mandibular width,
first premolar width,
intercanine width,
dental midline symmetry, and
mandibular midline symmetry.

For more detail of asymmetry, the Grummons analysis may be employed.

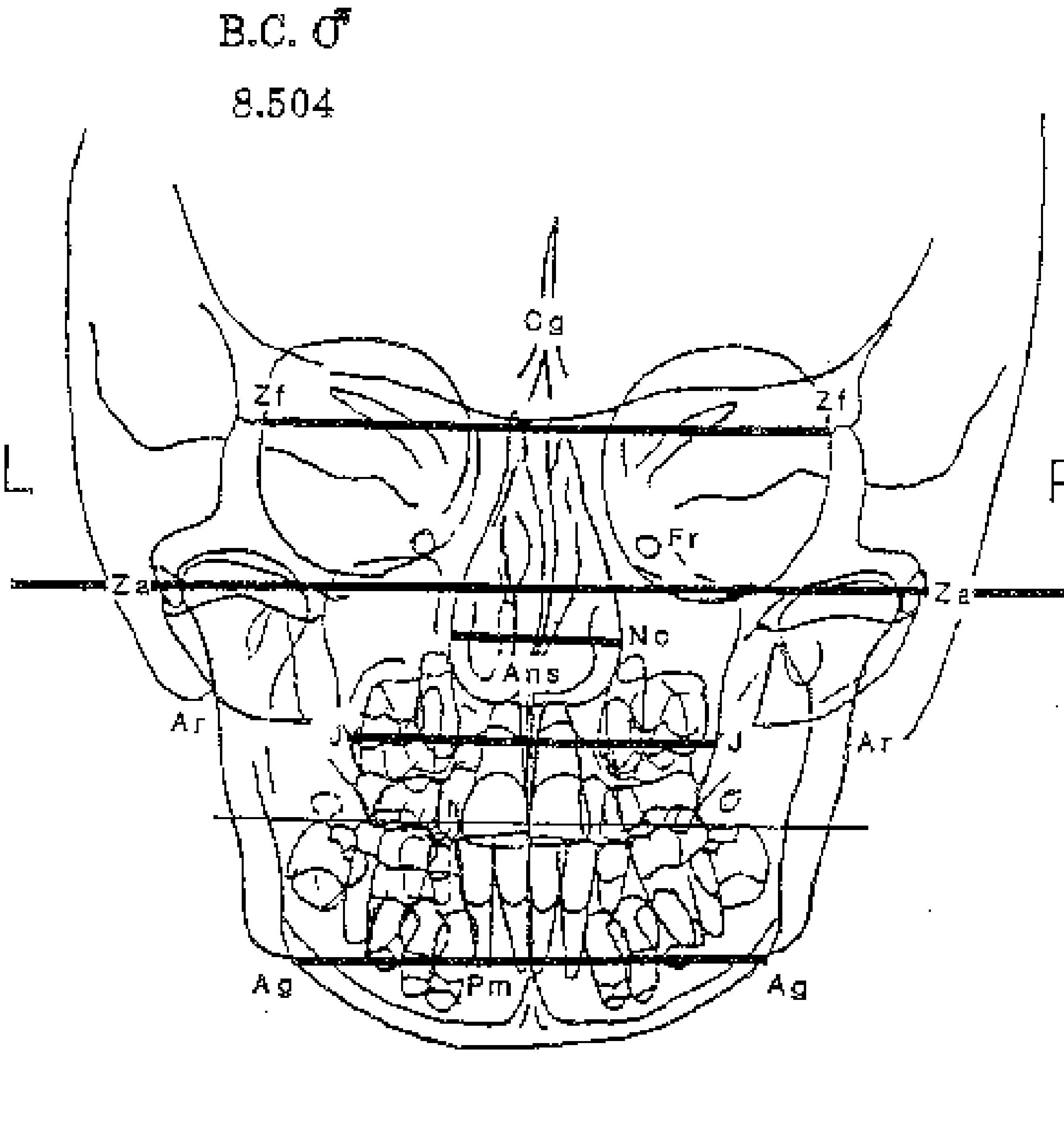


Fig. 6-3 Planes of reference employed for frontal analysis for transverse parameters

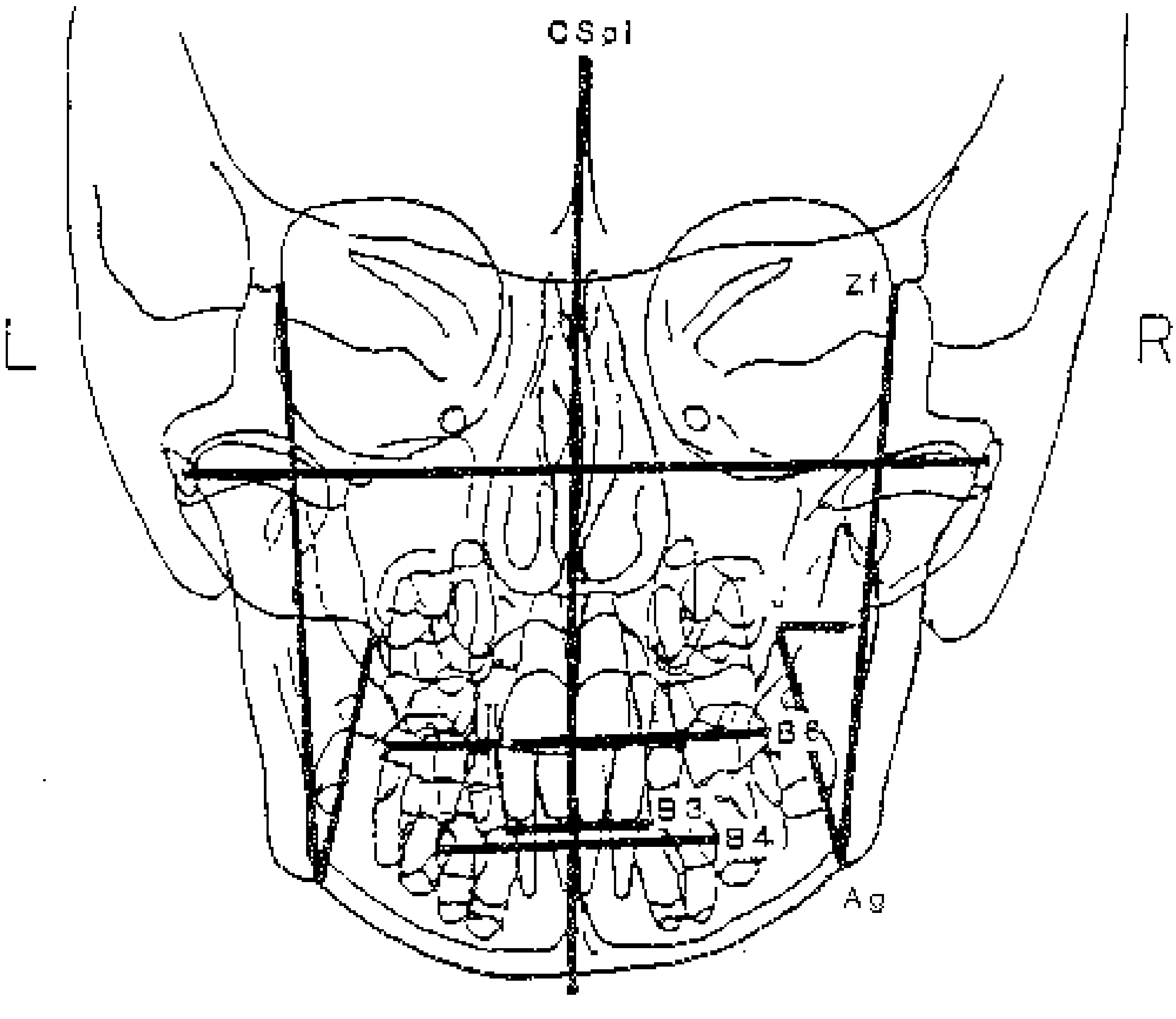


Fig. 6-4 Vertical planes of reference used for frontal measurements.

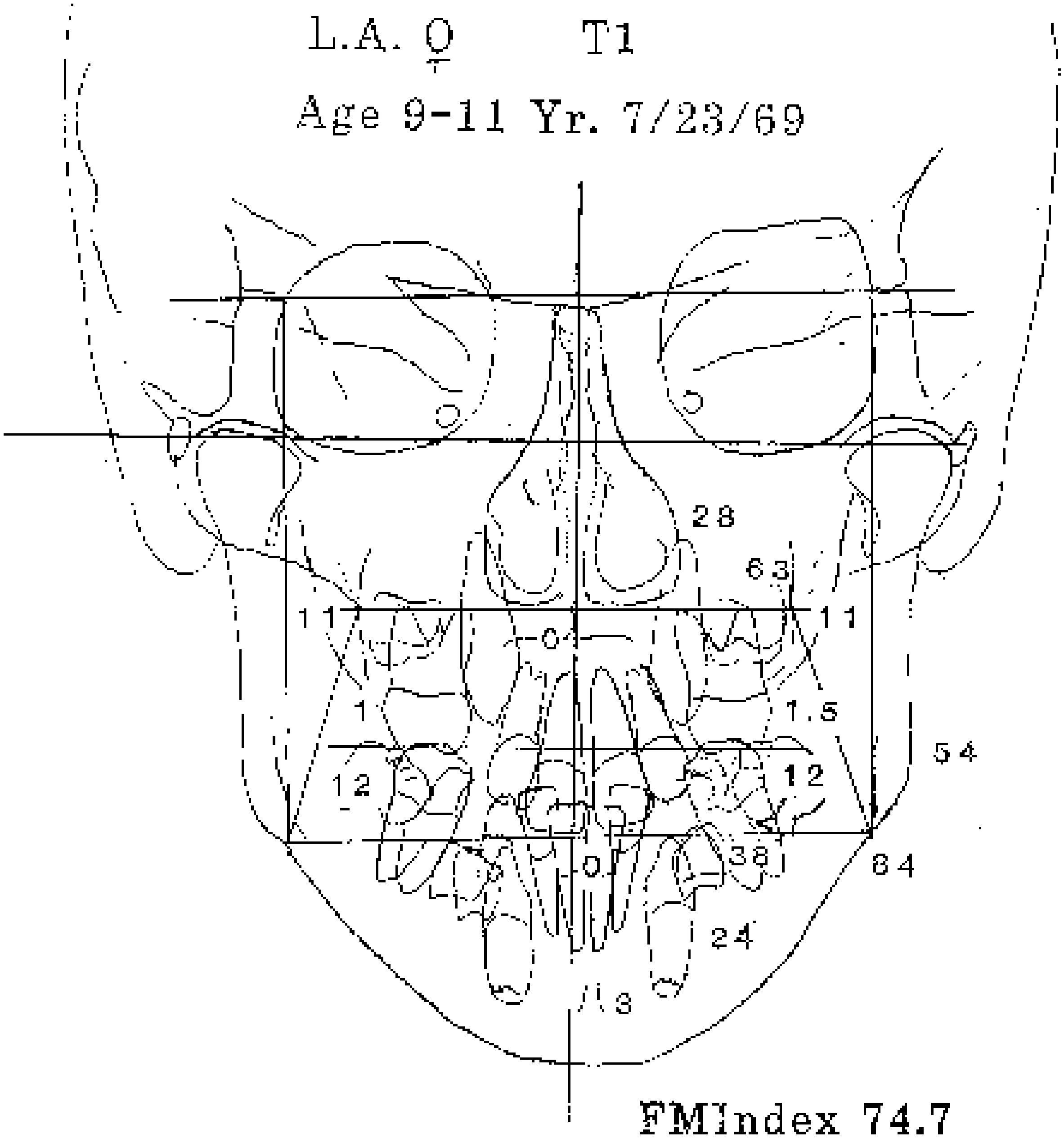


Fig. 6-5A Frontal tracings of female patient (L.A.) With fifteen measurements posted at sites for identification

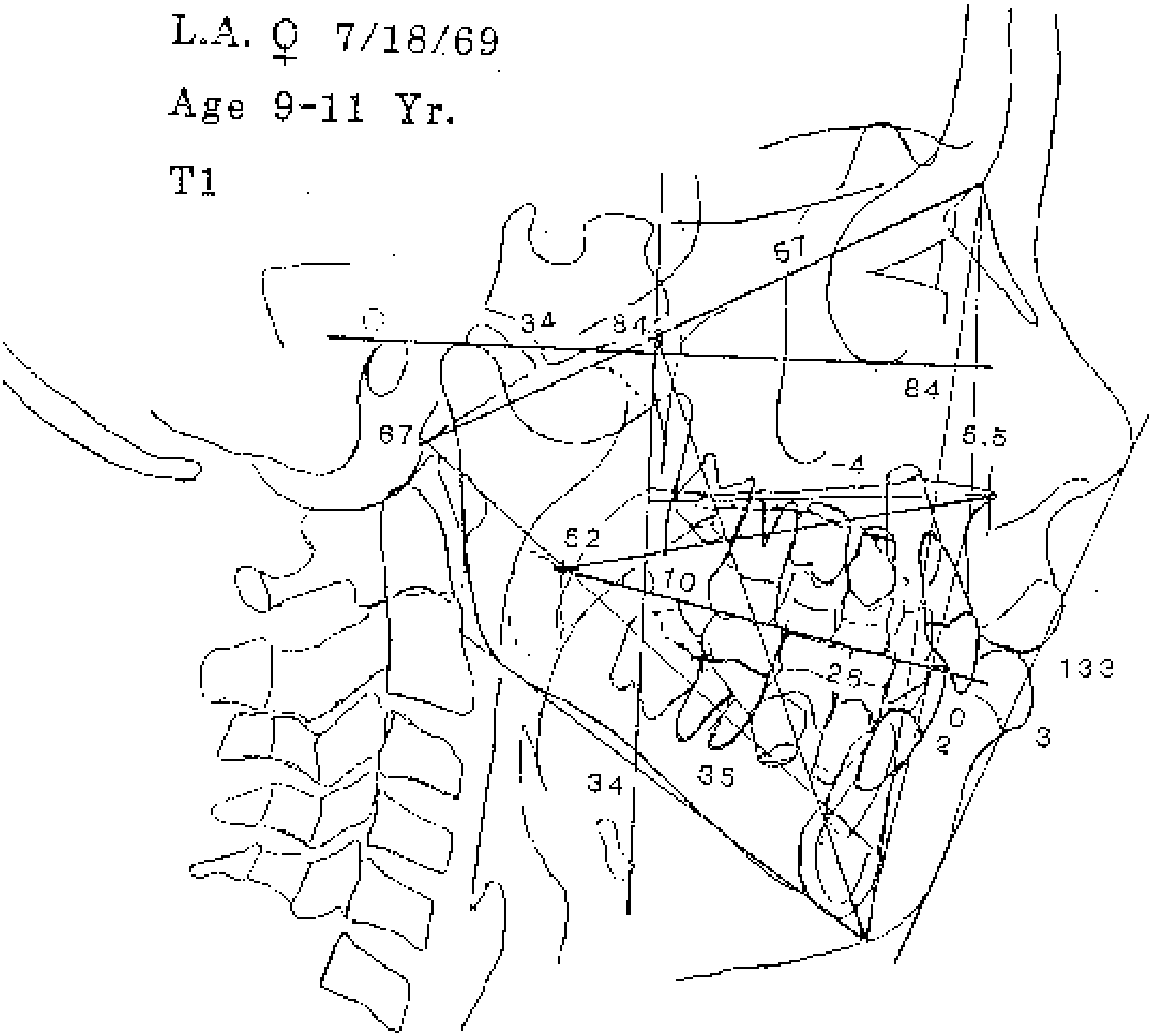


Fig. 6-5B Lateral analysis on patient L.A. for review.

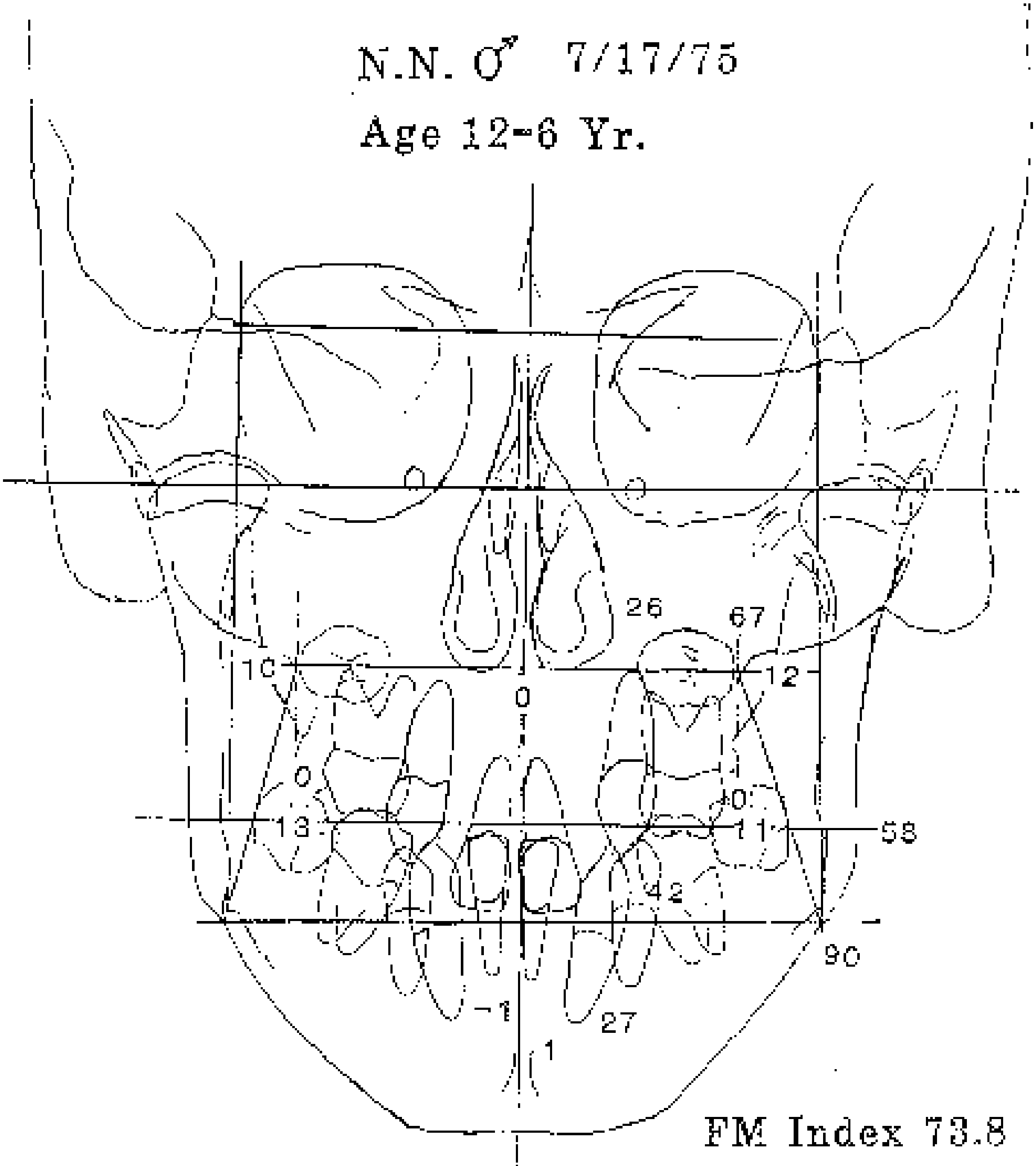


Fig. 6-6A Frontal tracings of male patient (N.N.) With analysis. Note slight mandibular asymmetry.

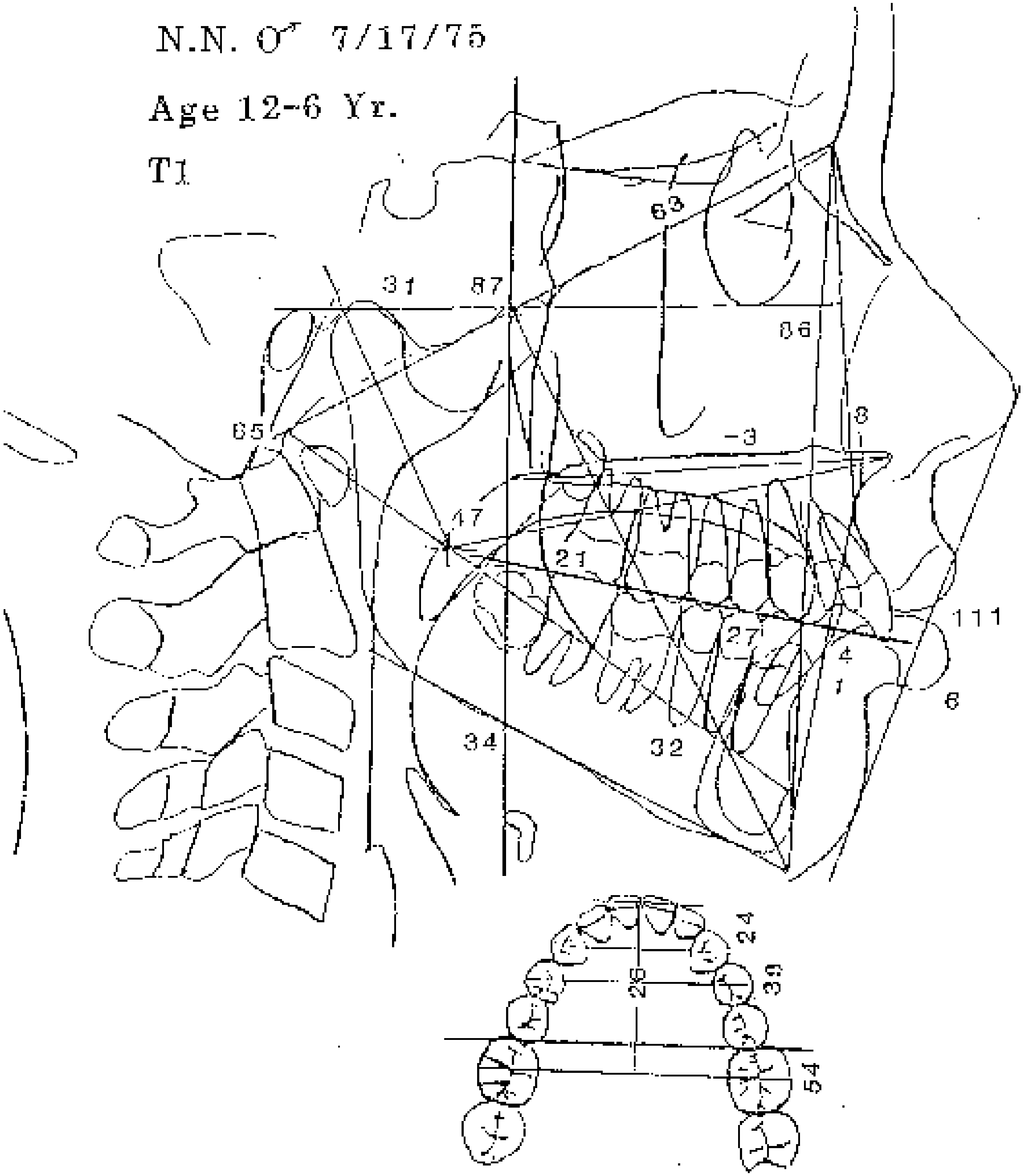


Fig 6-6B Lateral and occlusal analysis on N.N.

DIVINE PROPORTIONS

Cephalometric

The Frontal Divine Proportion analysis became a further enlightenment by 1985. An adult composite of 82 subjects revealed proportions between the orbits, between the nasal cavity and the maxilla, and between maxilla and certain landmarks in the ramus of the mandible (Fig. 6-7A). During growth there was an 80% ratio between the maxillary and mandibular referances (Fig. 6-7B). From the trigonium mentale in the frontal perspective the mandible grew at a mean angle of 60° and grew 35 mm. From 3 months to 18 years (Fig. 6-7C).

Photographic

The frontal photograph became an important base for clinical judgment (Fig. 6-8). While external tissues are observed in life experiences (with the exception of the teeth), facial beauty is highly dependent upon the underlying skeletal matrix in three dimensions.

⚥ ADULT COMPOSITE N82

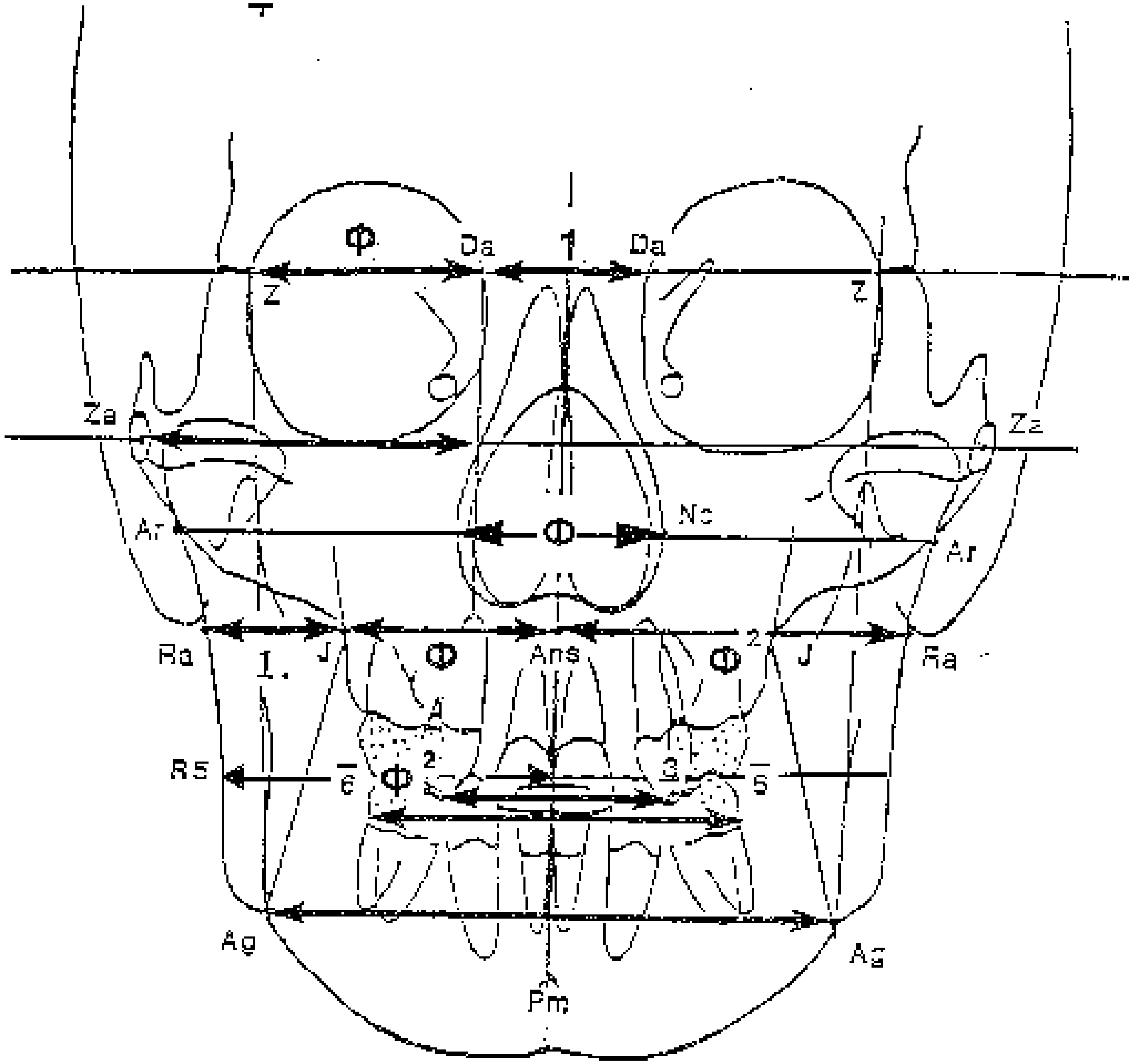


Fig. 6-7A The composite of 82 adult subjects with normal occlusion with Divine Proportion analyzed. The relationship is 1.0 to 1.618, or 0.618 to 1.0, signified by Phi (ϕ). 0.382 is Phi prime (ϕ').

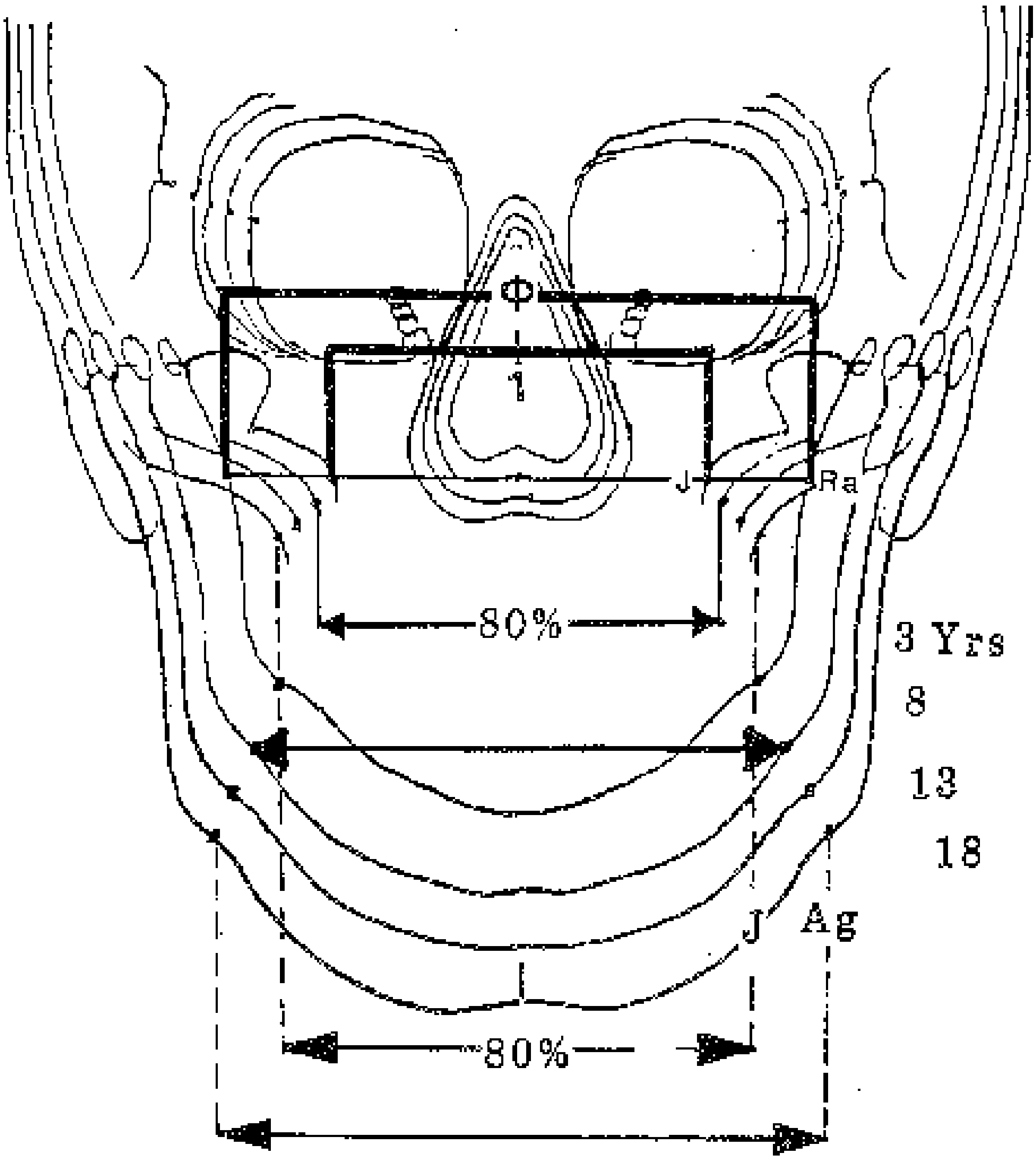


Fig. 6-7B The width of the maxilla (at J-J) holds about 80% in ratio to the ramus after age 3.

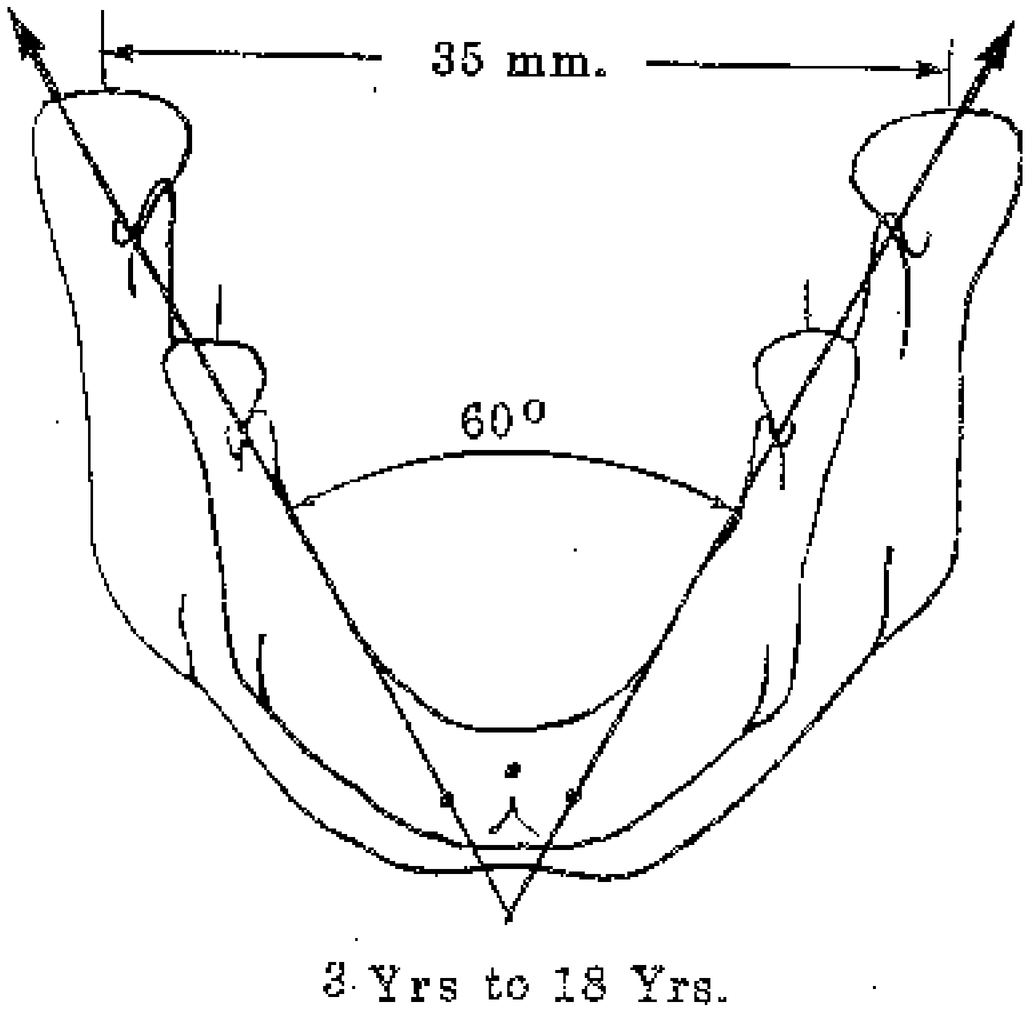


Fig. 6-7C A typical mandible in frontal view at age 3 months compared to 18 years on same patient. Note the growth at 60° and 55 mm., or essentially 2.0 mm. per year.

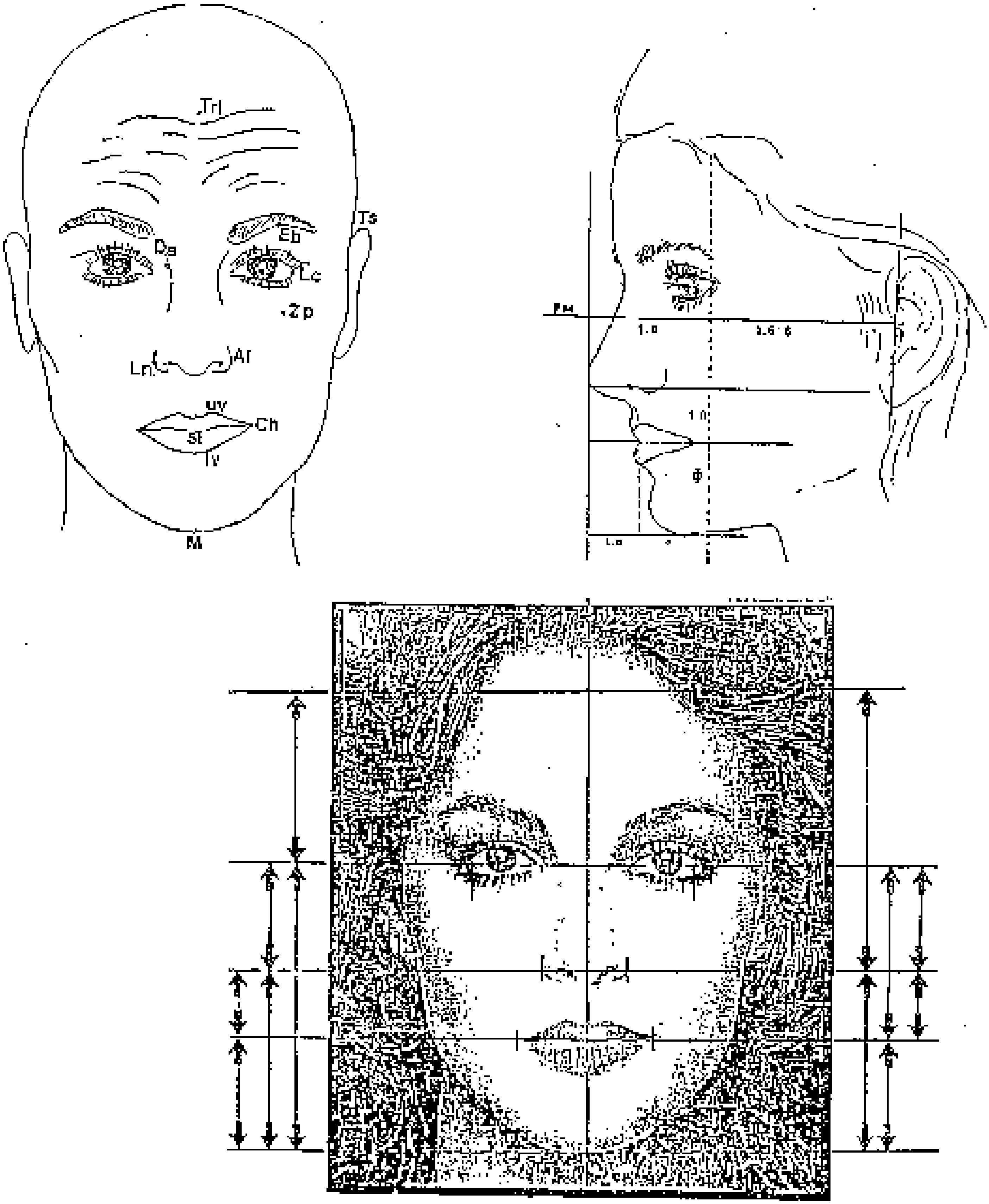


Fig. 6-8 Photographic analysis of an ideal female model for Merle Norman cosmetics.

Report on Findings at Vienna

In work with Dr. Rudi Slavicek direct measurements on the nasal cavity and dental area in adult males were made on N=65 skulls from the Weisbach collection (deaths circa 1850) now in the Museum of Natural History in Vienna, Austria (Fig. 6-9).

The Periform aperture was studied directly in the skulls for in height and width. Findings were: width (24.07mm. ± 2.2) and height (32.9 ± 2.7).

Cephalometrically, the width of the Nc point in N=34 normal male subjects was 31.0 mm. The width of the J points was 65.5 mm. The width of the Ag points was 85.2 mm. The first molar was 58.0 mm. The intercanine width was 25.0 mm. (Fig. 6-10).

The findings of these skulls essentially confirmed the programmed computer data skeletally. However, the molar width in the skulls was wider and prompts a new consideration of the standards.

Growth Behavior

Four principal issues are of concern in the process of transverse growth clinically, particularly during the transition from the mixed dentition to the permanent occlusion. The first interest concerns reference points, or anatomical parts and their natural behavior with normal growth. Second is the possibility of altered behavior with treatment. The third question relates to whether or not frontal growth changes can be forecasted. Finally, the application of the frontal diagnostic process pertains to planning modifications for the jaws and teeth.

From the frontal computer composites generated in 1968, contrary to the lateral, growth was not found to emanate from a single area. Growth in the frontal perspective was bipolar in nature (Fig. 6-11). This unilateral expression was theorized to be due to two separate blood supplies (or a separate neurotrophic supply for each half of the face). Growth behavior tended to focus from the area of the foramen rotundum for each side. This finding contributed to a better understanding of facial asymmetry. The phenomenon pointed out probably why identical symmetry is so rare.

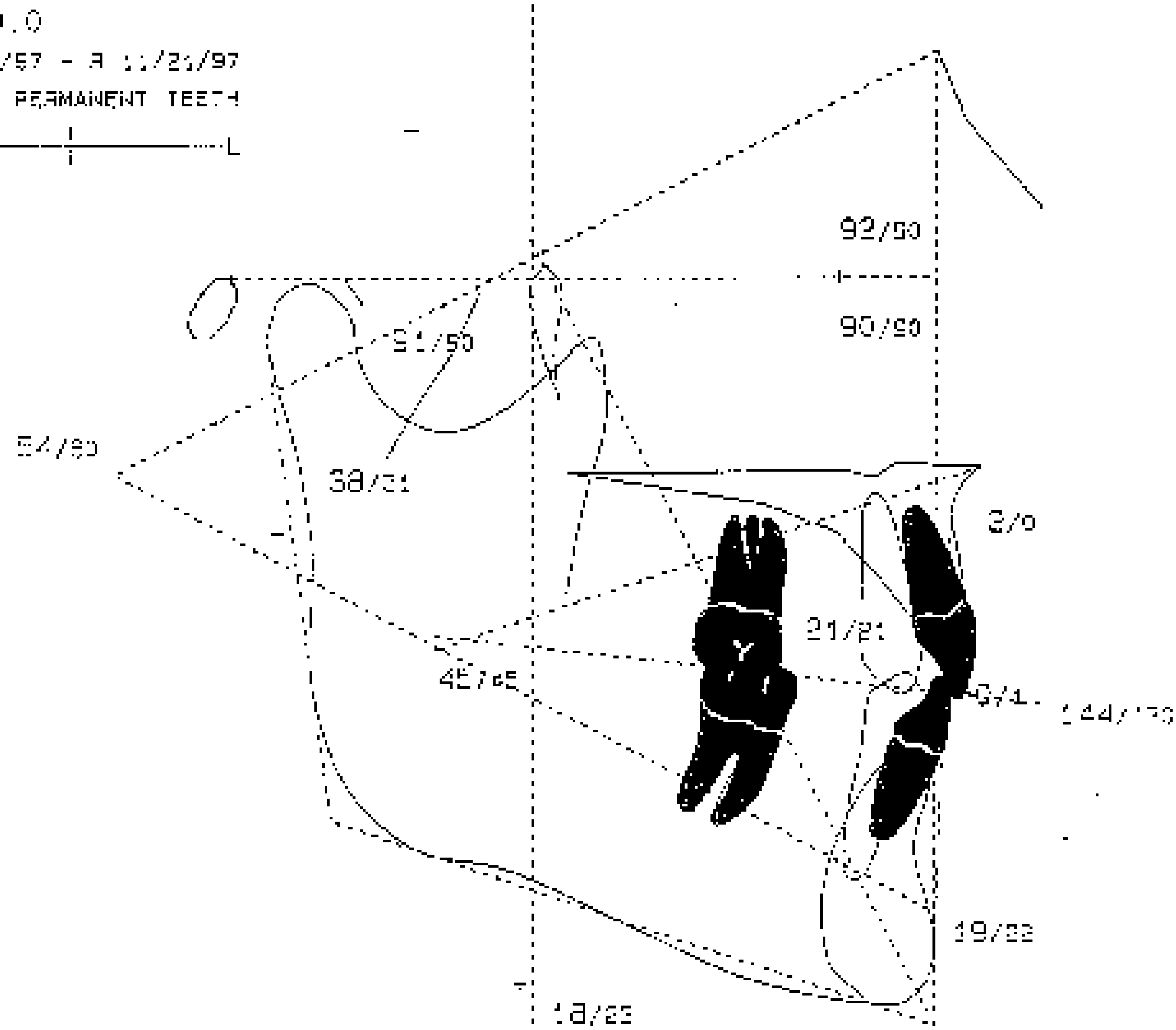
Interest came to be focused on the asymmetry and form of the periform aperture. Asymmetry in the nasal cavity was found to be important to the asymmetry of frontal facial esthetics of the nose and upper lip, particularly during the smile.

CASE: 7783 1000 1
RTOTAL
RICKETTS
M (CA) Caucasian
AGE: 30.0
X 11/21/97 - R 11/21/97
MISSING PERMANENT TEETH

TRACING

BEFORE TREATMENT

RMO™



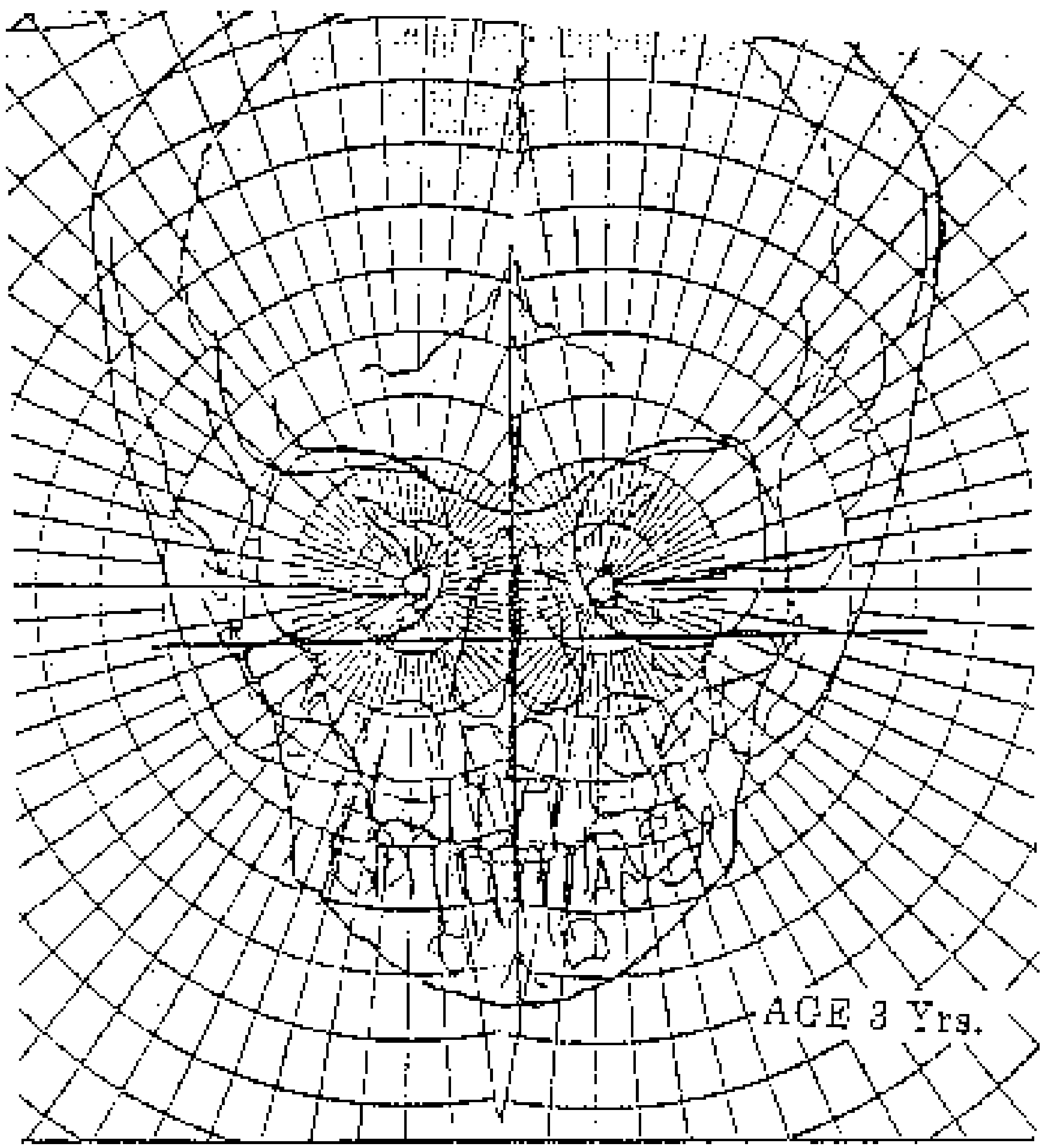
FACIAL PATTERN: BRACHYFACIAL						
# FACTORS	MEASURED VALUE		NORM		CLINICAL DEVIATION	
Interincisal Angle	142.5	dg	130.0	dg	2.3	**
Convexity	2.1	mm	0.0	mm	1.0	*
Lower Facial Height	45.4	dg	45.0	dg	0.1	
A6 Molar Position to PTV	21.1	mm	21.0	mm	0.0	
B1 to A-Po Plane	-0.2	mm	1.0	mm	-0.5	
B1 Inclination to A-Po	19.3	dg	22.0	dg	-0.7	
Facial Depth	89.7	dg	89.6	dg	0.0	
Facial Axis	91.2	dg	90.0	dg	0.3	
Maxillary Depth	91.5	dg	90.0	dg	0.5	
Mandibular Plane to FH	18.5	dg	25.3	dg	-1.1	*
Mandibular Arc	38.4	dg	30.7	dg	1.0	*
Total Facial Height	54.0	dg	60.0	dg	-2.0	**

RMO 1997

Fig. 6-10B Lateral composites of the same sample.

Frontal Growth -- The Bi-Polar Phenomenon

When the polar grid was studied relative to Time I and Time II, for the frontal composites one center could not be found. However, when each foramen rotundum was employed it was discovered that growth occurred from two centers or poles in the frontal perspective.



BI-POLAR

Fig. 6-11 This bi-polar behavior was seen at distribution of fifth nerve for each side (Foramen Rotundum).

Not visible on the frontal was soft tissue of the nose, lips and chin. However, an outline of soft tissue could be seen laterally in the frontal. A soft X-ray could reveal the ear. Also, the superior surface of the tongue could often be observed in the frontal view.

For the aforementioned computer research protocol, started in 1966, a triangulation approach was used in order to construct accurate frontal composites The study covered patients from the deciduous dentition (age 3) to an age when the third molar was erupted, or at least could be reasonably prognosed at age 18 years (in males). The study also included the eruption of the teeth in the frontal view. Samples of three-year-old children and mature males at age 18 years were employed to fill out the growth picture (Figs. 6-12A, 6-12B, and 6-12C). The data derived is shown on Chart 6-1 and Figure 6-12D.

Procedures for Forecasting in the Norma Frontalis

The original tracings of the Class I premolar extracted female (L.A.) And the Class II nonextracted male (N.N.) Are employed as a base for demonstration (see Figs. 6-5 and 6-6). Forecasts are first made **without treatment**, which becomes a matrix over which treatment objectives or goals are determined or established.

Four frontal gnomonic phenomena were discovered as derived from the composites of children studied during normal growth (Figs. 6-13A and 6-13B). The eruption and development of teeth were likewise investigated for a base of reference (Fig. 6-13C). Gnomonic behavior was employed as the starting base of reference further to be associated with the lateral forecasts. The vertices of these for the patients demonstrated were:

(1) Nasion (selected on the midplane at the height of the zygomatico-frontal sutures) [this was used for the mandible and nasal cavity].

(2) Os or Supraorbitale (selected on the midline at the mean height of the superior border of the orbits).

The two foramen rotundum were references for forecasting of the zygomatico-frontal sutures (or cranial reference). The nasal aperture point was obtained by inspection of the two foramen rotundum through the two zygofrontal sutures (at Z1).

AGE 3 Years

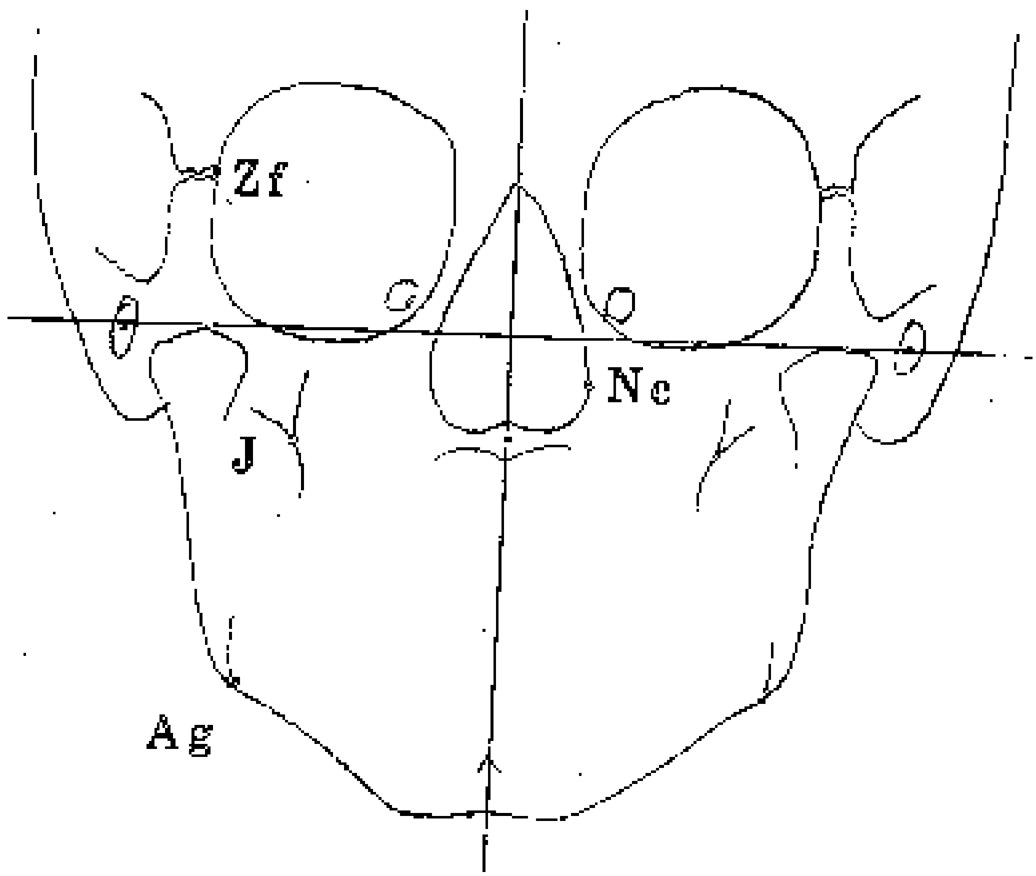


Fig. 6-12A Composite of children age 2 years with skeletal reference points noted.

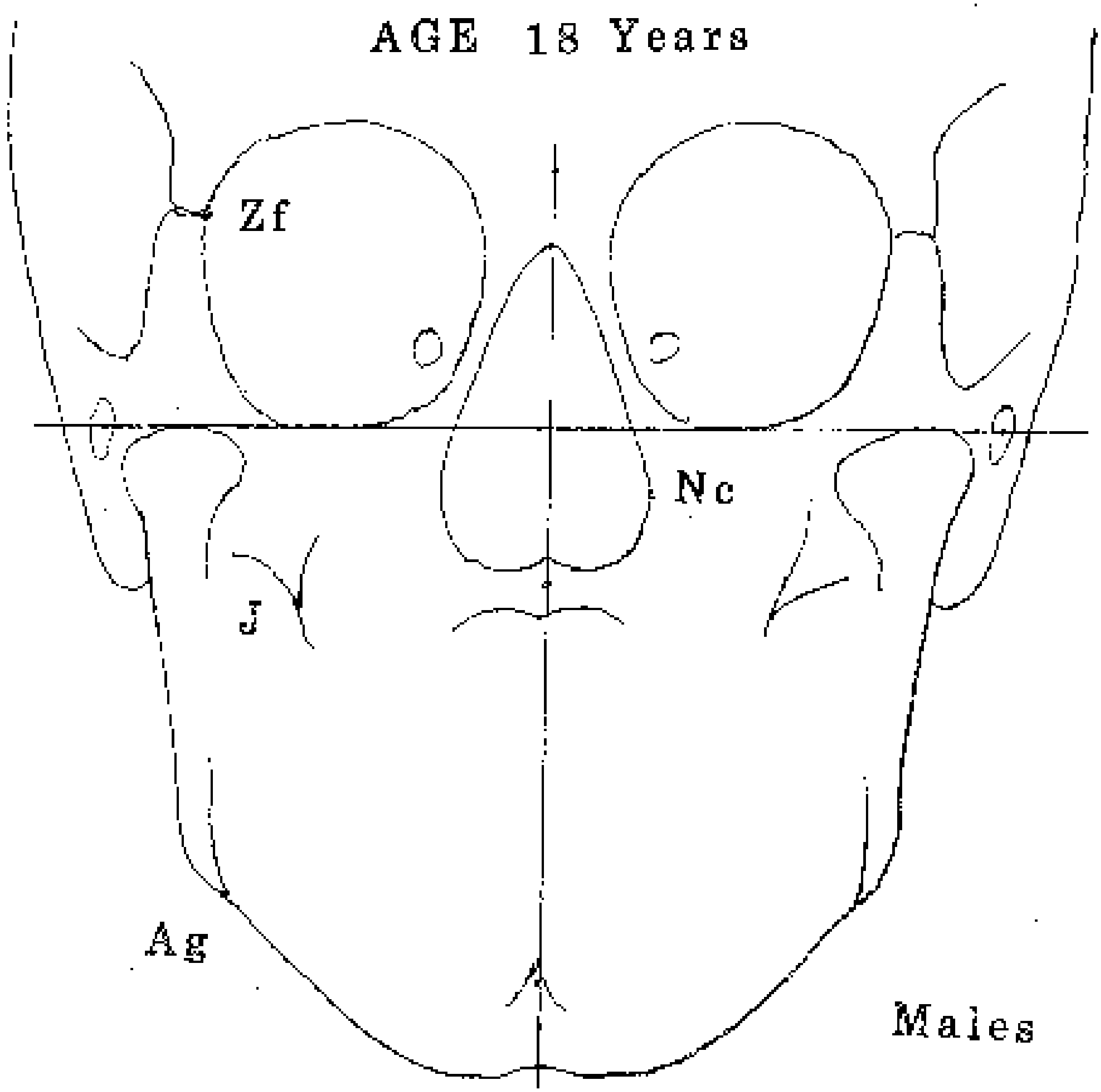


Fig. 6-12B Composite at age 18 years for males. (Females stop growing significantly at a mean of 14.8 years.)

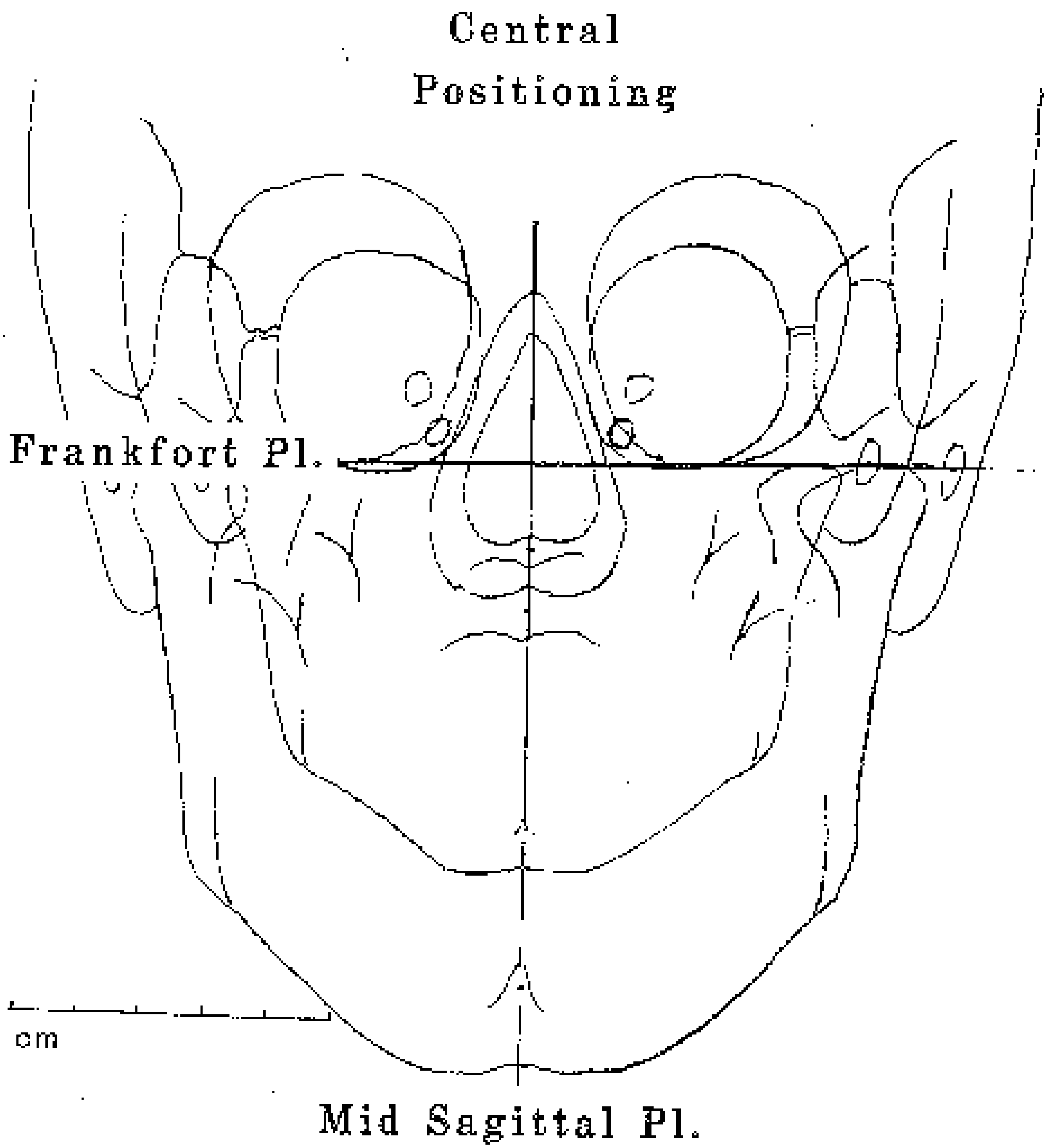


Fig. 6-12C Frontal orientation on the Frontal Frankfort Plane and midsagittal plane.

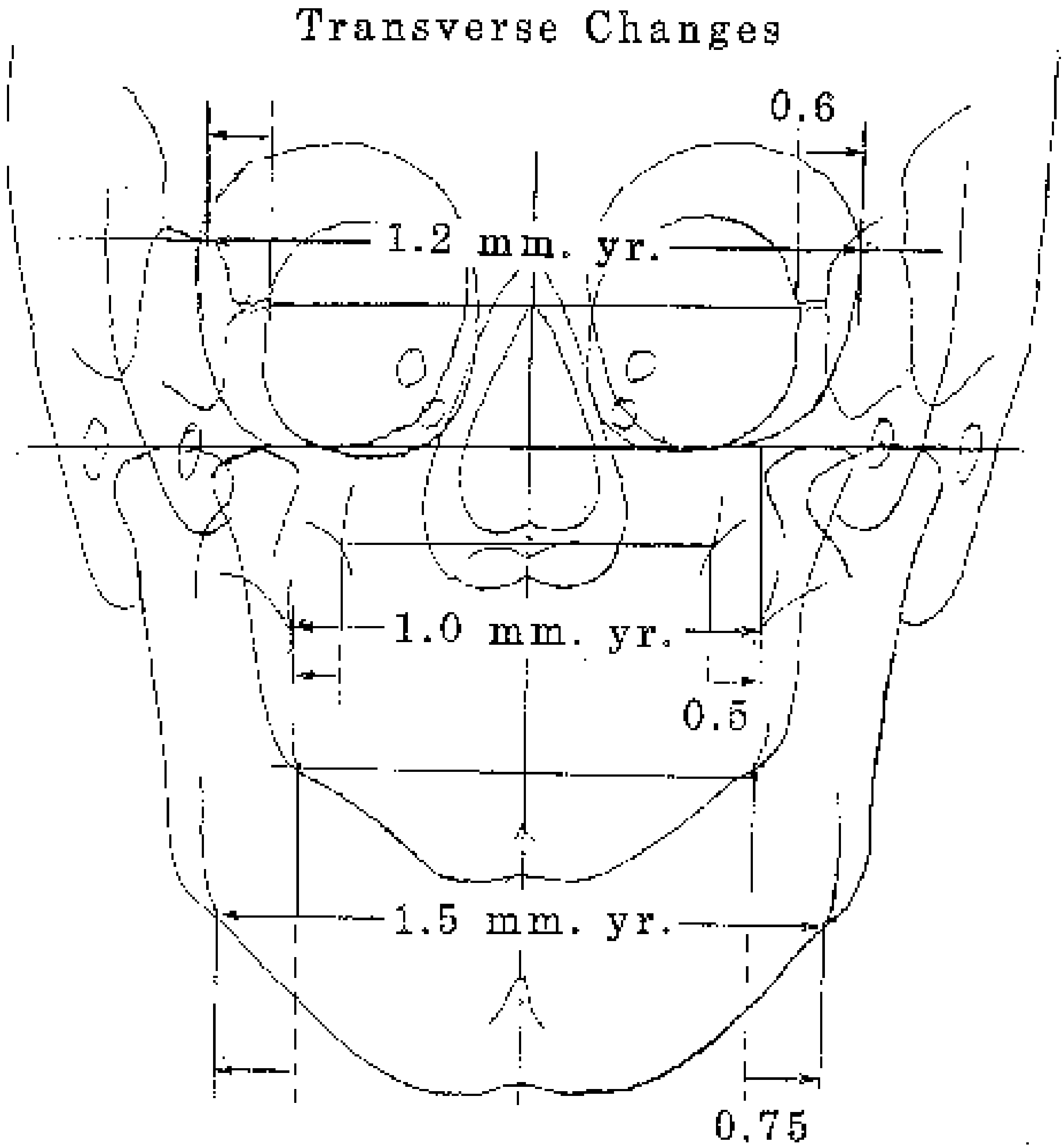


Fig. 6-12D Frontal tracings at age 3 and 18 years superimposed to show width increases of skeletal parts.

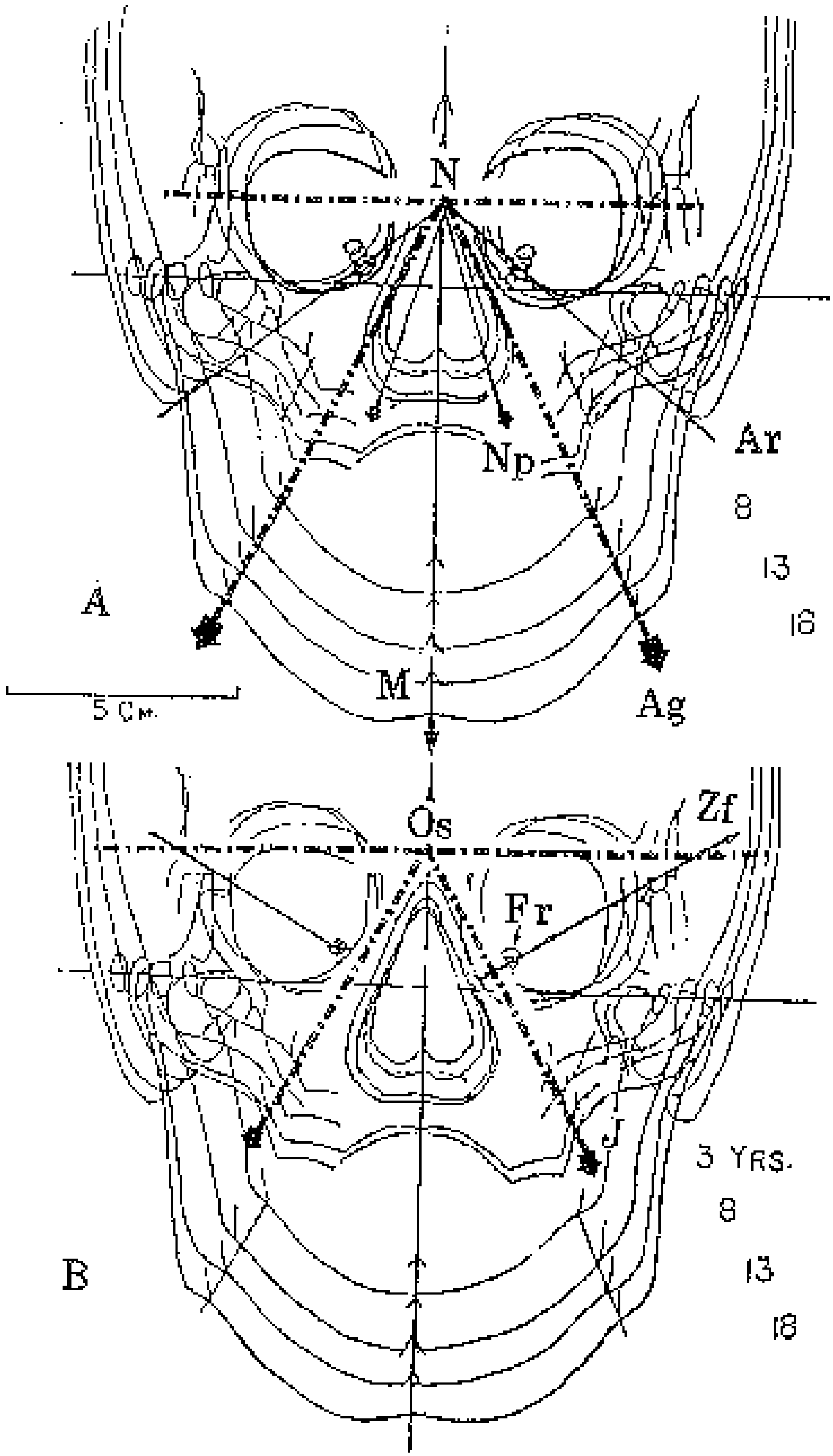
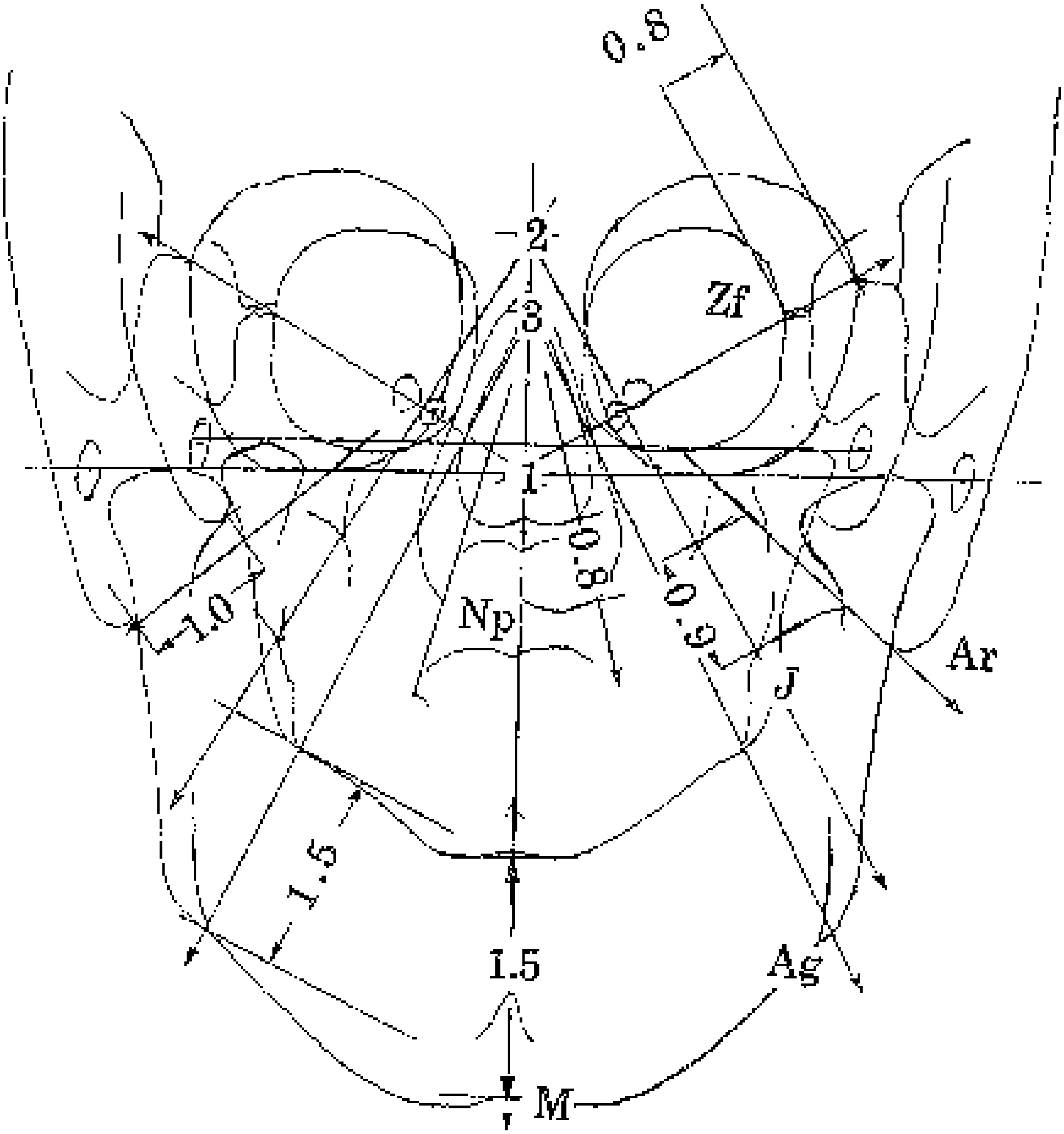


Fig. 6-13A Original computer composites as of 1968. A. Note vertex of figure from Nasion (N) for Np, Ar, Ag, and M. B. Note vertex for J from Os (Supraorbitale). Note radiation from Foramen Rotundum (Fr) for lateral suture in orbit (Zf).



Oblique Growth

Fig. 6-13B Modules of growth of five points from vertices of gnomonic tendencies from computer composites [at age 3 and age 18 for males]. Growth in mm. per year

1. Cranial oblique value for Zf = 0.8 from Fr.
2. Maxilla at J = 0.9 from Os.
3. Nasal cavity at Np = 0.08, Ramus at Ar = 1.0, Mandible at Ag = 1.5, Mandible at M = 1.5. Note the tendency for a pseudo polar phenomenon with values lower the closer to the central area nearer to Foramen Rotundum.

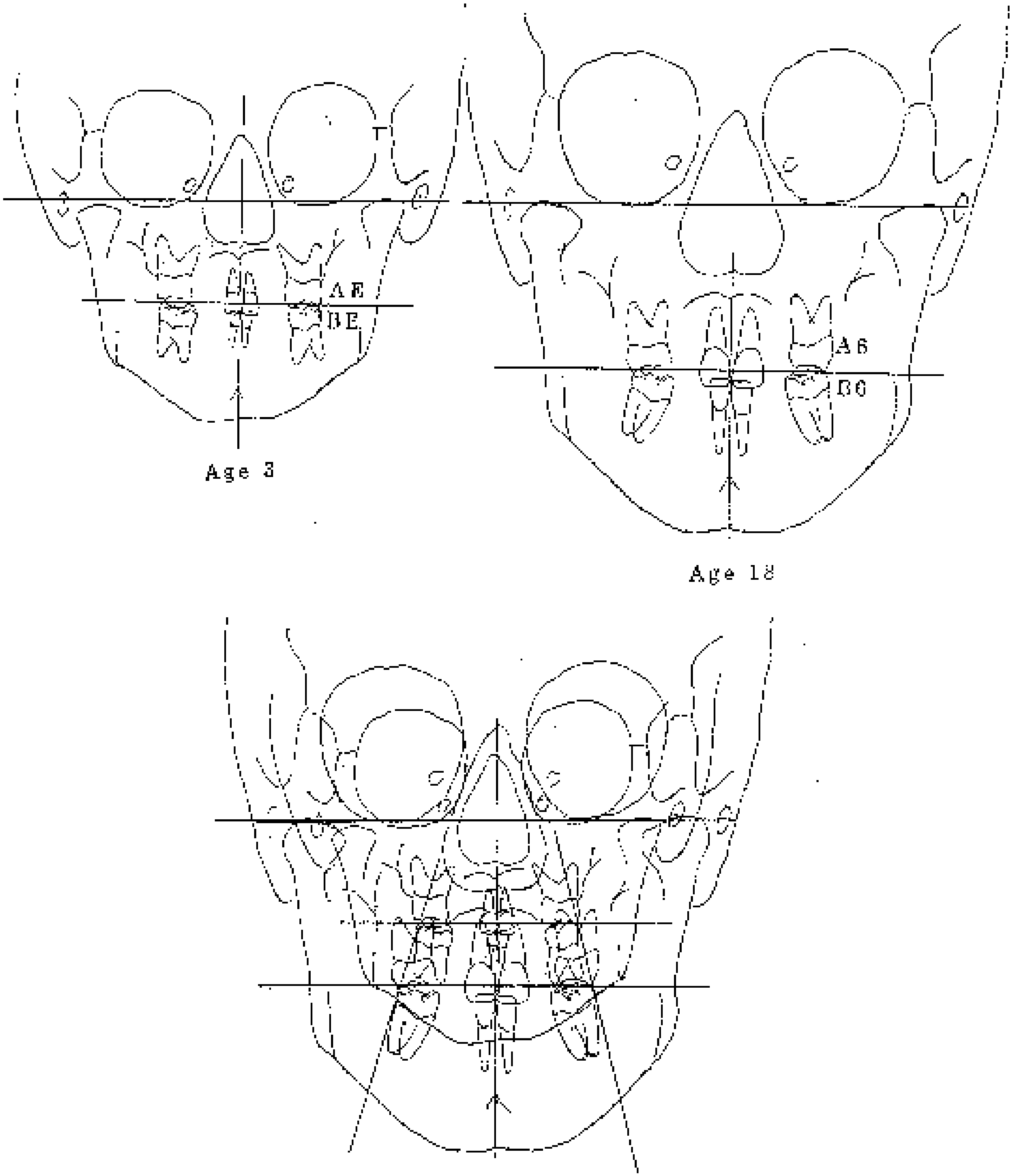


Fig. 6-13C Change of teeth positions is shown. Note point of molar from deciduous to permanent dentition.

Exercise for Forecasting the Frontal

Each original tracing was prepared with these reference lines as follows (Figs. 6-14 and 6-15):

Step 1: From N draw a line through each Ag point (for the mandible).

Step 2: From N draw a line through each Np point (Nasopalatine point) selected as the lateral-inferior point on the curve of the nasal cavity with the hard palate) [for the nasal cavity].

Step 3: From N draw a line to the lateral articular for each side.

Step 4: From Os draw a line through each J point (for the maxilla).

Step 5: From the center of each foramen rotundum (Fr) draw a line upward and outward through each Zf point and extend it downward and inward to the midline.

Technique and Data for Extensions

For the Forecasting of Frontal Dimensions (Fig. 6-16-A).

Step 1: On a new tracing paper establish at the center a vertical line as the Midsagittal Plane for the forecasting work.

Step 2: Mark a short line on the midplane for a reference for Nasion.

Step 3: Bisect the difference in the top of the supraorbital rim (if one exists) and mark the Os point on the midplane.

For the Mandibular borders:

Step 1: At the midline at Menton add 1.5 mm. per year similar to the Ag points (see Fig. 6-16-A).

Step 2: With the midlines superimposed and registered at N extend the Ag lines 1.5 mm. per year, and mark the new Ag points.

Step 3: From Nasion add 1.0 mm. per year at each articulare.

Conditional Factors: The lateral forecast can be employed to rectify the frontal for the extremes. If the face is severely dolicho in behavior, the Menton may be extended downward up to 1.7 mm. per year. If a joint compression and limited growth is experienced the Ag points may be extended only 1.0 mm. per year or less.

The frontal also becomes complicated with iatrogenic rotation of the mandible either during treatment or sometimes (as?) residual behavior in long term.

Step 4: For the laterao border of the ramus a reference can be established with 1.0 mm. Per year increased on each side downward and outward. This point is essentially a frontal Point Articulare (Ar).

For the Nasal Cavity:

Step 1: Superimpose Tf (the forecast) again on N.

Step 2: Draw a line downward and outward through each Np point.

Step 3: Extend each Np point a mean of **0.8 mm.** per year (see Fig. 6-16-A[4]).

Conditional Factors: More work is needed to determine the variation in nasal growth. Two factors are suggested, however. The first is the observation that the variation, in the human, is less extensive in the nasal cavity than in the lower face. Also, growth behavior is more orderly in the upper face than that seen in the mandible.

The second factor concerns extraoral therapy at young ages. Changes in the height of the palate anteriorly are classic, and angle of widening of the palate also may be dramatic. Therefore, frontal forecasts are to be altered with therapy.

For the Forecasting of the Maxilla:

Step 1: Superimpose Tf on the T1 Os mark.

Step 2: Draw lines from Os through the J points on each side.

Step 3: Add on the Os-J lines **0.9** mm. per year (see Fig. 6-16-A[5]).

Conditional Factors: Although the J points are difficult to determine with regularity, there seems to be nothing better. The tendency is to select the J point too far buccally. In addition, as shown by Enlow, there is a remodelling that occurs with maturation. The bone of the alveolar process in particular seems to differentiate and reduce around the teeth. During eruption of the upper molar teeth the alveolus appears wider, but as full development ensues the J point seems to reduce. Some point is needed for planning and the J point, selected as described, seems to be the most practical alternative.

For Forecasting the Cranial Reference:

Step 1: Superimpose on the original N point reference.

Step 2: Extend the lines from Foramen rotundum (Fr) through the zygomatico-frontal suture point (Zf) (upward and outward).

Step 3: Add 0.8 mm. per year (see Fig. 6-16-A[6]).

For all the points draw preliminary contours as follows (Fig. 6-16-B):

Step 1: At gonial angles, about 1 cm. each side of Ag.

Step 2: At Menton, about 1 cm. each side.

Step 3: At lateral articulare, 1 cm.

Step 4: At Jugal process and tuberosity, about 5.0 mm.

Step 5: At lateral border of orbit about 7.0 mm. each side of Zf.

For Completion of the Frontal Planes

Step 1: Connect Ag-Ag, J-J, and Zf-Zf with lines. Connect the facial contours as desired (Fig. 6-16-C).

Step 2: (Fig. 6-16-D) Draw the new Zf-Ag lines for each side which represent fronto-facial planes.

Step 8: Draw the new J-Ag lines which represent the fronto-denture planes.

* * * * *

The patient N.N. steps are illustrated in abstract in Figure 6-17.

The forecast of each facial skeleton is now essentially complete, and the next issue is the forecast of the teeth.

* * * * *

Forecasting of the Teeth in the Frontal

The first consideration is the position of the frontal molar Occlusal Plane.

Step 1: Bisect the height increase of the vertical increase on each side at J-Ag.

Step 2: Establish the new occlusal plane at that height (Fig. 6-18-A) (see also Fig. 6-17).

Step 3: Copy the same width position for each lower first molar (if the tooth is erupted to a function) (Fig. 6-18-B).

Step 4: Copy the upper first molar in the same bucco-lingual position relative to the lower as seen originally.

Step 5: Copy the position of all four canines (if they are erupted) relative to original Occlusal Plane. If not erupted their position is calculated from arch length conditions.

Step 6: Copy the same width of the lower first premolar.

Step 7: Place the upper incisor in similar locations relative to the midline.

Conditional Factors: The relationship of the upper and lower molars changes little after engaged in occlusion and after age 8 years.

The incisor relationship vertically is best viewed from the lateral. Also, without treatment major midline relationships tend to remain the same.

A problem with forecasting of tooth eruptions arises when the patient is in the deciduous or mixed dentition state. Therefore, some characteristics need to be recognized.

Long Range Forecast to 17.6

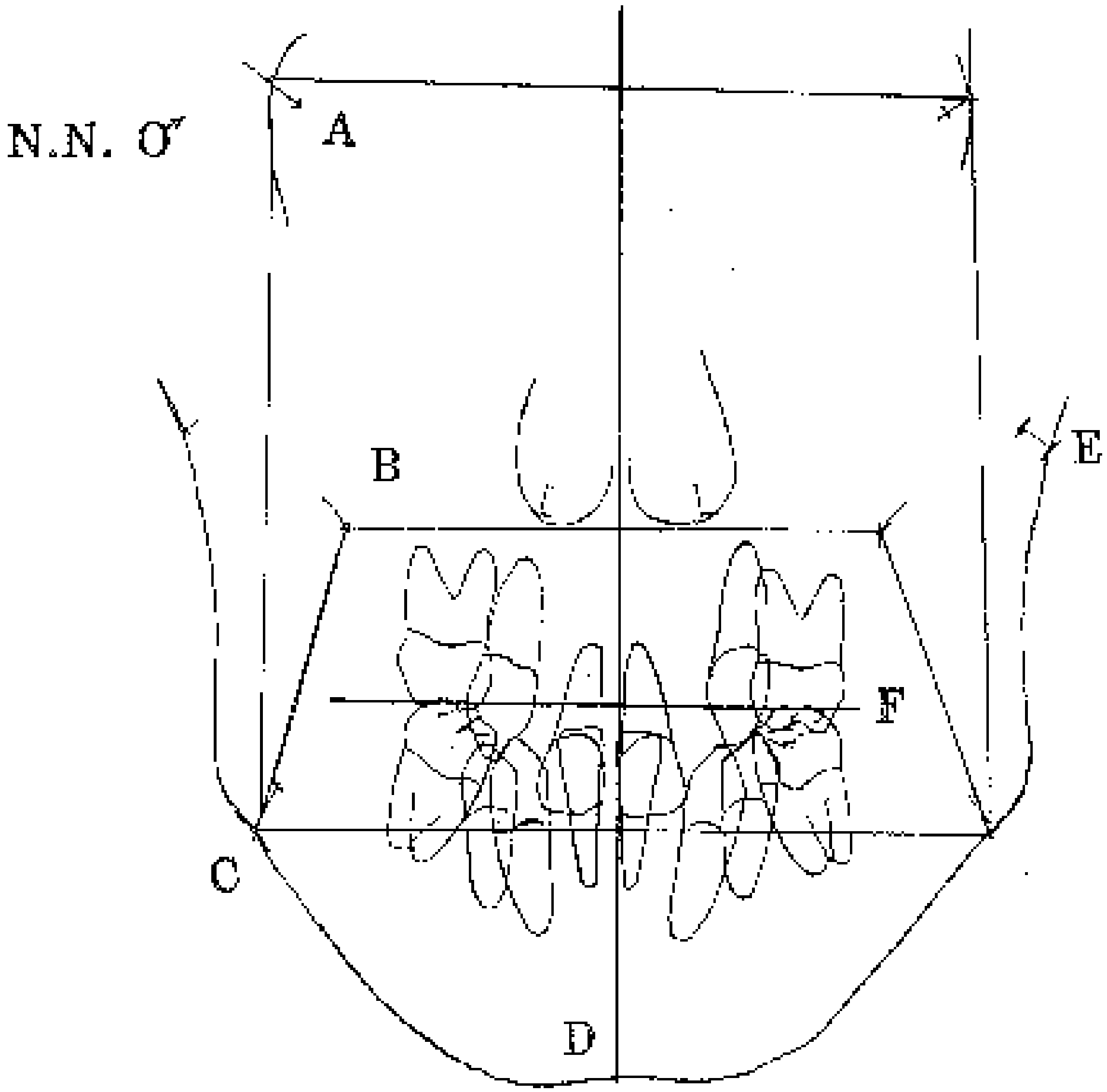


Fig. 6-17 Completed long-range forecast for patient N.N.:

A. Cranial forecast
B. Maxillary forecast
C. Mandibular forecast
D. Symphysis
E. Lateral ramal border
F. Occlusal plane and teeth

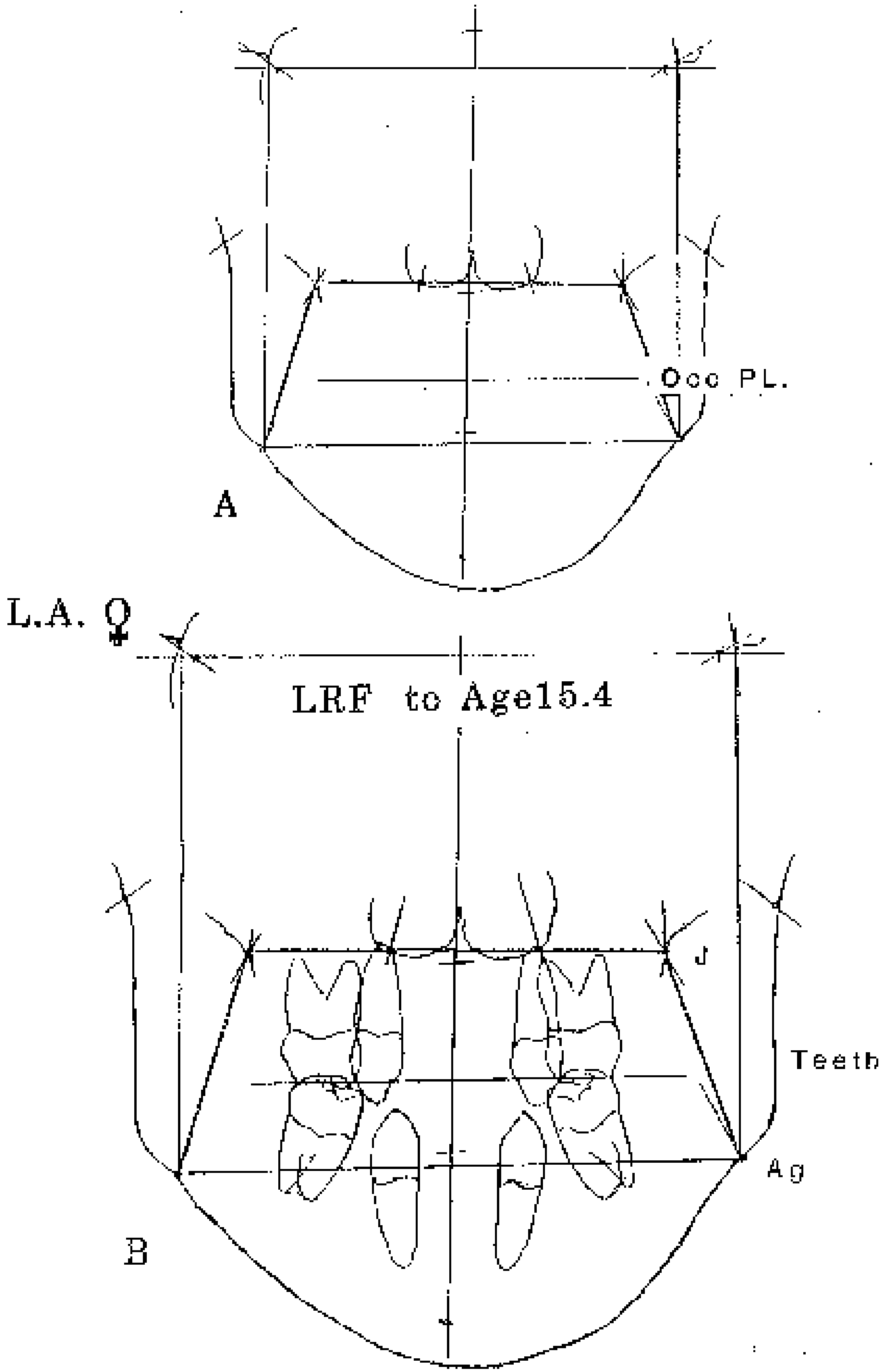


Fig. 6-18 Completed Long Range Forecast (LRF) untreated in L.A.

All four unerupted canines are observable in the frontal film. If the upper canines are in an upright position and located at the lateral border of the periform aperture a pattern of normal development usually occurs. The crowns tend to converge slightly as they pass through the constricted area of the maxilla. They then diverge as they fully erupt. The roots follow the path of the eruption of the crown.

If, however, the upper canine crown at age 7 or 8 years is medial and inclined palatally it may be predicted to become impacted. If the arch is constricted and the canine crypt is large, it can erupt high and labially positioned. In rare cases the crypt, active in blood supply, may resorb the root of the upper lateral incisor.

Similar conditions exist in the lower. If the canines are narrow and forward they tend to also erupt outward and move labially. They too tend to converge at the sublabial area and diverge with eruption in the frontal view. With very tight lips and a small retracted tongue the arch length is shortened.

* * * * *

The steps in the forecast for patient N.N. are demonstrated in Figure 6-17. Thus the frontal Forecast is completed (see Figs. 6-17 and 6-18). Comparisons can now be made for the forecast with the original T1 tracings.

Forecasting of Soft Tissues in the Frontal

Lips are not discernable in the frontal headfilm without a contrast medium. However, a clue to lip asymmetry, particularly in height, is made from the conditions of the periform aperture. Smallness on one side and height differences affect the symmetry of the nostrils which affects lip height. The shortness of the lip on one side is also often associated with vertical nasal asymmetry. Note: We have worked out a surgical procedure for control of upper lip height to a certain degree.

Another Forecasting with Frontal Proportions

Another estimate of proportional growth is seen from the "Harmonic Equations". There are nine divine proportions (1.0 to 1.618) to employ for facial and denture "balance" in the frontal (see Fig. 6-7A). Maxillary width J-J to the total width of the mandibular ramus at the J-J level is Φ'. Preliminary evidence suggests that the maxillo-mandibular relation (J-J width to mandibular width at the J-J level) maintains about an 80% ratio from age 3 to adulthood (see Fig. 6-7B).

Treatment Designing in the Transverse

In the lateral or sagittal plane, when growth and autorotation are experienced, straight mesio-distal changes are often not expressed. The vertical also is often involved, particularly in growing patients. Likewise, in the frontal view, transverse changes are combined with vertical dimensional changes. For this reason, the lateral VTO will give some information regarding probable Menton behavior in the frontal.

However, the **objective during treatment is not to alter natural mandibular behavior** in the Bioprogressive approach. Therefore, as in the lateral, the mandible becomes the starting base of reference. Because the **mandible** is the base the lower molars become the first element in the feedback or cybernetic planning context.

The Factors of Differences

Four factors need to be taken into account in the "Determination-Resolution Process". First is the relationship of molar width to normal standards. The actual mean in the model is 56 mm. ± 2.0 mm. A typical enlargement of 2 mm. More in the frontal headplate is 1.0 to 1.5 mm. each side, making it 58 to 59 mm. At the lower first premolar the enlargement is about 1.0 mm. more than the actual (see Figs. 6-14 and 6-15).

The second consideration is the relationship of molars to the "pattern". The molar is age-related to the J-Ag line. Present information yields the data seen in Chart IV.

The third consideration is the individual oral environment such as tongue and breathing habits, or thumb-sucking habits.

The fourth factor is the orthopedic changes anticipated in the maxilla via palatal dysfunction, palatal widening (with the Quad Helix) and the **transverse effects of the face bow** and other orthopedic hese are of particular value in the induced changes in nasal volume.

The Frontal VTO

With experience the maxilla and teeth can be "set up" with the modification from the data of the non-treated forecast. Therefore, for teaching purposes the untreated forecast can be constructed and then modified for the "designing process".

Induced structural or **skeletal changes are made first** in the maxilla and for mandibular rotations.

Because the mandible is the principal base of reference the lower becomes the "target arch". The behavior of the palate in the sagittal plane is considered for the maxilla setup in the frontal.

Planning of the teeth is best started with positioning of the lower first molars. The widest point on the buccal surface of the crown is used and labelled A6 for the upper and B6 for the lower.

Technique [Follow in Figures 6-19 and 6-20]

Step 1: Adjust the J points for the maxillary orthopedics required (by the modality chosen).

Step 2: Adjust the floor of the nose (or Ans) as indicated for the total objective.

Step 3: Alter the nasal cavity width according to the palatal objectives. In addition to natural growth the nasal cavity can be widened an extra 3 - 4 mm. even in the short range when treated for that objective.

Step 4: Adjust the **lower molars** to desired bucco-lingual positions. In practice they may be maintained, widened, or narrowed. In ideal occlusions the cephalometric mean is 59 mm. ± 2.0 mm.

Step 5: Set the **upper molar** to the lower, if in Class I, at −1.5 mm. buccally. If held in Class II the upper molar is -1.0 mm., whereas if treated to Class III the upper will be placed about 3.0 mm. buccally to the lower.

Step 6: Establish the bucco-lingual position of the **lower first premolar** as the target for the upper canine. **This is an underappreciated step because it helps most to determine arch forms.** It is also responsive to tooth mass or tooth size. The normal width is about 40.0 mm. actually, but cephalometrically is 1.0 - 1.5 mm. more. It is referred to as B4 at the widest buccal point.

When the first premolar is extracted the second premolar is positioned in its place.

Step 7: Correct and center the canines. The typical lower intercanine width is 26 mm. ± 1.5 mm.

Step 8: Center the lower central incisors.

Step 9: Center the upper incisors.

Conditional Factors: In cases of asymmetry of skeletal skeletal structure, loss of teeth on one side or in case of decisions to extract on one side, the denture midline may not be centered with the facial midline. The usual practice is to plan first to center the denture to the midplane and the maxilla to the midplane as well. However, in some patients that effort may be impractical and heroic. Minor asymmetry can be acceptable and will not be noticed by the layman. Therefore, minor midline deviation may be planned. The midlines of the upper and lower denture should coincide, at least for the plan, unless one lower incisor is missing.

Thus the new transverse positions designed for the jaws and the teeth in combination with the sagittal objectives determine the matrix on which the treatment regime is formulated.

The Analysis of the Forecast

In contrast to a lateral four-position analysis, the frontal forecast analysis employs two positions as seen in Figures 6-19 and 6-20. These are the J-J plane for the maxilla and maxillary teeth and the Ag-Ag plane for the mandible and mandibular teeth.

The actual T2 tracings of both example patients are shown in Figures 6-21 and 6-22.

The comparisons of the frontal forecasts to the actual treated condition after five years are witnessed in Figures 6-23 and 6-24.

SUMMARY

For comparisons of a frontal forecast a consistent Frankfort patient orientation for the exposure is critical.

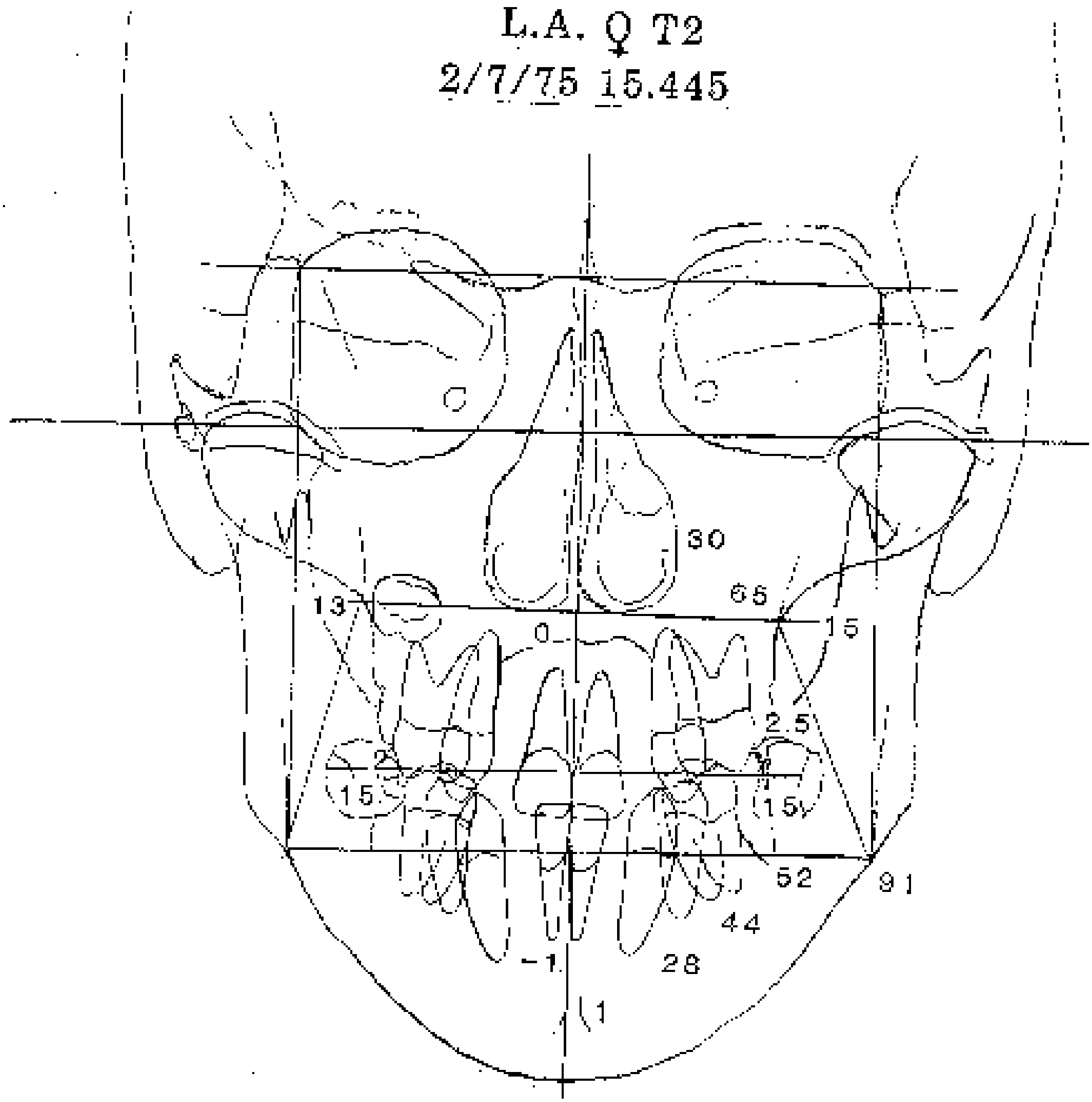


Fig. 6-21 Actual T2 for Laurie (patient L.A).

It is clear that transverse problems are present and common in Class I, Class II, and Class III conditions.

Traditional Theory

The theory taught by Angle and Brodie was that the tongue posture, size, and function is involved in malocclusion. For instance, in Class III the large tongue, held in a lower than normal position, produces lower molar positions wider than normal and maintains them in their buccal locations. Brodie advised that the denture be treated "around the large tongue" in open bite cases.

Every seasoned orthodontist knows that retention of treated crossbites can be difficult, particularly if started in the "late case". The posterior open bite and mild crossbite is the most plaguing of all retention problems in the author's experience.

Also, two factors observed clinically are those seen following extraction therapy. They are noted when the occlusion does not seem to "want to settle". Close examination suggests that the teeth encroach on the tongue space and the tongue is pushed into the occlusal space. In fact, the author has been faced with more than one patient complaining that they "don't have enough room for their tongue" in their mouth.

Secondly, there is also a complaint that even with good fit of the teeth and normal alignment in some extraction results, the **buccal space is void in the smile.** This has been referred to candidly as "vacant buccal corridors".

Thus, the transverse dimension is of concern in facial morphology, facial growth, oral function and is of profound intrest in facial esthetics.

Current Theory

Another fact that was missed by many clinicians in the past was the bucco-lingual situation of the upper molar in Class II. The awareness of the problem emerged when patients were worked up by the computer service to possess crossbite when the clinician insisted that none was present. Rework of the frontal films yielded yet again the crossbite finding. The buccal surface of the upper molar, due to mesial drift, was medial to the lower.

This finding gave rise to the consciousness that nearly all severe Class II upper molars are both mesial and medial in relation to the lower. In Class II the upper molar is rotated and occludes with a narrower portion of the lower arch. In treatment, therefore, the upper molar must either be expanded or the lower must be contracted if the molars are to be placed in a good Class I relation. Without extraction for the treatment of Class II the upper must usually be expanded. This fact makes a palatal "holding bar" contraindicated. With extraction and loss of lower anchorage, the lower molar is commonly moved forward and narrowed or contracted in the process.

The Long-Range Forecast

The main issue in clinical orthodontics in any forecast is the determination of whether or not the adult facial pattern will accommodate expansion. As suggested, without change in the oral environment and without treatment the lower molar width, and the upper molar relative to it, tends to change but little. Moorrhees found, with natural development, that an increase in width of 2.0 mm. at the first premolar occurs during the transition from the deciduous first molar. Arches "grew" and ascended the scale when analyzed with the Brader arch guide.

With various expansion methods width in both arches is increased and sometimes radically. The treatment changes in a female patient (V.F.) with a bilateral lingual crossbite is offered to possibly stir interest in the visualization process (Fig. 6-25).

A study of the 20-year long-term treated results of Dr. A. Goldstein indicated that following premolar extraction technique the width dimension of the lower molars **decreased without exception.** Width is consequently a consideration in both expansion and extraction therapy. Treatment changes in the frontal or in the transverse dimensions can be dramatic.

Significant attention to the nasal cavity gradually develops from experience with the frontal film. On average, the **width at the widest point of the nasal cavity** increases 0.5 mm. per year **totally** (or 0.25 mm. each side). When these are quadrupled in one year there is little question of the orthopedic effects of treatment.

Some principles are forthcoming from consideration of the frontal, as follows:

1. The maxilla in the past was consider as a "given" the most permanent and most normal, but current techniques often start with upper jaw and upper arch management. (Example: headgear, Quad Helix, and sectional mechanics.)

2. Because no single center is present for growth assessment, vertices of gnomonic or allometric behavior becomes the source of reference and predictive

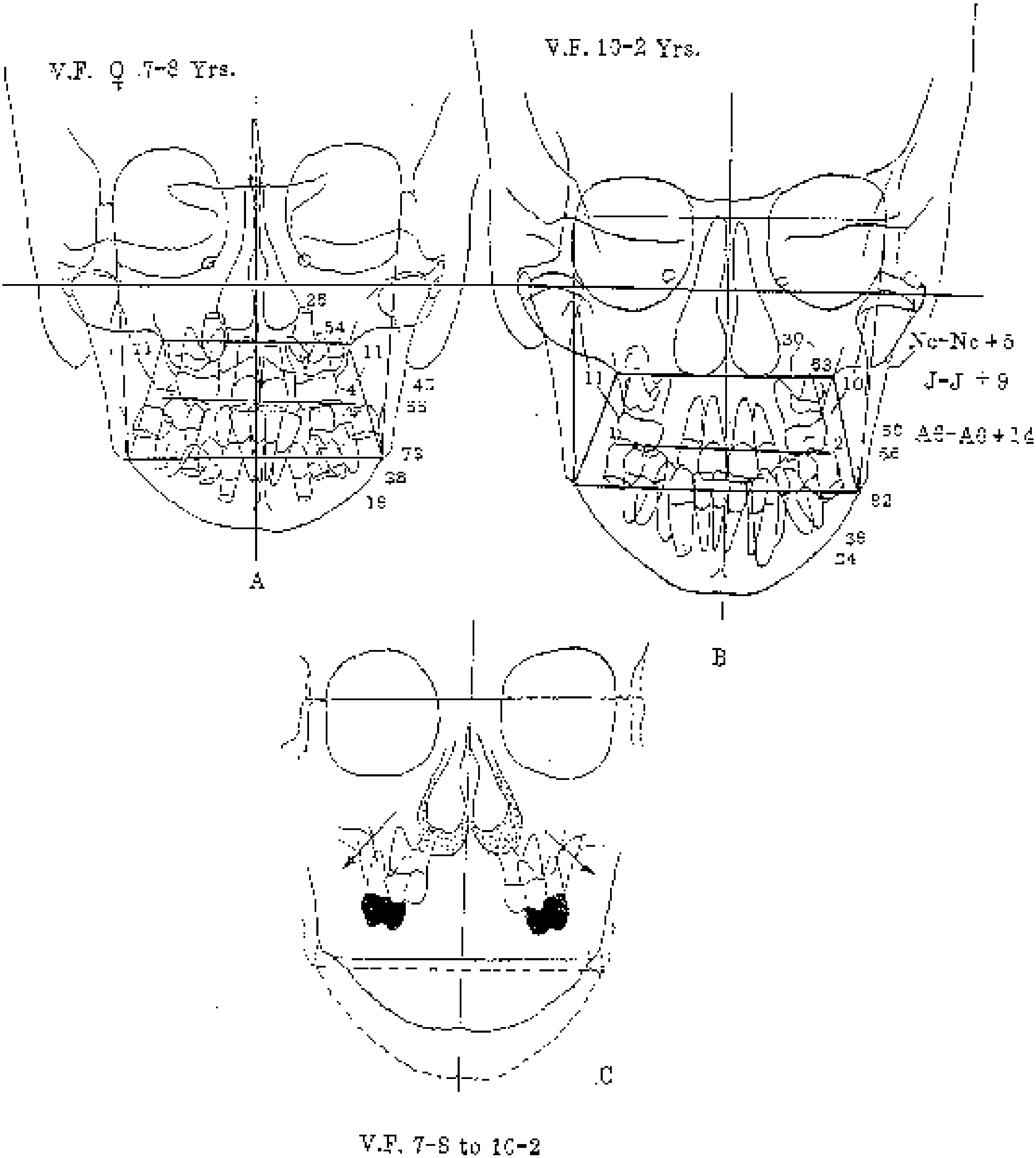


Fig. 6-25 A female patient with bilateral lingual crossbite is demonstrated in the frontal analysis and growth analysis. Note the expansion of the first molars.

information.

3. When condyle growth is inhibited width of the ramus is also affected.

4. When idiopathic condylar hypertrophy is present overgrowth of the ramus laterally also may be present.

Conclusions

In conclusion, this chapter attempted to show the present state of the art for forecasting in the frontal perspective. It was concerned with factors in frontal facial esthetics. People face each other in communication; therefore, harmony and balance in the frontal view is significant to the clinician in orthodontics and maxillo-facial surgery.

The development of frontal landmarks was explained. Growth changes at particular points were shown and some unfamiliar points may need to be reviewed.

But the issues in the present thesis and for application clinically are concerned with forecasting and for planning transverse treatment changes. This particularly related to the mid-face and the most proper orientation for the teeth.

The technique of frontal forecasting was based on gnomonic behavior discovered in composites of untreated children and adult subjects. The antegonial tubercle (*Ag*) was a key on the mandible and jugale (J) was the key area for the maxilla. The main focus for the maxilla and the mandible concerned growth downward and outward in direction.

Due to the ideas of straight lateral movement with a jack-screw, the idea may persist that changes with treatment are also straight lateralward. However, examination over periods of treatment and the long range show that this is clearly not the case. The vertical therefore also needs to be appreciated in the frontal perspective.

Ancient Greek scholars invented the term physician. It was observed that they were "those who work with the ways of nature". Nature is the physical world around us and within us. When the frontal view is fully appreciated the orthodontist truly becomes a physician of the face.

The nasal cavity has emerged as quite important to function and esthetics of the nose and **the upper lip.** The nasal cavity is assessed in form, size and symmetry. Once this fact is realized a diagnosis is not complete without this consideration.

Due to a dearth of demand, frontal computer forecasts have lagged behind work with the lateral. Nevertheless, with the increasing focus on esthetics and the details of the smile, the transverse dimension will have its day in the sun.

PREDICTION, PLANNING, CONSTRUCTION and MECHANICS

CHAPTER SEVEN
THE TREATMENT DESIGN IN LONG RANGE -- TO MATURITY

INTRODUCTION

In the late 1950s Dr. Robert Moyers stated in a presentation that "Ricketts really does not make a prediction. he simply draws a pretty picture and then makes it happen." It was an accurate statement because short periods of growth concerned only the minor two-year basic growth matrix and included the effects of treatment required. The mandible was physiologically rotated -- as would be anticipated from the influence of the mechanics indicated to treat the particular condition. The maxilla or Point A was modified as thought possible, feasible, and desirable. The modifications were made according to data derived from treated patients whose changes were measured when treated by specific modalities.

After the maxillo-mandibular skeletal relations were established, the teeth were then set up according to desired positions or for objectives. The nose was grown and the lips modified according to data also accumulated.

Thus, the most ideal objectives for the particular individual were set up on the tracing paper. They could consequently be visualized -- hence the Visual Treatment Objective (VTO), the name suggested by Dr. R. Holdaway.

The clinical work, or the modality and procedure selected, was to be directed at fulfilling the stated objectives. In retrospect it can be said that the objectives were first for esthetics and secondly positions deemed to provide the best odds for stability and long-term health.

The image, on paper, was rendered in order to visualize a proposed outcome before treatment was started! It was to begin with a visualized goal in mind.

It was an educational and selling tool as well as a vehicle for planning mechanical anchorage.

It was highly successful for communication to the patient and the parent. It further served well for calculations for the selection of mechanical regimes.

The established **objectives** were presented to the patient and parent, and discussed. The objectives were changed if discussion with the patient or factors so indicated. Once agreed upon, the **final** decision was reached and the plan for the course of treatment was communicated and the commitment toward the goal was made.

Said again, that final **prospective**, once accepted as the goal, was then employed to **calculate anchorage requirements in order to produce that objective.** This was the reason the VTO worked -- not because of some "magic formula" or "crystal ball gazing". It was **not a wild guess,** it was a goal!

Another reason the planning scheme worked so well was that, in a span of two years, the treatment changes to be induced **would often far overshadow** the **contribution that growth could make.** The majority of the so-called "prediction" was therefore a construction on paper of the **requirements for tooth movements** to be accomplished. The whole procedure, in the end, was focused on **esthetics and function.** It was frowned upon by many clinicians in the beginning, and condemned by teachers, possibly due to a lack of understanding of the application of the procedure.

The Modular Concept

Clinicians and educators who did not even examine the method nor try to understand it nor learn to use it remained steadfastly opposed and resistant to the whole idea. They believed that only average amounts of growth were added to the different lines of reference, and they believed further that the skeletal parts were immutable. It was therefore assumed that "predictions" were utterly impossible.

Indeed, one year's growth data was employed as one module (or a standard unit of measurement). Thus a 15-year forecast would contain 15 modules (Fig. 7-1). But when certain characteristics were observed the mean values were reduced or increased accordingly. Sexual differences were pointed out at the very start.

Also, periods longer than 24 months were sometimes planned in the younger patient. For example, longer periods may have been scheduled for very severe Class II conditions, in order to **utilize more growth as an aid for the correction.** The theory was that if a patient **grew faster** than average, and as growth was built into the plan of treatment, it should take a shorter time, say 18 months, to complete the

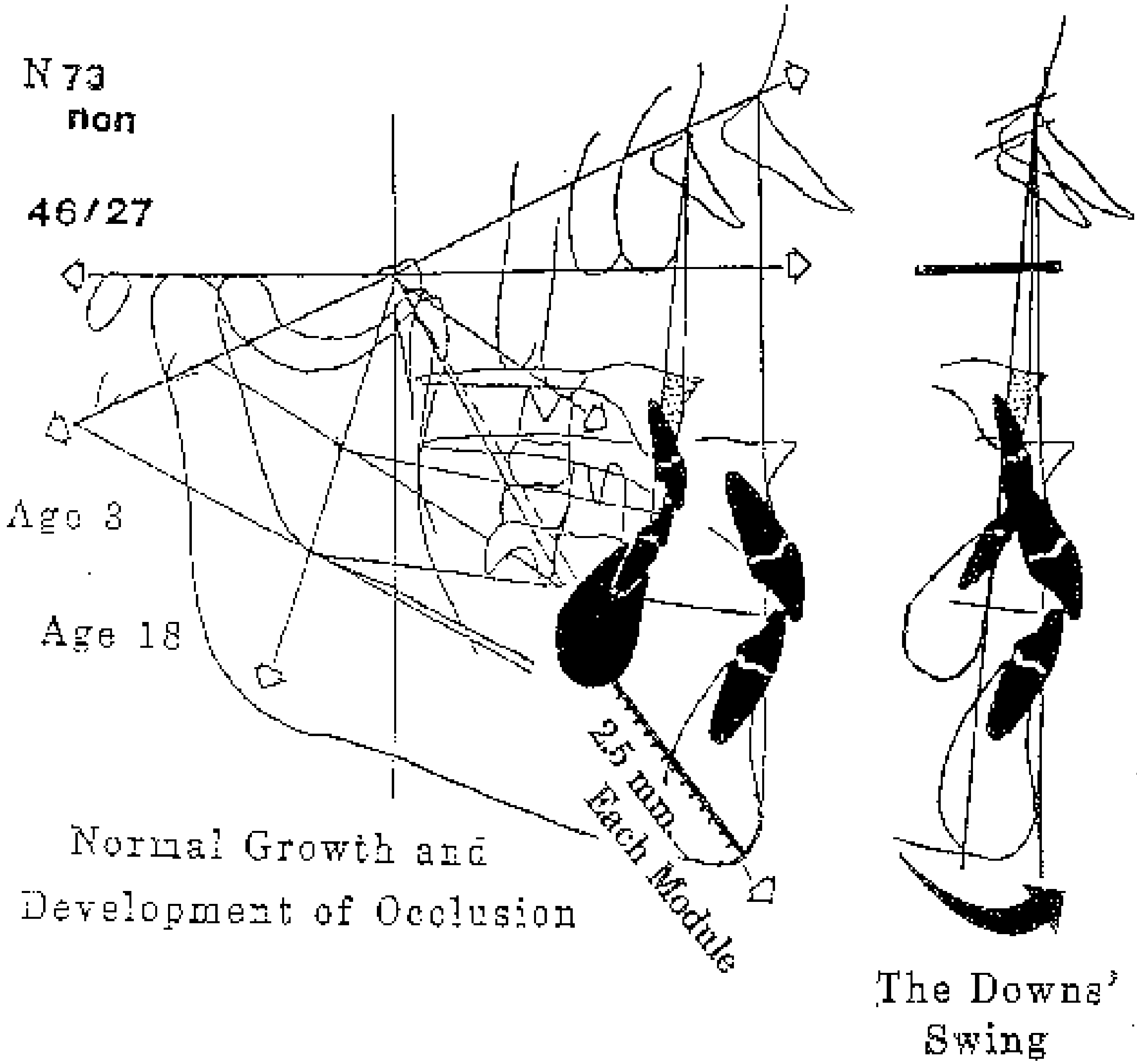


Fig. 7-1 From Ricketts (1990), showing updated behavior of the Facial Axis and depicting the concept of W.B. Downs for the swing of the chin via the change in the Facial Plane from Frankfort Plane. The modular concept is also depicted.

correction. If **slower development** occurred, then 30 months might be necessary to enjoy the **fruits of two ordinary units or modules of growth as planned.** There was no mystery; it was a common-sense approach.

The author wonders why this appeared so erudite to many colleagues. Why the derision? When even the first method was tested in 1955 the successful forecasted result **for the** mandible **was 94%** of the first 60 patients studied!

Degree of Difficulty

In essence, the entire VTO exercise helped first to indicate the nature of the **difficulty** of the **treatment problem** for the individual patient. Secondly, the resulting objective -- by comparison to the beginning tracing -- revealed the extent of the skeletal and dental movements necessary for the execution of the plan. This became known as the "**analysis** of the **forecast**". It was developed into fundamental superimpositions for evaluation. When the tooth positions sought were interpreted, the process served as a basis for planning anchorage. The planning was accomplished by the analysis of the VTO.

The analysis by 1970 took the form of the classic four positions: (1) the chin, (2) Point A, (3) the upper teeth, and (4) the lower teeth (Fig. 7-2).

With the use of the VTO the practice of orthodontics became **not a matter of fitting the patient to a technique;** rather **it became one of engineering** of **mechanics for specifics based on that one** individual's **requirements. This** became the basis for sequential stages of treatment

The fulfillment of the objectives for the patient was **contingent upon the application of the proper mechanics.** Operators could draw from the total mechanical armamentarium at their disposal. The idea was to master a variety of techniques in order to accomplish orthopedic and orthodontic objectives. It was necessary to know of the **possibilities** that had been demonstrated. Agreement on possibility created a problem with the basic knowledge to apply the method of cephalometrics in general. This possibility concept, in fact, led to the Bioprogressive approach and the variety of techniques applicable thereto.

* * * * *

LONG-RANGE GOALS (VTG)

From a logical point of view, when possible, the orthodontist may derive 57 benefits by viewing the child to maturity **[see Outline I and Notes** in the following **pages].**

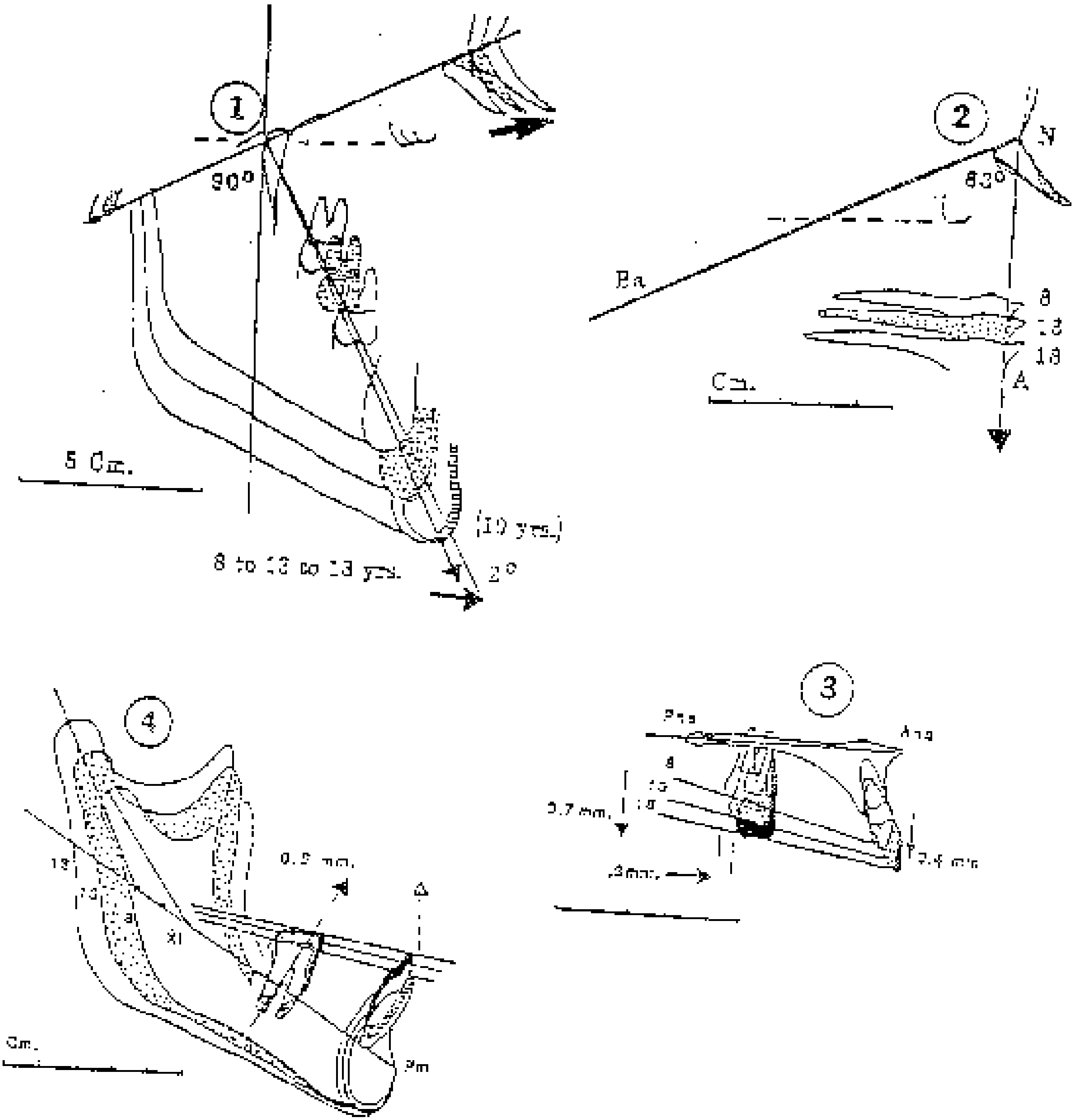


Fig. 7-2 The traditional four-position analysis for the mandible (chin)[1], the maxilla Point A [2], the maxillary teeth (from the palate) [3], and the mandibular teeth (from the corpus axis) [4]. Note data posted. A fifth position is on the PTV at the level of the first molar.

OUTLINE I

ADVANTAGES OF A FORECAST TO MATURITY OF YOUNG PATIENTS WITH MALOCCLUSIONS

[Five major categories with 57 specific applications]

CATEGORIES OF BENEFITS:

I	For communication
II	For growth use and the determination of orthopedic objectives
III	For Calculation of growth contribution to orthodontic corrections
IV	For use as basis for detailed planning of mechanics
V	For aid in the prognosis of retention problems

NOTES ON OUTLINE I

I FOR FOURTEEN FUNCTIONS FOR COMMUNICATION
(With a long-range forecast)

A. From the doctor to the patient and parent for:

1. Visualization of adulthood morphologic potentials;
2. Patient's consideration of later facial size and form, for aid in their decision-making relative to specific treatment presented at young age;
3. The fact is presented to patients that more is involved than just teeth;
4. A confidence level is promoted in the clinician due to the completeness of the information base;
5. Forecasting provides an aid in deciding the best age (or phase) at which to start treatment;
6. A forecast may indicate whether treatment will even be needed (7% of Class II conditions self correct).

B. For the clinician for:

1. Prognosis of risks;
2. A thought form for reference in selection of mechanics;
3. An image at maturity without treatment for consideration of skeletal, dental and soft tissue conditions which still need correction;
4. A raise in the confidence level of the practitioners in planning;
5. A higher data level on which to make judgments;
6. A framework for monitoring during the correction and after;
7. An aid for making the sale to the patient;
8. Practice enhancement -- puts the user ahead of competitors who are without it.

II FOR TWELVE FACTORS IN GROWTH USE AND THE DETERMINATION OF ORTHOPEDIC OBJECTIVES

A. Convexity Management:

1. The amount of skeletal maxillary reduction required (after natural growth contribution to convexity reduction or convexity worsening);
2. The amount of molar movement desired in both arches;
3. A feedback for determination of treatment requirements in the entire lower arch;

4. Requirement for alveolar modification at Points A and B. (Both are affected by therapy.)

B. **Concavity Management:**
1. The amount of maxillary skeletal advancement required for Class III;
2. A feedback for needed retraction of lower arch with progressive mandibular growth;
3. Amount of advancement in certain Class II brachyfacial types. (Some become concave with treatment.)

C. **Vertical Management:**
1. The determination of probable natural lower face height (centure height) as a basis for bite correction;
2. The amount of intrusion indicated for deep bite;
3. The amount of extrusion required for open bite;
4. As a framework for selection of torque formulas for the incisors;
5. For a basis for judging excessive mandibular rotation.

III. CALCULATION OF GROWTH CONTRIBUTION TO ORTHODONTIC CORRECTIONS (FIFTEEN FACTORS)

A. **Class I:**
1. An accommodation of expansion in long range;
2. The amount of incisor advancement desirable;
3. An indication of the amount of reduction needed with extraction.

B. **Class II:**
1. Contribution of mandibular growth to correction of the arches (both Division 1 and Division 2);
2. The amount of maxillary incisor advancement needed in Class II, Division 2;
3. The amount of lower arch advancement permitted or required;
4. The amount of over-correction necessary;

C. **Class III:**
1. The amount of either maxillary incisor advancement or arch movement required;
2. The amount of reverse torque needed on the upper incisor;
3. A prognosis of excessive mandibular growth;

4. A prognosis to suggest a delay for later surgery of maxilla or mandible;
5. Help in determination of the amount of mandibular rotation to be attempted.

D. For All Three Types of Malocclusion:

1. Probable final arch form;
2. Torque formulas for all types;
3. Prevention of excessive overtreatment in specific patients.

IV. FOR USE AS BASIS FOR DETAILED PLANNING OF MECHANICS

A. The natural forecast to maturity as a framework for treatment designing;

B. Aid in constructing the Visualized Treatment Goal (VTG) (long range) denture emplacement;

C. Anchorage requirement determination for anchorage preparation or slippage;

D. Denture emplacement for the avoidance of flat mouths;

E. Denture emplacement for achievement of best esthetics at maturity;

F. Avoidance of retreatment;

G. Prognosis of ultimate posterior space for upper molars;

H. Prognosis of ultimate space for lower third molars with indication for germectomy;

I. An aid for the determination for lower surgical lip release;

J. The long range as a feedback for short-range decisions (VTO);

K. Aid in selection of a candidate for mandibular posturing;

L. To set a target for planning emplacement of occlusion on more total basis (three-dimensional);

M. For selection of patients for genioplasty.

V. FOR AID IN THE PROGNOSIS OF RETENTION PROBLEMS

A. Treatment rebound expected (30% do not close after treatment);

B. Prognosis of bite relapse (open or closed);

C. Long-term effect of tight lower lip (estimate of muscle adaptation);

D. Compensations required to prevent overuse of maxillary retainers and iatrogenic inducement of joint derangement;

E. The long-range effects of continued pathologic growth;

F. The effects of asymmetry in mandibular growth behavior;

G. A framework for the final resolution of the mandibular advancing hypothesis;

H. The forecast to maturity as a diagnostic tool to determine abnormal growth behavior.

One **main** contribution of the forecasting method is to determine the wisdom for extraction or non-extraction. Another is to help indicate the natural convexity or concavity changes most likely to ensue without treatment (see Fig. 7-1). This helps to determine **the skeletal and dental changes that remain to be accomplished** in order to satisfy the individual objectives. The foremost benefit has been the vision or the image of the **esthetic** objective before it is attempted, and the tooth changes required to produce it. The VTO (for a typical two-year duration), originated in 1950, went through evolutionary changes. It was modified for computerization in 1970. However, the arcial behavior of mandibular growth was discovered in 1971. It proved to be very superior to all the previous methods. Therefore, about ten years later, by 1980 it was the only scheme recommended and taught by the author. As a result, **only one forecasting technique needed to be mastered**. This was the arcial mandibular method, as described in Chapter Four of this two-volume manual (Fig. 7-3).

Natural Growth

The growth outcome of conditions such as Class I, long-face open bite, severe Class II, or Class III without treatment can be shown to a parent (see Chapter Five). The indications for initiation of treatment may in this way be visualized for the layman's benefit. Remember in the Bioprogressive approach structural and functional changes are the initial or primary objectives.

Class III will commonly develop to a worsened state when left unchecked to the teen ages. However, seven percent (7%) of Class II conditions may self correct (or 1 in 14 Class II conditions in young patients). **A forecast may therefore suggest no treatment at all!**

The question presents: "What will be the long-term effect of growth and development?" Imaging is a current major issue in clinical competition, as societies around the world approach the information age with the liberal use of the computer and allied technology. In other words, **what benefits or what worsening will natural development produce by maturity?** This includes the ultimate condition of third molars and total facial esthetics.

* * * * *

Rebound and Recovery in Long Range

The VTO (for one to two years) needs to take into account primarily the influence of treatment on the maxillo-mandibular relations resulting from specific modalities.

ARCIAL GROWTH

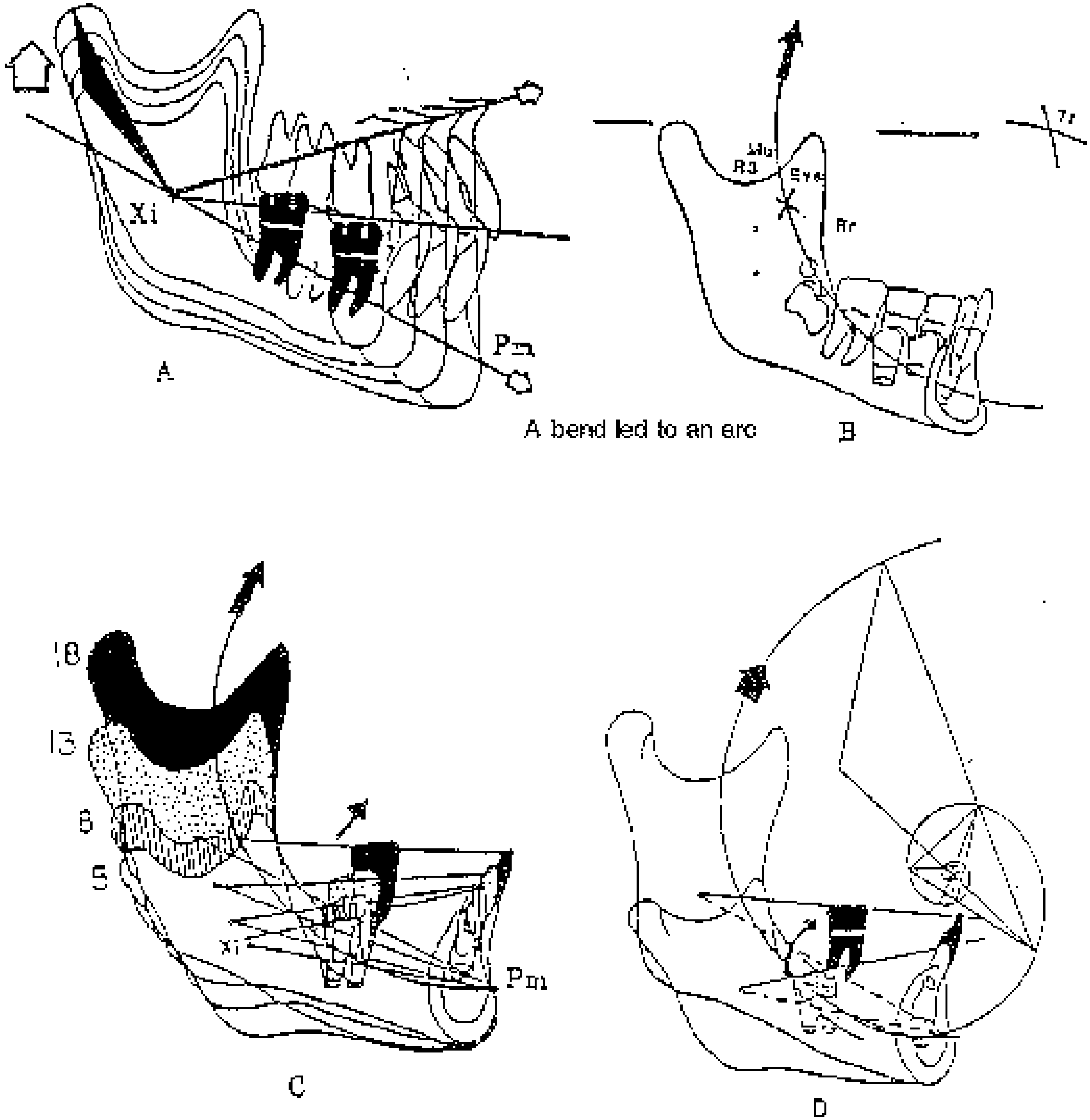


Fig. 7-3

A. Corpus–Ramus bending in normal growth.
B. Method for arc construction from Pm and Eva.
C. Longitudinal comparison of arcial growth with upward and forward development of the lower arch.
D. The arc is thought to be the long leg of a logarithmic spiral.

Studies led the author to conclude that **all deep bites should be treated by intrusion of anterior** teeth, other than condyle compression cases. After mandibular physiological rotation (from bite leveling and elastic traction), it was shown that the rebounding process in 50% of clinical cases occurred as the mandible tended to close again. But Cornforth's findings suggest that **30% of patients treated with certain modalities do not recover** from severe opening mandibular rotation. In a few patients the growth of the condyle seemed to be permanently damaged by some process, and the rotation was either the cause or the result. But when an entire statistically significant sample does not express the growth of normal controls or untreated controls, a heavy suspicion arises that iatrogenics of treatment is present.

A maximum **safety margin** of two degrees (2°) rotation on the Facial Axis during treatment was theorized. **Complete recovery seems to be absent when patients have been opened 3° or more during the treatment process.** In some patients they were 7° rotated and stayed so. **Iatrogenics can be more powerful than most clinicians may realize**, certainly more than is taught currently.

Sad to say, it appears that the faces of **some patients would have been better off without orthodontic treatment** in the light of the results with some of the modalities studied. The long-range forecast thus becomes a powerful diagnostic tool of altered growth when it occurs! The process can help to determine the iatrogenic conditions produced! It may take away some of the excuses! **It is therefore feared by many clinicians.**

Forecasting is, however, arguably the orthodontist's greatest learning tool.

* * * * *

Prevention of Excessive Rotation

Bioprogressive techniques may consist of (1) Utility Arches, (2) segmented mechanics, (3) cortical anchorage, (4) concatenation wires, (5) anterior intrusion techniques for deep bites, (6) posterior intrusion for open bites, (7) specific pressures for cervical traction on the upper molars alone (and at night only), (8) the sensible application of the quad helix, and (9) certain mandibular posturing methods (see Chapter VIII).

With the foregoing appliances employed as taught, mandibular rotation is not abused. The **rebound behavior required is consequently less** in amount and less in frequency following Bioprogressive methods. Also, retention is easier and results are consequently more stable.

Thus, with the Bioprogressive techniques practiced, the **long-range forecast is the same for the mandible and its general position in the face whether the patient be treated or not treated.** For other modalities the procedure may not work in this manner, and allowances must be made in the VTO and VTG.

Maxillary Orthopedics is True Orthopedics

The same rebounding principle does not apply to the maxillary complex. Some minor rebound has been experienced in the midface. This is the reason for recommended gradual reduction in frequency of wear of extraoral traction together with the advice for overtreatment and progressive withdrawal of mechanics. But extraoral **orthopedics** (skeletal change) **in the midface (maxillary complex) did not rebound on average** as discovered by long-range studies (15 years' duration) in 1990 (Figs. 7-4A, 7-4B, 7-4C, 7-4D).

Therefore, the visualized treatment goals (VTG) to maturity may be dependent on the individual clinician's **technical methods, his or her ability, and the age at which treatment was conducted.** Hence, the natural growth without treatment for the mandible becomes the starting base unless, as stated, it is impaired by accidents, diseases, or is iatrogenically affected.

* * * * *

General Statements Regarding Orthopedics and Orthodontics in the Long Term

1. Modalities differ in results in both the short and long range (see Fig. 7-4).
2. Mandibular posturing devices (Herbst, Bionator, Activator, Frankel, Bimler, Jasper, Jumper) have been tested in seventeen (17) samples by computer composites. **No long-range increases in mandibular size** were evident (Fig. 7-5). A temporary (two- to three-year) alteration of form or bending was measured which generally tended to **rebound but not always.** But also, the same type of temporary bending was measured to occur with **vigorous** intermaxillary traction, 400 grams total. **This opening-bending, with the recovery, may explain** some of the **relapses** which many have observed.
3. With functional correction, the maxilla has been observed to undergo a favorable morphologic transition over five years following dental malocclusion reductions.
4. When used properly, extraoral traction may produce permanent maxillary

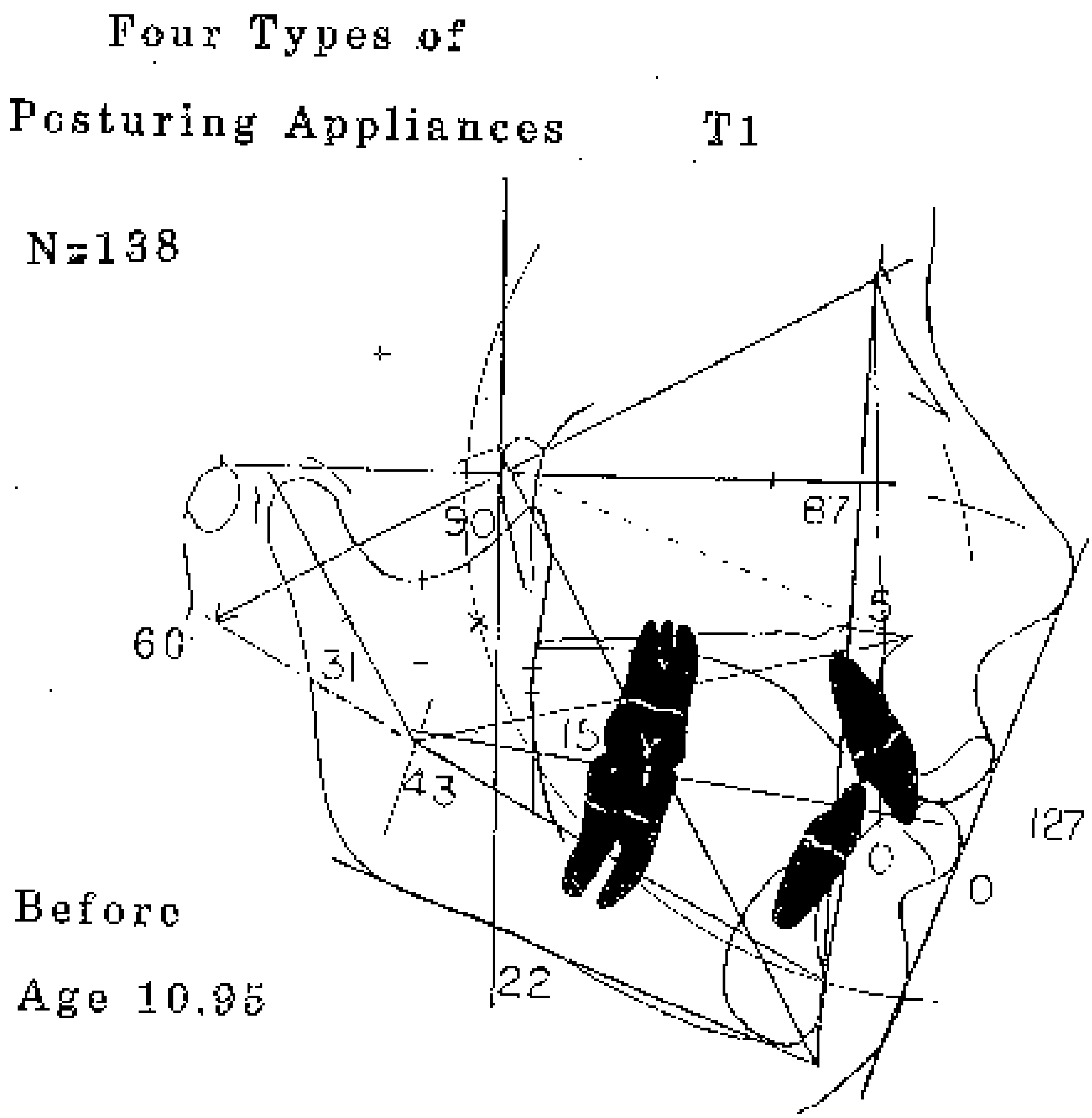


Fig. 7-5A T1 -- Four groups of Class II patients treated with removable mandibluar posturing techniques are composited (Activator, Bionator, Bimler and Frankel). Note 90° Facial Axis and other values which show a normal mandible. The maxilla is 5 mm. forward of the Facial Plane.

The lower incisor is in supraocclusion and the maxillary incisors are protrusive. Thus, on average, the Class II was mostly located in the midface and upper denture.

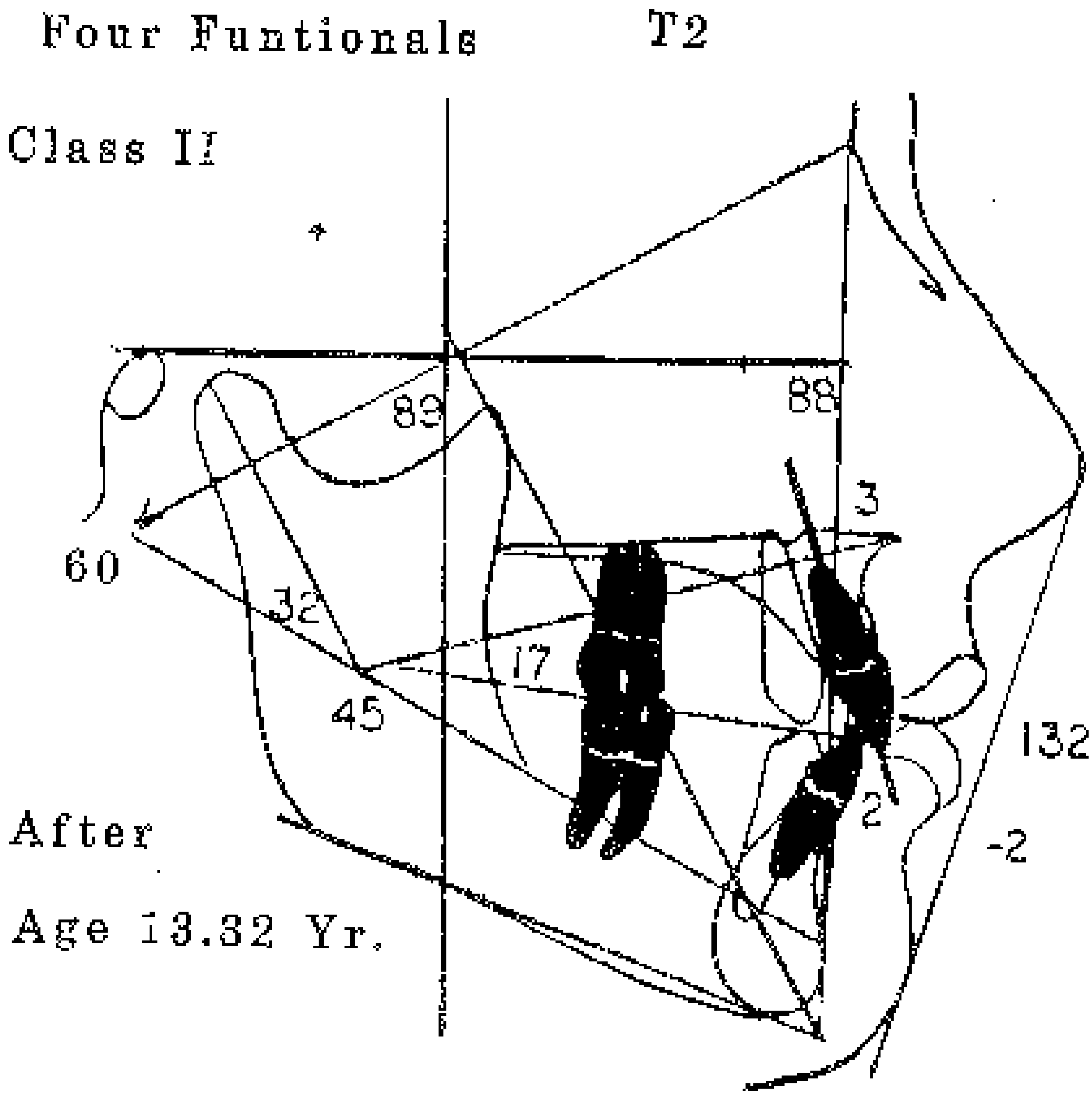


Fig. 7-5B **T2** -- Treated N=138 sample seen in Fig. 7-5-A. Note the corrected profile Slight opening of the Facial Axis and movement of the teeth are noted. The Facial Angle improved from 87° to 88°, and the convexity was reduced 2 mm.

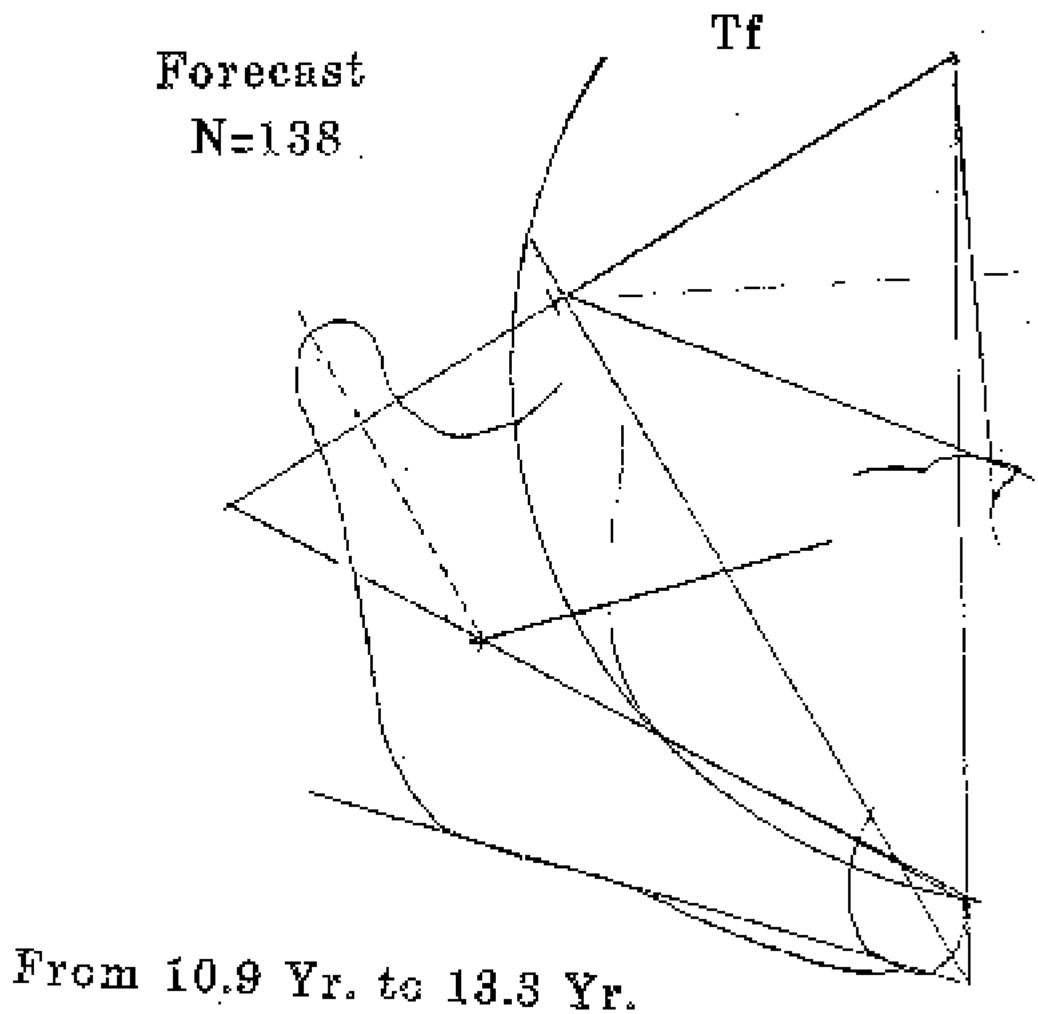
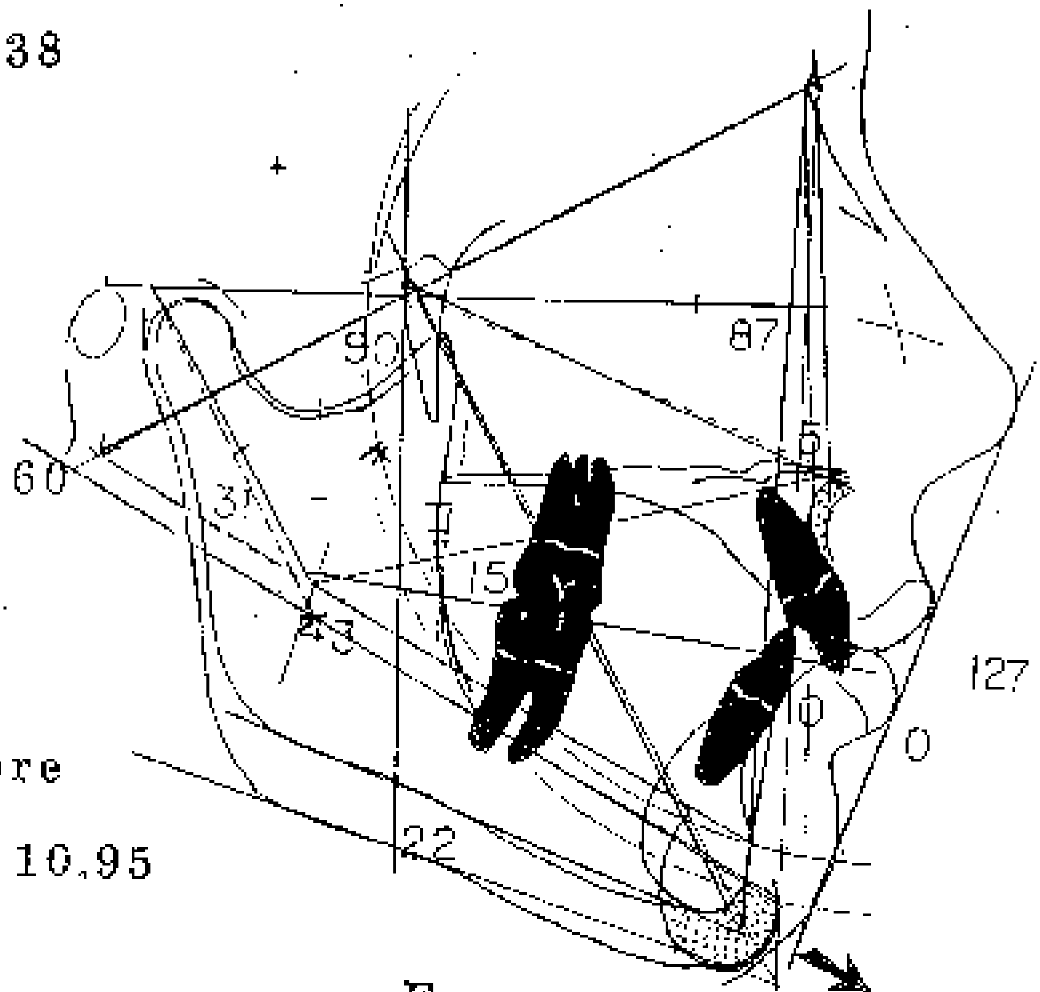


Fig. 7-5C **Tf** -- The forecast of the N=138 composites seen in **T1** is shown to the age of the actual T2. Note the areal method for the mandible and projection method for the cranium and maxilla.

Four Types of

Posturing Appliances T1

N=138



Before

Age 10.95

Forecast Comparison

Fig. 7-5D The T1 and Tf (forecast) are superimposed on the BaN plane at Cc. Note the predicted behavior of the chin (dotted) and the maxilla (dotted). The Facial Axis closes usually 1° each 7 years, and this shows about 1/3 of one degree. The chin moves downward and forward 2.5 mm. each year, and at 2.5 years would be about 6.25 mm. which is very close to this resulting forecast.

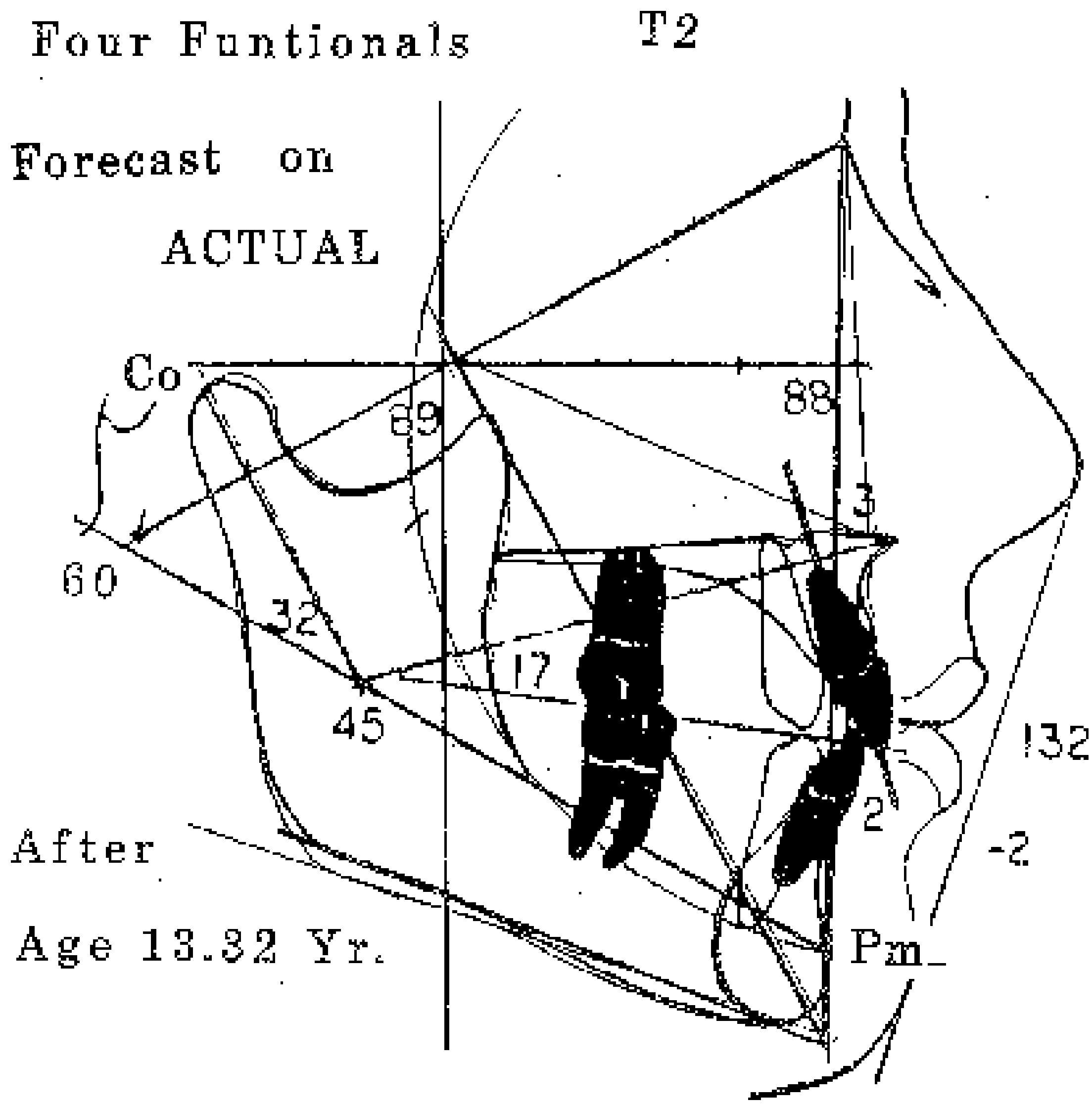


Fig. 7-5E N=138 untreated forecast seen I Fig. 7-5C is superimposed on the actual T2. Note the good fit of the basicranium and maxilla. Mandibular length (from Pm to Co) is essentially the same but suggests a slight form change with a (2°) rotation of the Facial Axis.

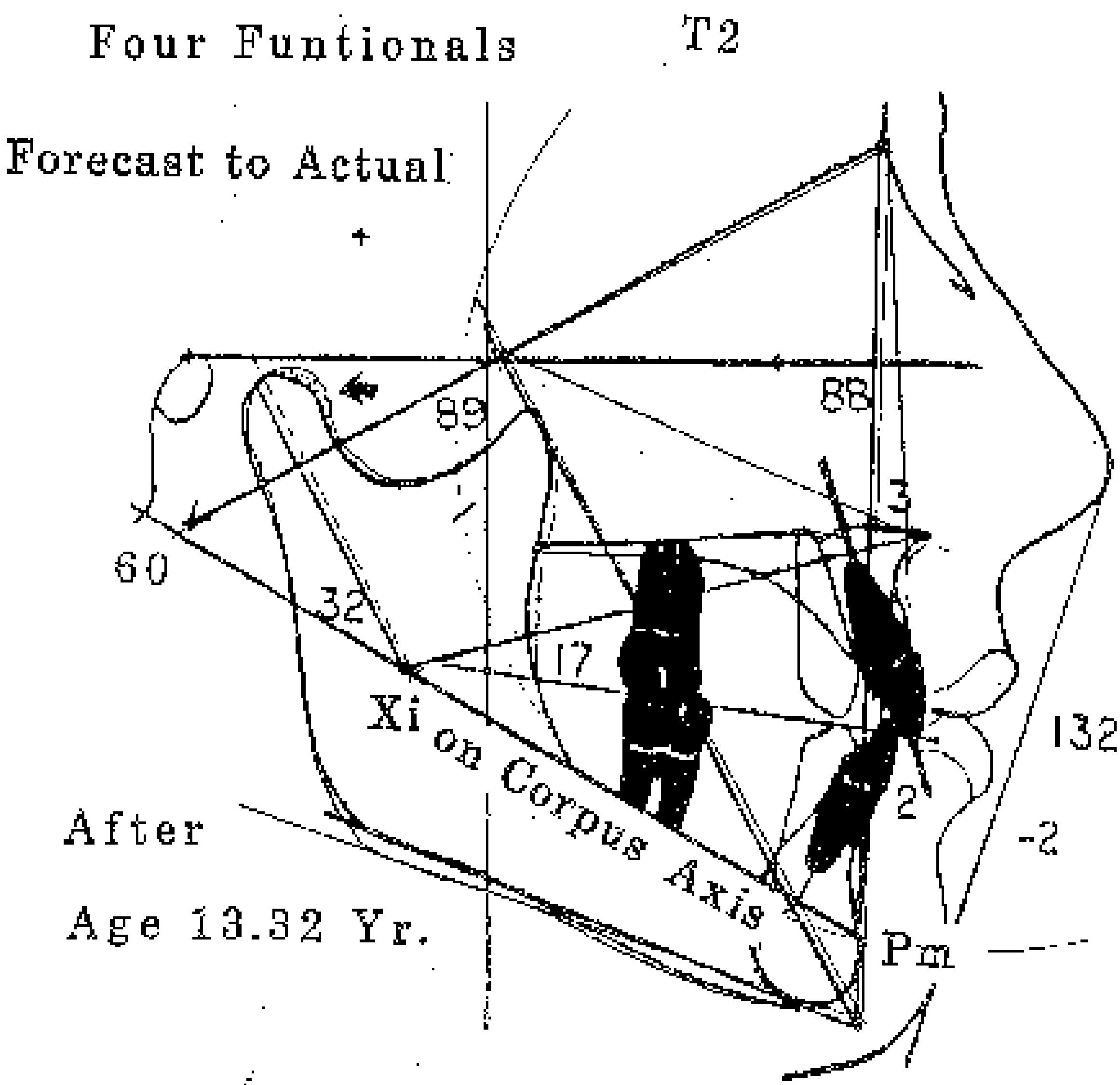


Fig. 7-3F The forecast is superimposed on the Corpus Axis Xi-Pm at Pm. Note a posterior bending and flattening of the Condyle with opening of the Condyle Axis CoXi

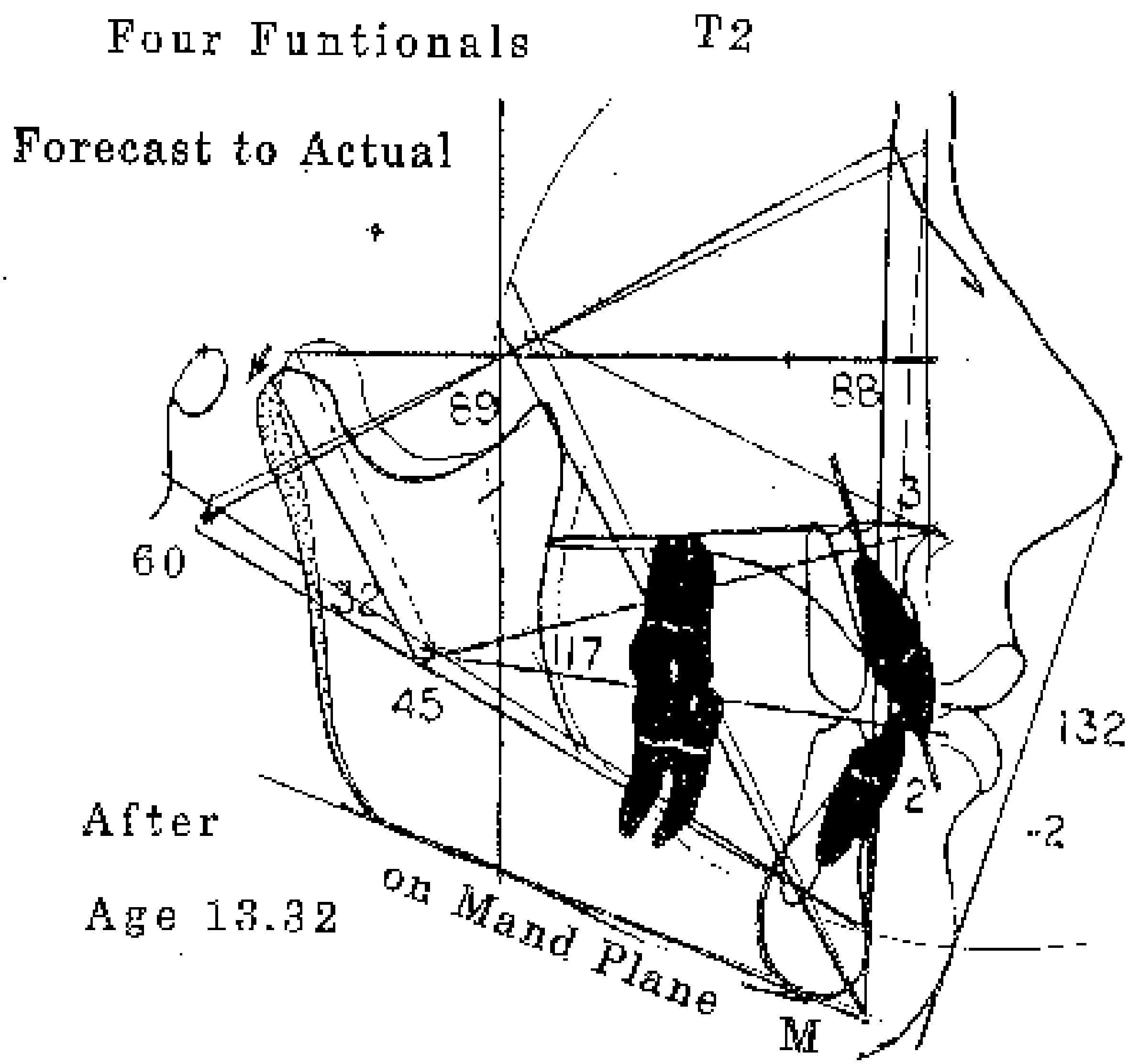


Fig 7-5G The forecast superimposed on the mandibular plane at Menton. Note the relative shortening of ramal height compared to the forecast. The amount of posterior bend (dotted) was a surprise in this and isolated patients.

changes in **all three planes** of **space** (see Fig. 7-4).

5. Successful and permanent intrusion of teeth, the distal movement of molars, and successful arch expansion were found to be contingent on the techniques employed and how they were used.

6. After treatment, forward shifting of the upper incisor during retention is not unusual (see Fig. 7-1). The chin continues to move forward, with normal growth and particularly in functional rebounding or recovery.

7. Tight lips, producing strong resistance, were found to sometimes contribute to upper incisor trapping in all types of malocclusions (see previous chapters).

8. Cut-offs for the sexes surprisingly displayed how far typical growth can go: the mean is 14.8 for females and 19 years for males and is surprisingly consistent.

9. Teeth that were intruded stayed intruded if placed in proper relationship and function.

10. It should be remembered that the VTG is a goal, **or a long-term objective!**

* * * * *

Factors in the Construction of the VTG

Discussion:

The Chin -- Long Term

As a principle, the **size** and **form** of the mandible with treatment is forecast the same as for non-treated natural growth (see Chapter Four). The exception is for patients who experience long-term condyle **jamming either** by **over-rotation or** from **absence of posterior vertical dental support**. The exception also includes those who undergo mandibular growth inhibition by condyle compression, even by chronic clenching.

During **specific types of treatment** there is some evidence that the glenoid cavity via the temporal bone may be influenced to produce a small contributing factor in the long term. It was shown to be slightly influenced forward in the treatment of Class II composites and backward in Class III treated composites.

Sufficient data is not available for predicting the amount of inhibition of growth in the Class III. However, it is conceded by informed scholars that a change in the mandibular pattern can be induced in young Class III patients.

During normal behavior the Facial Axis, as a mean, will close about one degree each seven years. This average was found to be true of untreated samples for all types of faces! When, on average, a group of treated growing patients does not witness a closing of the Facial Axis it suggests that the mandible has been opened permanently.

Short-term patients treated with mandibular posturing for deep bite opened on the Facial Axis one degree as a mean. Samples treated long-term stayed close to the original Facial Axis.

Short-term deep bite cases treated with Secondary Edgewise mechanics (straight wire with stronger wire than used currently) opened a mean of 4.0° on the Facial Axis. Begg cases exhibited a similar rotation. A two-degree recovery on average is anticipated but more long-range samples are needed for final data.

Short-term cases with cervical traction for Class II used as described by Ricketts did not, as a mean, open on the Facial Axis. Long-term cases treated with cervical traction (by Dr. A. Haas) without incisor intrusion opened a mean of 2°.

Vigorous mechanics during extraction therapy tended to open the Facial Axis 2.0° on average.

All these are generalities. However, individual response is to be monitored by the sophisticated clinician. When openings are seen beyond 2.0°, then a change in mechanics may be considered.

* * * * *

The Linear Function of an Angle (one degree)

Before going further, however, it is well to realize the geometric relation of a degree to a linear measurement (Fig. 7-8). One degree in space represents millions of miles but one degree (1°) at a distance of 55 mm. (or a radius) is equal to 1.0 mm. on the chord of an arc. At a 100 mm. radius one degree represents 2.0 mm. At a 165 mm. length a change of only 1.0° will be a 3.0 mm. difference (see Fig. 7-8).

The common length of the Facial Axis for a female at maturity is in the 120 mm. range. For the male it often is in the 135 mm. range. For the SNA or BaNA angle a 1.0° angle change is almost equal to 1.0 mm. because the length of the N-A line is often near 55 mm. The length of the Facial Plane N-Po (or to Gn) may be in the 160 mm. range. Therefore, its 1.0° change can amount to close to 3.0 mm.

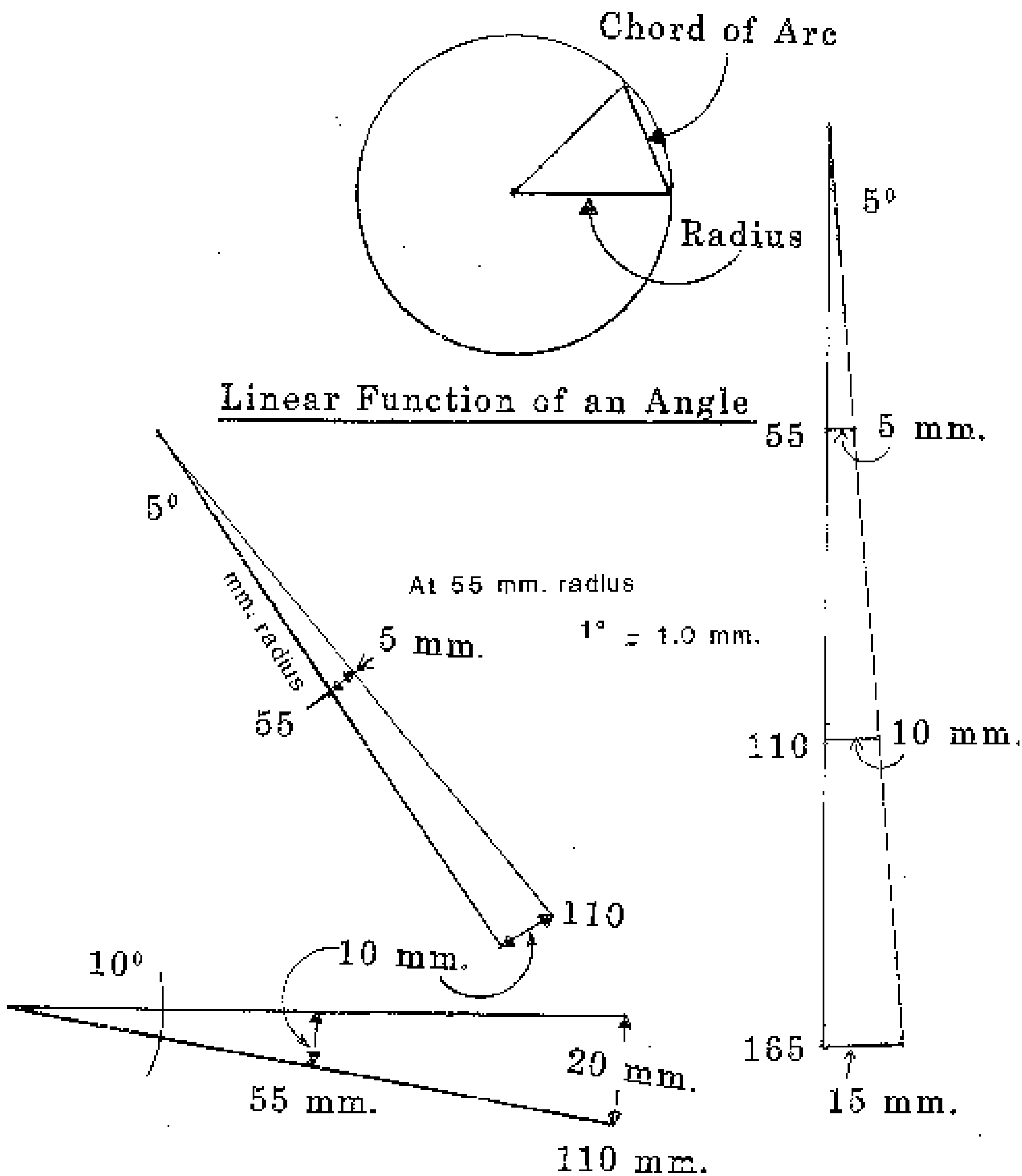


Fig. 7-6 For cephalometric understanding of the meaning of an angular change it is well to note that 1° at a 55 mm. radius is 1 mm. on the chord of the arc. It is 2 mm. for 1.0 degree at a radius of 110 mm., and 3 mm. at 165 mm

Only 3 degrees of difference in a male Class III could amount to 9 mm. on the Facial Angle.

Technique for Building the Treatment Objectives from the Untreated Long-Range Forecast

The forecasting method was described in the procedures in Chapters Four and Five. The same two patients (Laurie [L.A.] and Nicholas [N.N.]) who were used for demonstration without treatment are now employed again for treatment designs (Fig. 7-7 and Fig. 7-8).

For the Mandible (chin)

The position of the chin is of primary interest. It can be altered in the treatment design by changing the Condyle Axis relative to the BaN Plane or the Frankfort Plane.

Discussion

The goal with treatment is *not* to disturb natural growth potential in Class I and Class II. Contrarily, the objective in Class III is to inhibit growth. Research has suggested that the most successful inhibitory phenomena result from ocning rotational procedures.

As a result of experience, the author has built the treatment design (VTG) directly into the forecast in one rendering (see N.N. in Chapter Eight).

However, for teaching, as shown herein, the principles of the axial mandibular method and cranial extension methods without treatment are described first. These forecasts are then modified, for clarity of presentation, according to the goals deemed advisable.

A long range is three years or more, and the short range is less than three years. Females at age 12 or more are therefore considered short range because by age 15 effective growth has stopped.

Procedure

Employ the untreated forecast, either the long or short range, as a working form.

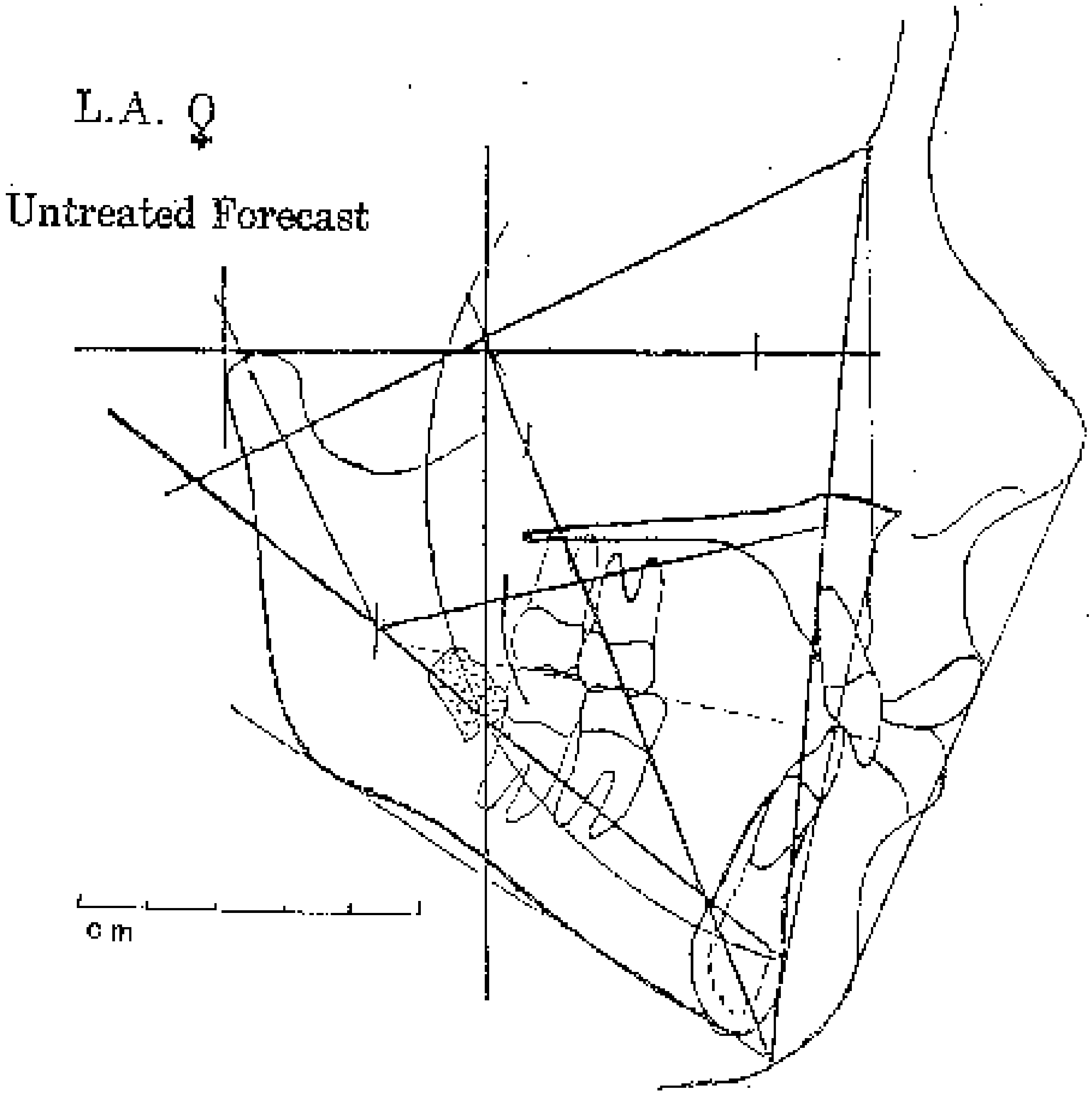


Fig. 7-7 The completed forecast, including the soft tissues, for female patient L.A.

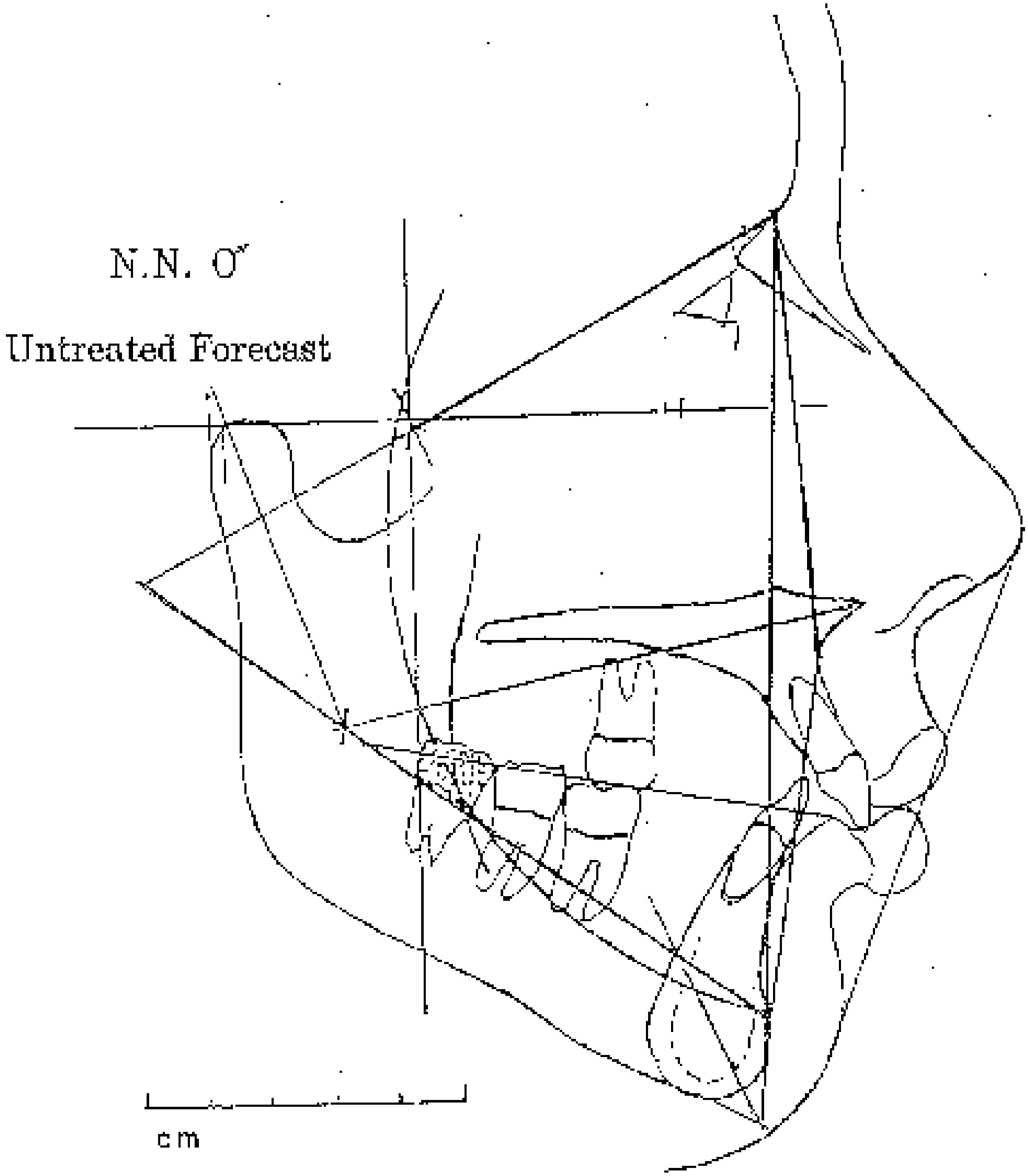


Fig. 7-8 Full forecast for male patient N.N.

For the Mandible:

Step 1: On a new tracing paper copy the untreated mandible and extend the condyle axis and the corpus axis for ease of work. Mark the condyle center (Fig. 7-9A for patient L.A.).

Step 2: While registering on the condyle center, rotate the mandible via the condyle axis in response to the mechanics required for the correction. (The patient L.A. was rotated 1° for teaching reasons but a full recovery occurred.)

Conditional Factors: If a deep bite or Class II has been treated, with traditional edgewise therapy a 1° to 2° rotation may be experienced.

If it is short range, the 2° cut-off for maximum rotation may be used, **if the principle is understood.**

The following formula is used for traditional arch leveling and elastics are employed in the short range: Each millimeter of **deep bite** is weighted for a 0.25° opening. Each millimeter of Class II correction (overjet) is given a weight of 0.25° for change on the axis during treatment. **Convexity** change (torque on upper incisors) is also weighted for 0.30° per mm. of reduction.

If, however, intrusion mechanics is employed, via the Utility theory, and if cortical anchorage is employed with sectional mechanics (see separate manual on sectional mechanics), the formula is modified or essentially negated.

Step 3: After the mandible is rotated, as shown in Step 2, copy the three basic reference planes: FH, BaN, and PTV (Fig. 7-9B).

Step 4: Record Nasion and Cc Points. Erect the new Facial Plane (N-Po) the Mandibular Plane, and the Facial Axis (Cc-Gn).
Note: The opening or closing of the Condyle Axis will usually reflect the same change in the Facial Axis.

The mandibular working base is now provided with Step 4.

For the Maxilla

Step 5: Superimpose BaN on N.
Modify the anterior nasal spine (which means the Palatal Plane). Move Point A with the palate first and then as will be influenced by torquing and retraction of the incisors. Dash in first and then superimpose on the Ans and recontour Point A.

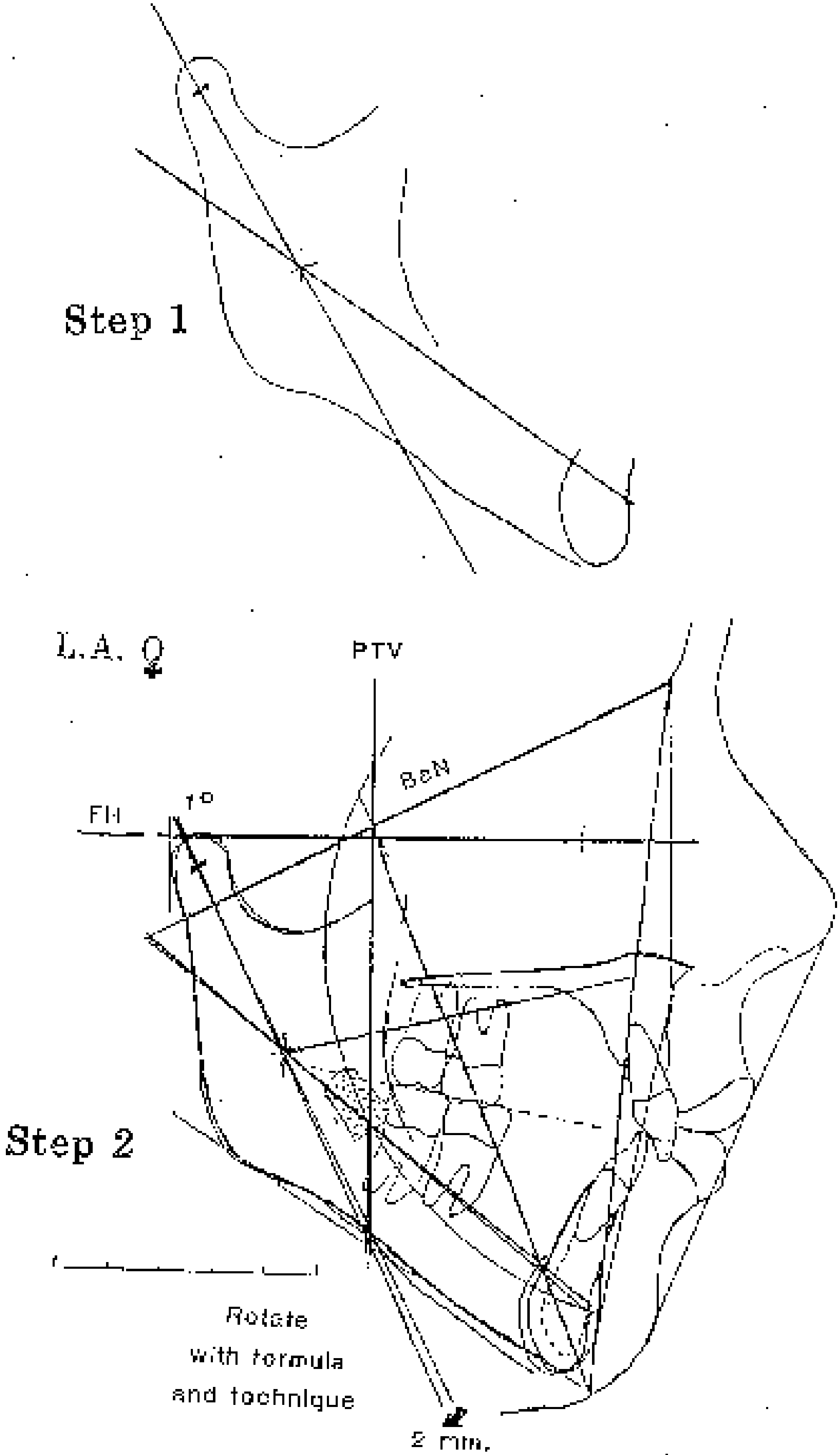


Fig. 7-9A *Step 1:* The predicted mandible and internal planes are copied and the center of the condyle is selected.
Step 2: The mandible is rotated on the original forecast as prospective of treatment influences – here 1°.

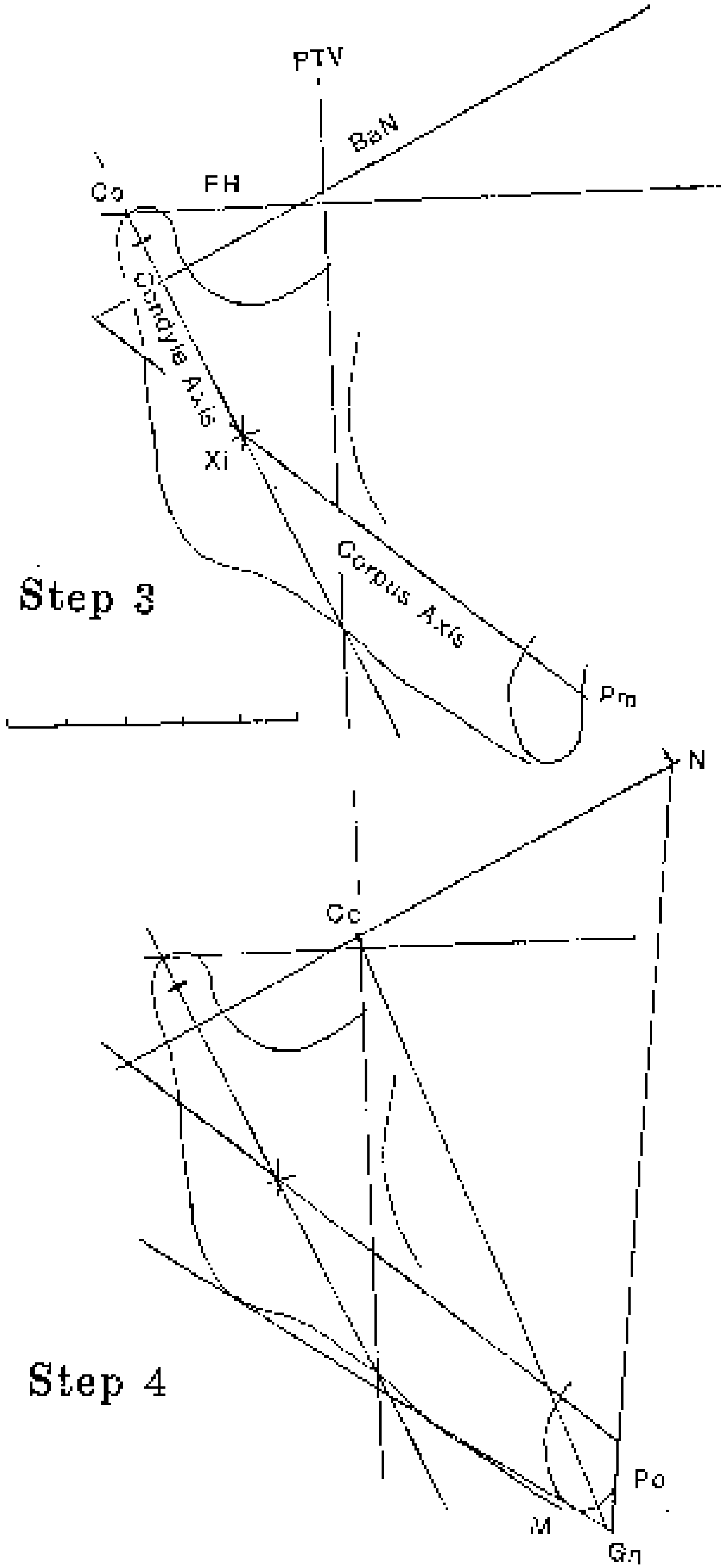


Fig. 7-9B *Step 3:* After rotation (if any) the basic cranial planes are copied.
Step 4: Nasion and Cc are selected and the facial planes are erected.

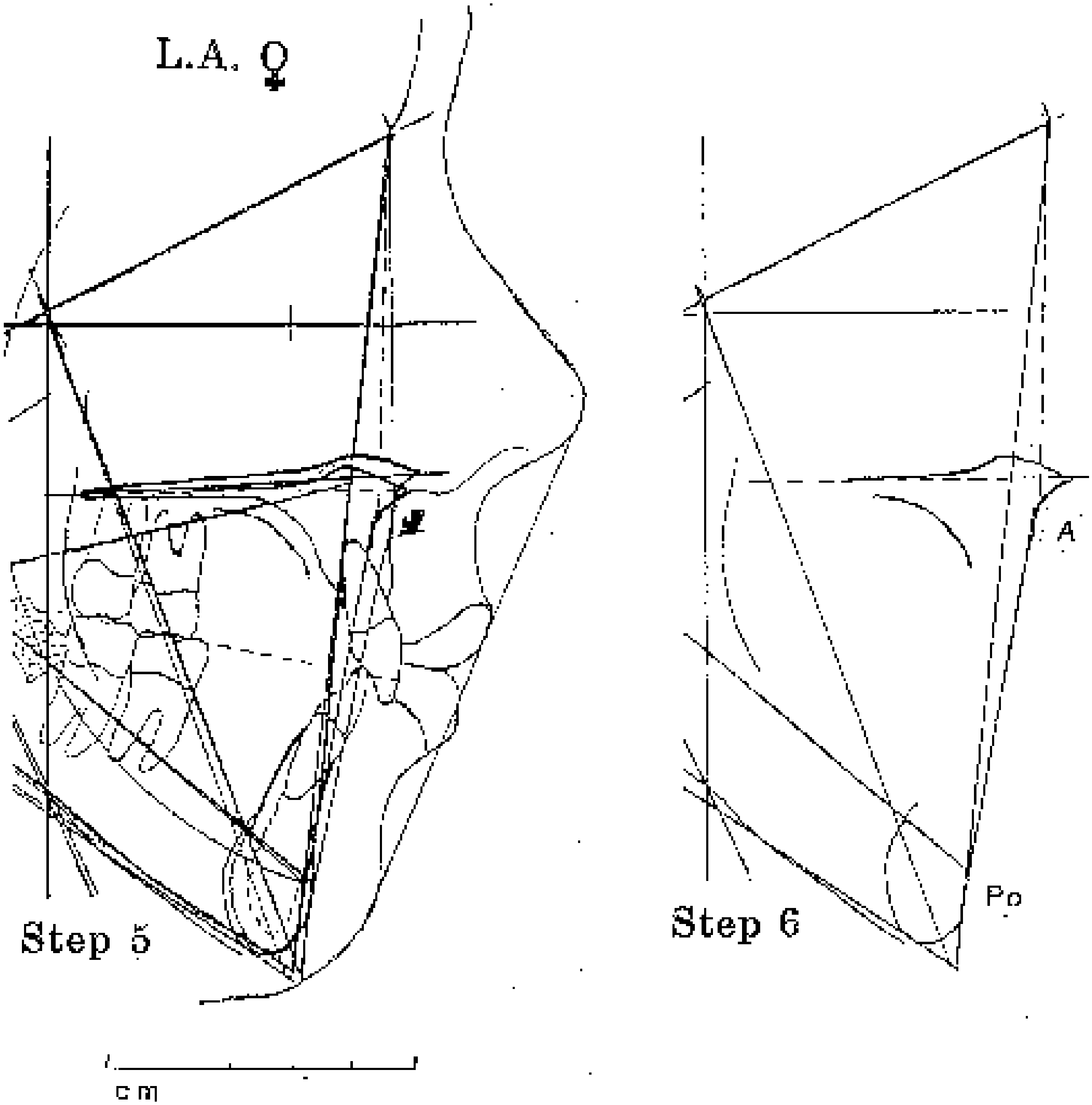


Fig. 7-9C *Step 5:* The maxilla is modified as desired or thought possigle and feasible.
Step 6: The APo plane is established as a reference for the teeth.

Conditional Factors: Research data proves that the maxilla can be changed permanently in three dimensions (see Fig. 7-4). For an objective from samples of normal Caucasian **adult males** the convexity was found to be near 0.0 mm. with a Clinical Deviation of ± 2.0 mm. For adult females the ideal convexity was +2.0 mm. ±2.0 mm. Common sense is used with the **feasibility factor** considered in establishing the convexity goal.

It is recognized that a **Palatal Plane change to include Ans will also affect the soft tissue nose position** (see Chapter Eight for Patient N.N. at nine months of treatment). Facial anchorage (face mask) will move the maxilla **and the nose** forward. Cervical traction will move the hard palate downward and backward **and take the nose with it!** Intermaxillary elastics can have a moderate effect on the palatal plane. Thus specific clinical methods can **change or treat the face, not** just the teeth.

Step 6: Draw the new APo Plane.

The maxilla and the maxillo-mandibular relationship have now been established as a target for emplacement of the teeth.

* * * * *

For the Teeth

Discussion

The Divine Occlusal Plane may serve as a guide for long-term planning. This working plane toward idealism is drawn from Xi Point to the "Golden Point" between Point A and Point Pm. The Golden Divider can be used or the Divine point (Dp) position can be calculated. The total height is measured and multiplied by 0.618 in order to determine the Divine position for the lower incisor (Fig. 7-10).

Step 7: Establish the Divine Occlusal point for height and draw the divine occlusal plane from Xi Point.

The Lower Incisor

Discussion

The author agrees with Tweed's conception that **the lower incisor is the key tooth for the setting or emplacement of the whole denture.** This is particularly true for long range. The **height** (or vertical position) of the lower incisor is determined from the **incisal edge directly on the Divine Occlusal Plane.**

The **protrusion** of the incisor is a **choice by the doctor.** Black or Asiatic

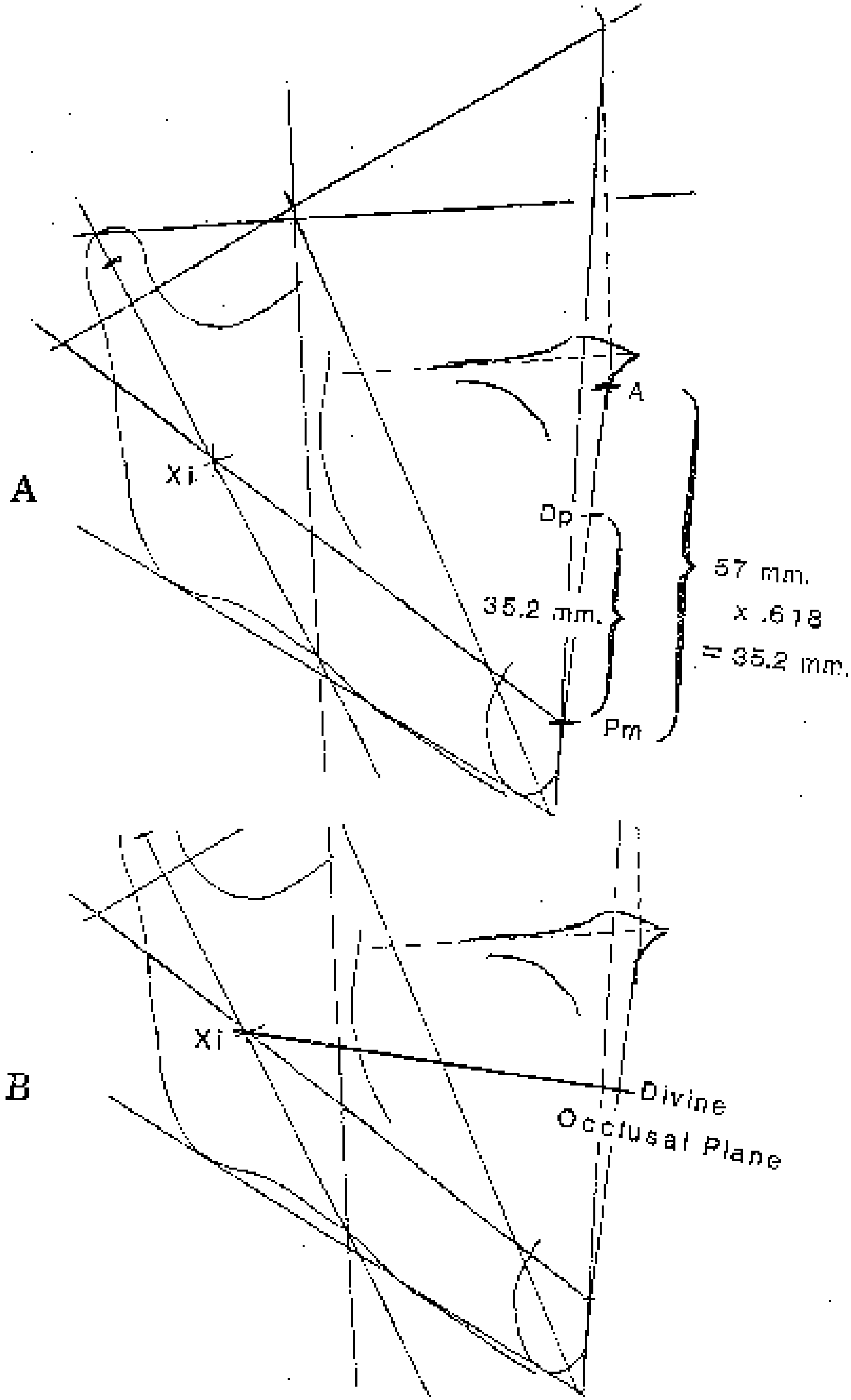


Fig. 7-10A **A.** Procedure for calculation for height of the occlusal plane. Dp, the Divine point, is located by taking the distance from A to Pm and multiplying by 0.618 This yields the lower denture height.
B. The Divine Plane is from Xi to Dp.

faces may receive gracefully more protrusive dentures, as do some Caucasians (see Chart V).

The objective for situating the lower incisor initially (in 1950) was at +1 mm. ± 2.5 mm. at 22° (Fig. 7-11). This was derived from a sample of 15 beautiful normal untreated children age 8.5 years. That position was used as a mean goal through the first 25 years of practice for both "denture balance" and **pleasing esthetics** (see Fig. 7-11).

A 1990 study revealed the mean of 73 untreated subjects to be +2.0 mm. to the APo Plane. But when 60 stable treated patients were added to the data, making a sample of N=133, the lower incisor was a mean of +1.6 mm. (see Fig. 7-11; also see Chapter Five, Fig. 5-3).

Many orthodontists prefer an objective of +2 to +3 mm. for the lower incisor to the APo Plane. The more forward the tooth the more forward inclined it may also need to be. The average lower incisor protrusion was found to be 16° to the occlusal plane. This was confirmed also in the 1990 studies (see Fig. 7-11).

The lower incisor has been placed as objective as far forward as +5 mm. in some patients throughout the author's entire career. These are usually large faces with loose flaccid lips.

Successful emplacement of the denture is also contingent on muscle equilibrium. Personality is a further consideration in denture emplacement. The outgoing personality benefits from a prominent denture. **A flexibility in emplacement makes good sense.** Limiting our efforts for fullness of the mouth or the full smile is unwise and impractical.

The foregoing factors are kept in mind as the goal for lower incisor position for the female patient L.A.

Step 8: Set the lower incisor at desired position (for the individual). The ideal may be 1.5 mm. at 22° and at the Divine point (Fig. 7-12A).

The Lower Molar and Arch Depth

Discussion

In long range, the lower first molar is set 1 mm. below the Divine Occlusal Plane for the Curve of Spee. It is placed at the appropriate arch depth which, in non-extraction, starts with a cephalometric average of 23.5 mm. From the mesial margin to the center of the incisal edge.

Larger teeth may be up to 24.5 mm. and smaller teeth may be as little as 22 mm., but the **frequency of the mean figure in normal occlusions is surprising.**

FINDINGS IN RACIAL TYPE AND TREATED COMPOSITES

Race	$\overline{1}$ to APO	Interinc.
Peruvian (Male)	2.5	130
Brazilian (Mixed)(Male)	2	133
Navajo (Davenport)(12 yrs.	4	126
Male Caucasian	1	130
Female Caucasian	1	130
Black (male)	4.5	120
Oriental (Male)	5	121
Mexican (Male)(Velarde)	3.5	124
Normal Mix (7 and 12)	2	132
Treated		
Class I Expansion	2.5	127
Class I Extraction	0	137
Class II Deep - Brachy	2	123
Class II Open Bite-High (F[illegible])	1.5	132
Class II High (2-stage + 3 conv.at end)	2.5	125
Class II Deep (Female) (5 years)	2 2	Ret. 125 P.R. 129
Class II Deep (Male) (5 years)	3 2	125 131
Class II Deep (Male & Female) (5 years)	3 2	126 130
Class II Bionator	3	125
Class II Old Edgewise	2	133
Class II M. Post Comp.	2	132
Class III	3	131

CHART V

More findings from computer composites for lower incisor position and interincisal angle

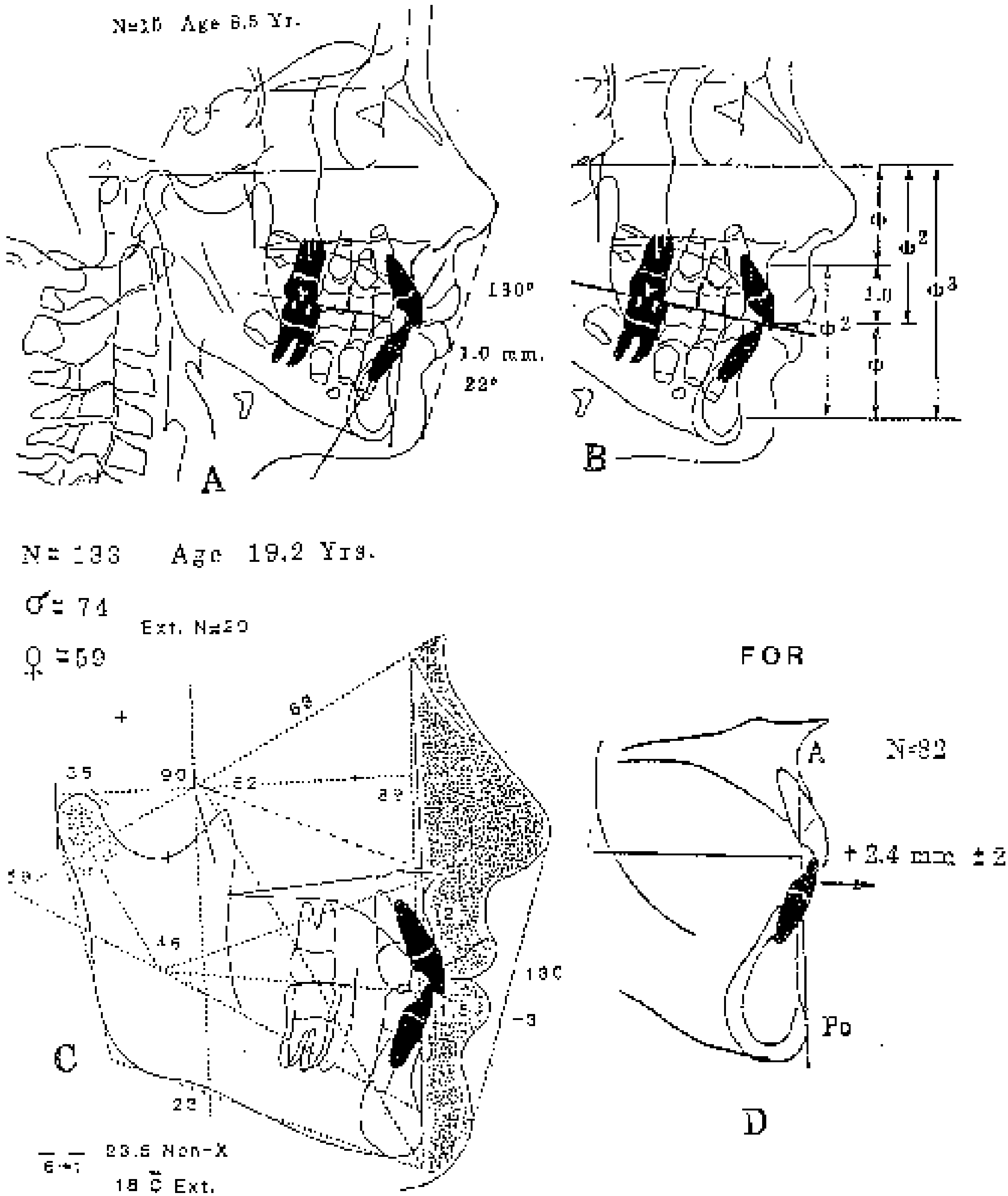


Fig. 7-11 **A.** Lower incisor in N=15 8-year-old children, −1 at 22°.
B. Divine Proportions in same sample.
C. Lower incisor in N 133 adults, −1.6 at 23°.
D. Lower incisor in N=82 normals from Foundation for Orthodontic Research. +2.4 at 25°.

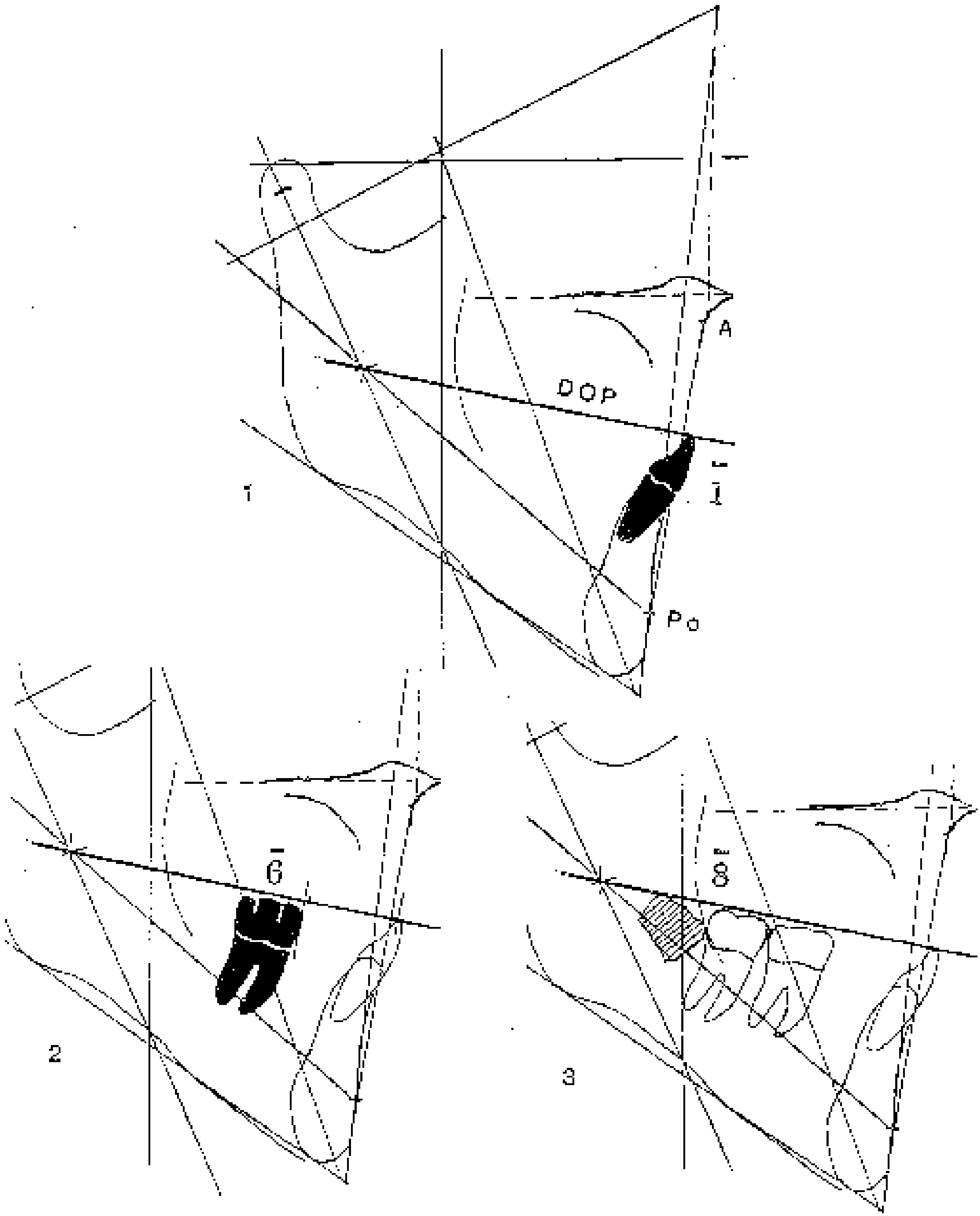
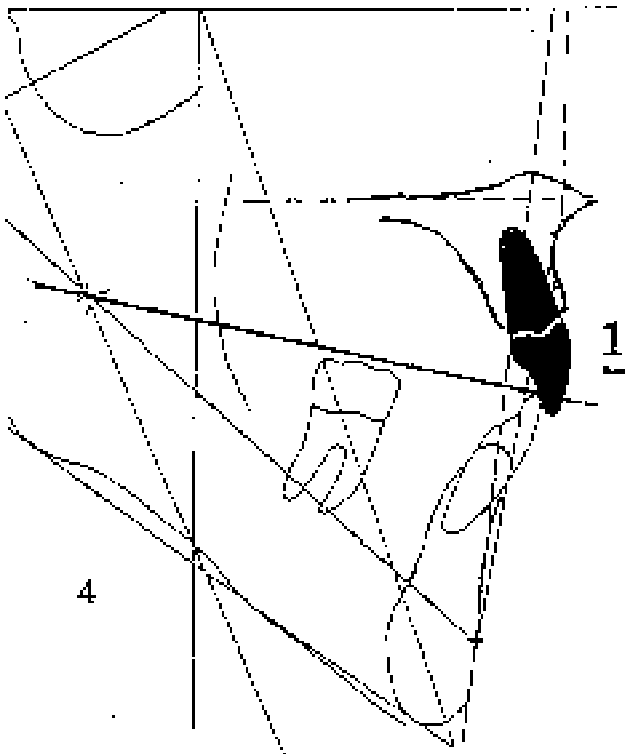
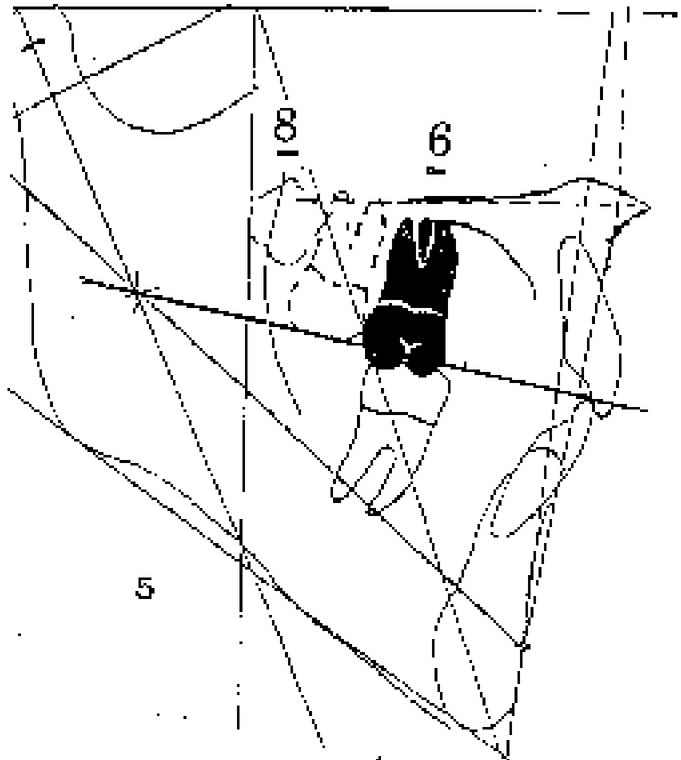


Fig. 7-12A
1. Set lower incisor at 1.5 at 22° to APo plane with incisal tip on the DOP.
2. Set molar 1 mm. Below DOP at 18 mm. Distal to the incisor edge center.
3. Place second molar, calculate space, and estimate third molar





L.A. ♀

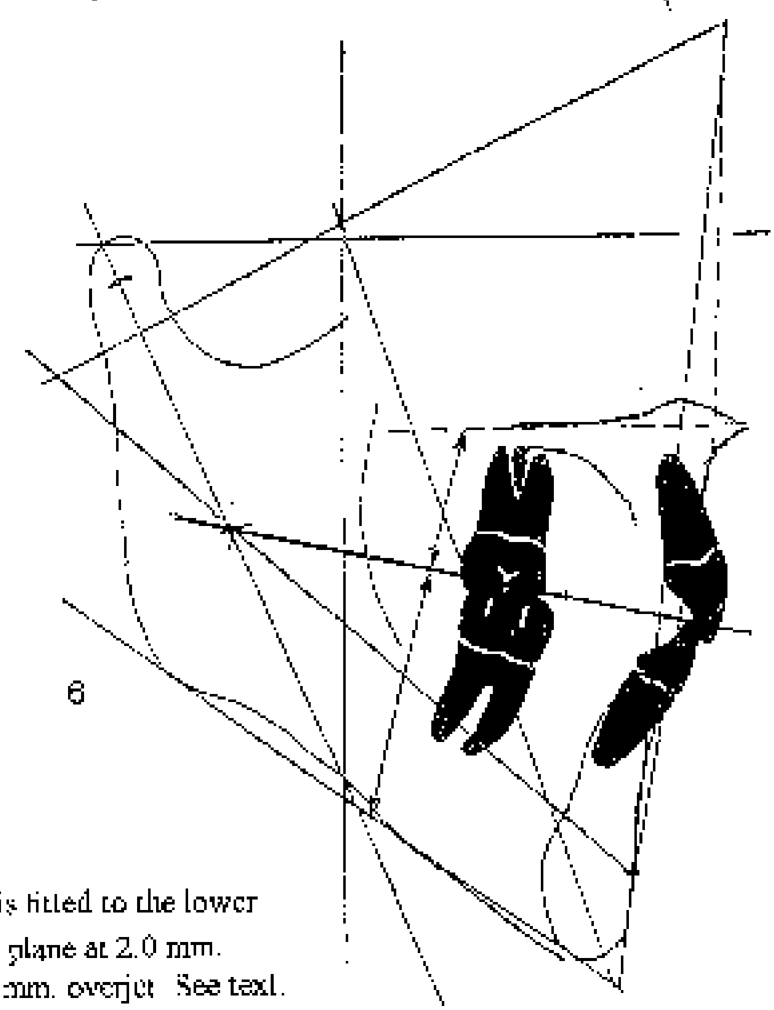


Fig. 7-12B

4. The upper incisor is fitted to the lower -- and to the APo plane at 2.0 mm. overbite and 2.0 mm. overjet. See text.
5. The upper molar is locked with the lower as the base. The space for 8 is estimated.
6. The entire denture is oriented to the occlusal plane and the APo plane. Note the occlusal plane at the second molar height is Golden to the Palatal Plane and Mandibular plane.

Arch form (signified by the first premolar in the cybernetic circle) (see Fig. 7-21) will also play a minor role in arch depth. Ovoid arch shapes are shorter in depth while tapered arches are somewhat greater in the depth from incisor tip to the mesial of the molar.

The emplacement of the denture within one clinical deviation range as determined by the lower incisor tends to produce maximum esthetic harmony and maximum functional integrity.

When two premolars in the lower arch are extracted the arch depth is reduced to a mean of 18.0 mm. with similar deviations contingent on tooth mass and arch form. Ironically, inter-canine width increases are frequently slightly greater in extracted patients.

Step 9: Calculate the resultant position of the lower molar and place it relative to the Occlusal Plane at the appropriate cephalometric arch depth (see Fig. 7-12). In patient L.A. premolar extraction was indicated, and therefore the molar distance from incisal edge was set up at 18.0 mm. Calculate the third molar space on the forecast (see Fig. 7-12A). (In Laurie [L.A.] an impaction was predicted even with extraction.)

The Lower Third Molar

Conditional Factors: The determination of the third molar space was described in Chapter Four. However, for treated patients add the second permanent molar (with the template, and reduced 1.5 mm. from the size of the first molar). The second is placed 2 mm. higher than the first molar. Position the third molar on a curve 2 to 3 mm. above the second molar for a working model if space is available (see Fig. 7-12).

The space for the lower third molar by maturity is measured in two ways. First it can be assessed from Xi Point. A space of 25 mm. Or less from the second molar indicates a guarded prognosis. Anything more is favorable and if it is as low as 20 the molar is usually impacted. It can also be related to a Ramal-occlusal point which is at the occlusal crossing of the external oblique ridge. A percentage odds can be determined from this point. Not uncommonly the third molar will erupt when 50% of the third molar crown is located distal to that ridge. When 5 mm. of space is available from that vantage point, therefore, the prognosis is 50% (see Fig. 4-15). Each one-millimeter difference changes the odds (for space) 10% due to a 10-mm. molar size.[3]

The Upper Incisor

Step10: Calculate the upper incisor relative to the lower. Place the upper incisor at 2 mm. overjet and 2 mm. overbite at a starting ideal 130° relative to the lower in normal morphology (see Fig. 7-12).

Conditional Factors: In treatment planning the upper incisor is placed relative to the target lower. The goal, in good mesofacial patterns, is an Interincisal Angle of 130° by maturity (mesoversion) (see again Chart V).

Short faces (lower face height less than 44°) and those with protrusive dentures may exhibit 120° to 125° angles (proversion). Long faces (lower face height angles at 48° or above) may be as high as 135° to 140° (retroversion).

The ideal overbite and overjet is 2.25 ±0.8 mm. This was found in a normal untreated sample (N=82). Overbite-overjet varies with type, but higher interincisal angles may theoretically contribute to the relapse to deeper bites and **show a suggested correlation with crowding in the lower incisor area. Deep bite even with crowding is prevented by excessive incisal wear.**

The Upper Molar

Step 11: Place the upper molar in a good locked Class I relative to the lower molar unless one-arch tooth loss is experienced or a uniarch extraction is performed (see Fig. 7-12).

Conditional Factors: A review of the literature, and past practices with certain patients, particularly adults, led to upper premolar extraction and leaving a Class II molar condition. Yet when patients treated at younger ages were studied at maturity, space was now available for all the upper molars. With already an excessive forward drift of the upper molar in adult patients, perhaps upper premolar exaction can be justified. However, with Bioprogessive sectional mechanics, and using push coil utility sections and cortical anchorage in the lower, it is amazing how seldom upper extraction only was found necessary.

---

[3] Note: In an oblique direction forward and inward from the external oblique ridge the mean bony space was 7.0 mm. in a study of adult male subjects, which is about 5 mm. with the living soft-tissue situation.

Long-range forecasting in the severe Class II condition may reveal the ultimate space available for the upper third molar from the Pterygoid Vertical plane. The best orthodontic technique to be selected may be directed by the forecast when the operator understands the process.

It will be remembered that the **upper third molar erupts in the absence of maxillary growth and that it erupts backward and outward**. Also it may be five years later than the lower to mature into occlusion, and it is significantly smaller than the second molar.

Extraction Conditions

When extraction of premolars is practiced the typical arch depth in the lower is reduced to 18 mm. ±1.5 mm. as shown in Figure 7-12 (and Figure 8-9 in the next chapter). If **loss of anchorage** and forward movement of the molar ensues **more space should be available** for third molars. Even so, with adequate space available in the VTG the lower third molar may need treatment for uprighting.

The hard tissue VTG is now completed. The forecast for L.A., in actual size, is demonstrated in Figure 7-13.

* * * * *

SOFT TISSUE FORECASTING

The soft tissue is forecasted by using certain profile hard tissue references. These are Nasion, Anterior nasal spine, the teeth, and the outline of the symphysis. The procedure starts with the nose followed by the upper lip, lower lip and chin. For patient L.A. the VTG result is shown (Fig. 7-13). In addition, the four-position analysis of the forecast is presented. However, for a presentation of the step-by-step procedure all the way in a straight VTG construction the soft tissued is covered in the male patient N.N. (for a five-year experience).

A Detailed Male Forecast with Treatment Goals Built In

Nicholas was a Class II deep bite and is used to demonstrate forecasting techniques. The series is shown, starting with Figure 7-14. A minimum matrix tracing may make it easier for the student to comprehend (Fig. 7-14A). The tracing is without numbers. The patient N.N. was treated with cervical headgear, utility arches, and elastics and sectional mechanics, and finished with straight wire.

The forecasting procedure is divided into five stages: [1] mandible (arc), [2]

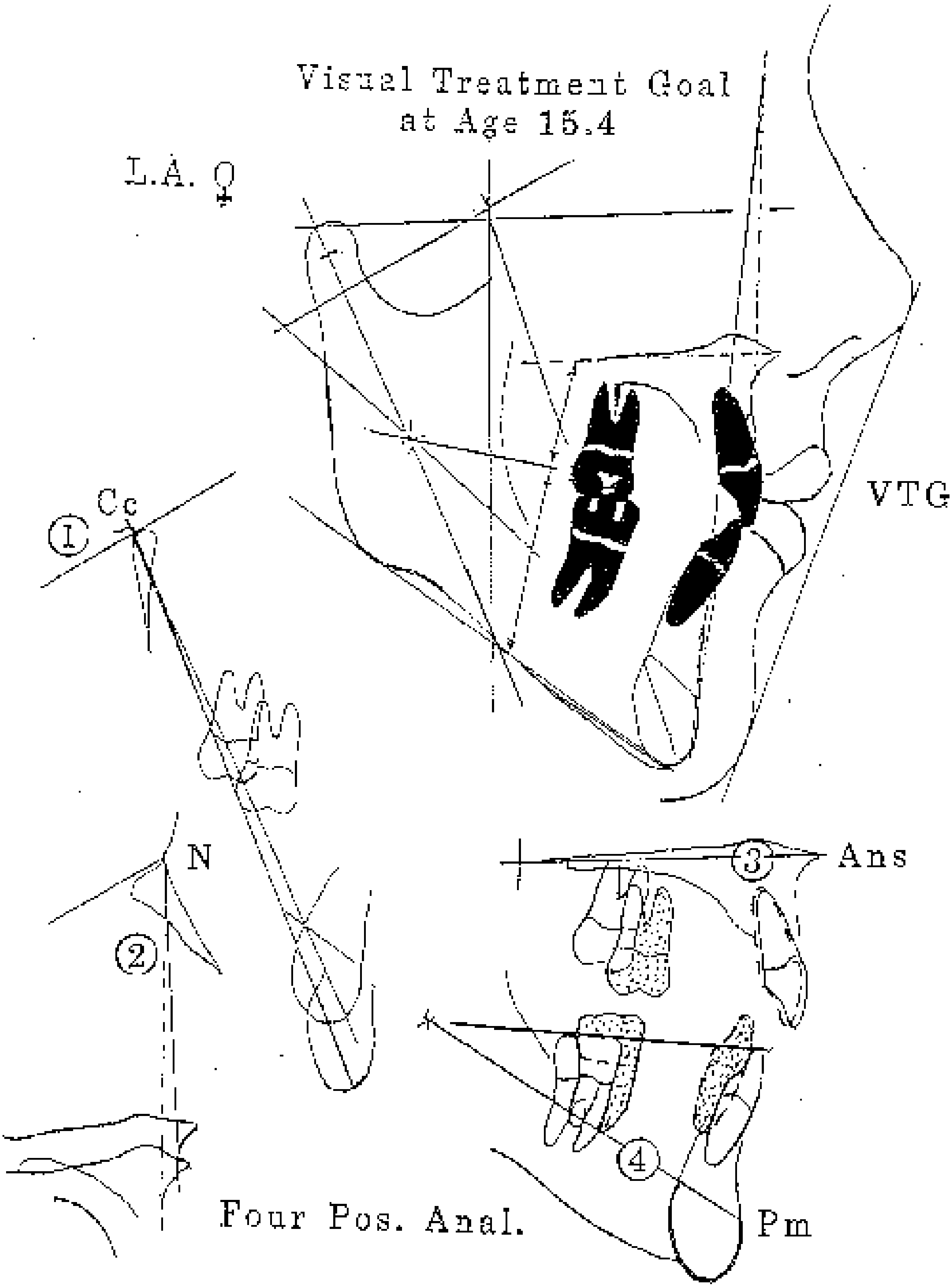


Fig. 7-13 The finalized VTG on patient L.A. to age 15.4. The four position analysis of the VTG (1) for the chin behavior, (2) for the maxilla, (3) for the upper teeth, (4) for the lower teeth. Note forward movement of molar permitted with extraction.

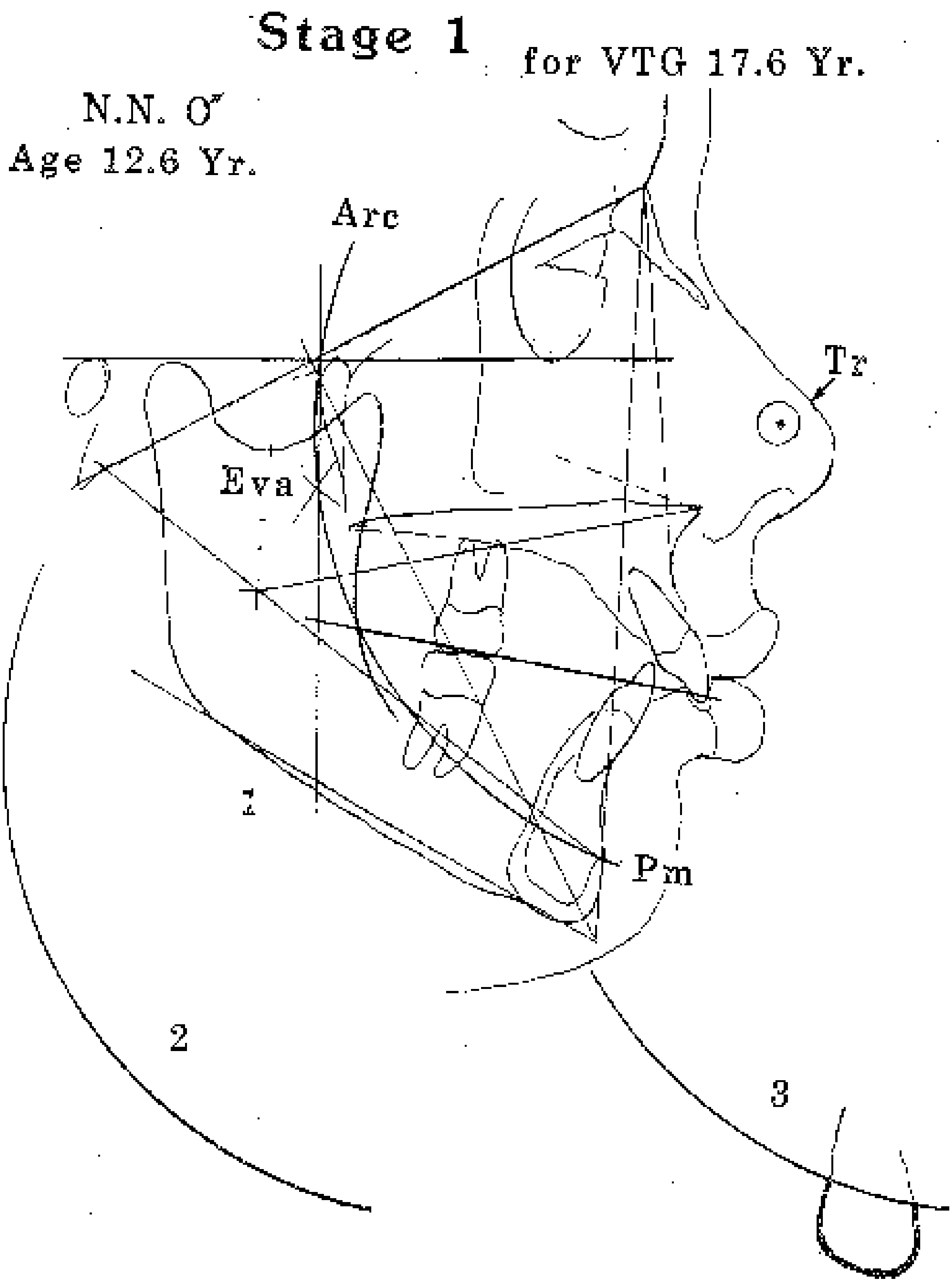


Fig. 7-14A *Step 1:* Minimum tracing and line Tr is point of True radius from Eva to Pm.
Step 2: Arc on separate sheet.
Step 3: Addition to symphysis (in male).

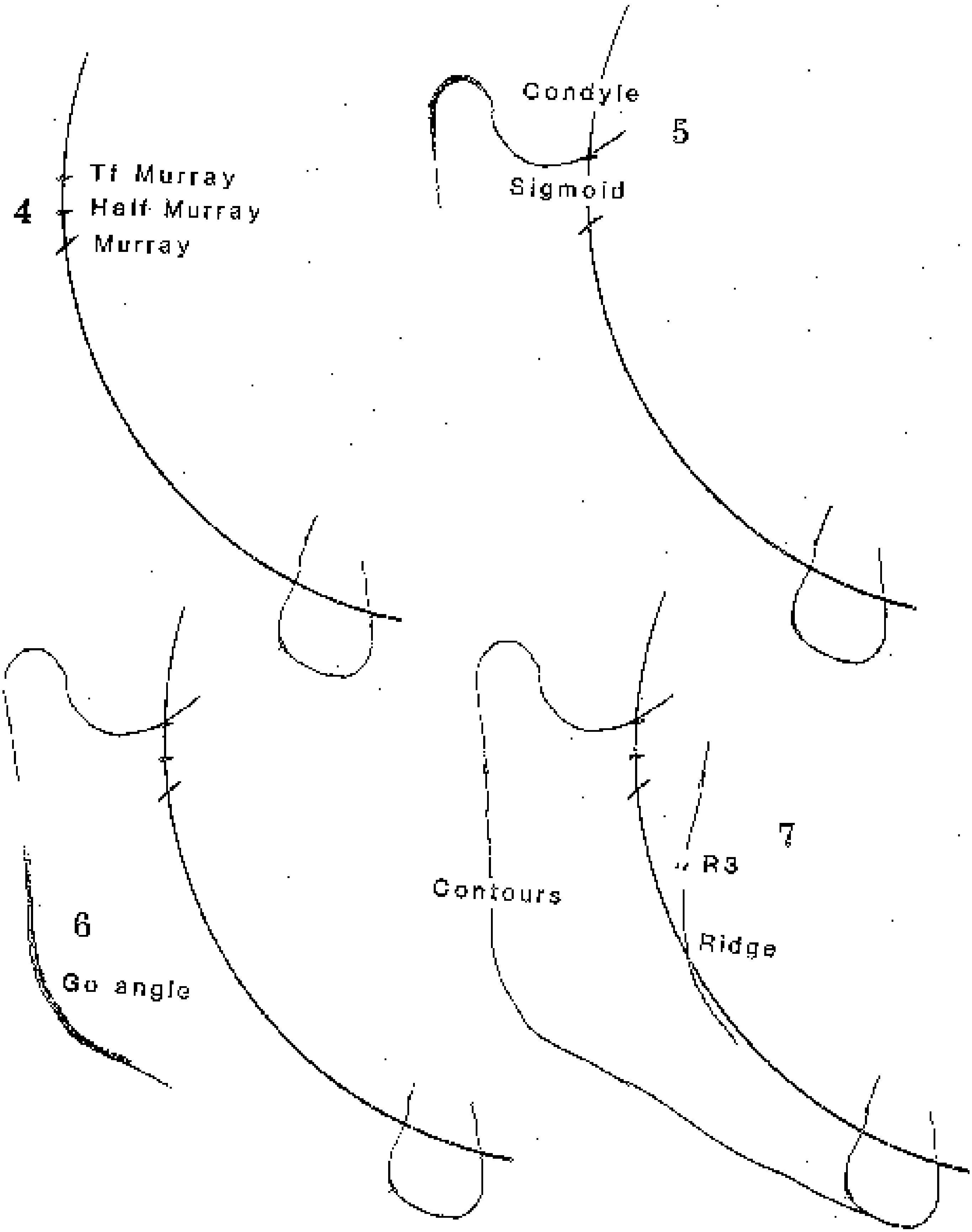


Fig. 7-14B *Step 4:* Calculation for growth on arc 2.5 mm. per year.
Step 5: Sigmoid notch and corrective condyle added.
Step 6: Gonial angle braced in males (except flat ones).
Step 7: External oblique ridge.

the craniomandibular matrix, [3] the maxilla, [4] the teeth, and [5] the soft tissue.

There are essentially about thirty steps in the sequence. Each is numbered, and the description is attempted on the illustrations. Unfortunately, the last headplate taken was at age 17.6, not to a 19-year-old maturity. The four next steps are seen in Figure 14-B. Figure 7-15A shows the processes for extension of the cranial and facial planes. **The most difficult part is the match of the mandible to the cranium (Fig. 7-15B).**

The result and effect of maxillo-mandibular changes are shown in Figures 7-15C and 7-15D.

The processing for maxillary growth and orthopedic change is seen in Figure 7-16.

The teeth set-ups are exhibited in Figure 7-17.

In Figure 7-18 the soft-tissue forecast is demonstrated in eleven moves.

The final Visualized Treatment Goal is shown on Figure 7-19.

The final tracing made at age 17.6 years shows the third molars erupting as predicted. The comparison of the execution to the VTG is shown in Figure 7-20.

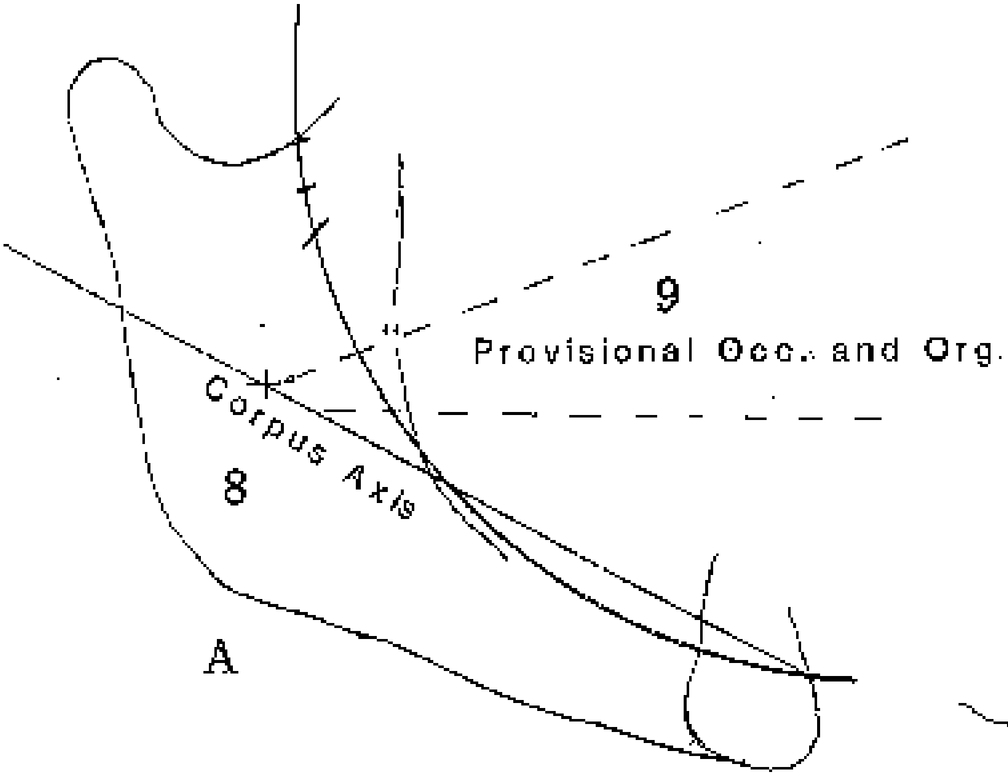
Soft Tissue Forecasting With Treatment

Discussion:

If not guarded against, rapid treatment with the full bracketed techniques with straight wire levelling and intraoral elastic traction may produce a protrusive denture. Also, the lower face height may be dramatically increased by inordinate mandibular autorotation. **Both these factors produce increased lip strain** and unattractive lower faces.

Severe lower facial height (Ans to Menton) increases during treatment, therefore producing a need for mentalis activation for the attainment of a lip seal for speech and deglutition. The soft tissue chin may in this event appear to be reduced in appearance. Such results led in the past to the practice of frequent premolar extraction.

During therapy following premolar extraction, efforts were made in many techniques to move the lower incisor lingually. The goal was to create a recess at the Point B area. This was practiced in order to produce a prominent chin



Stage 2

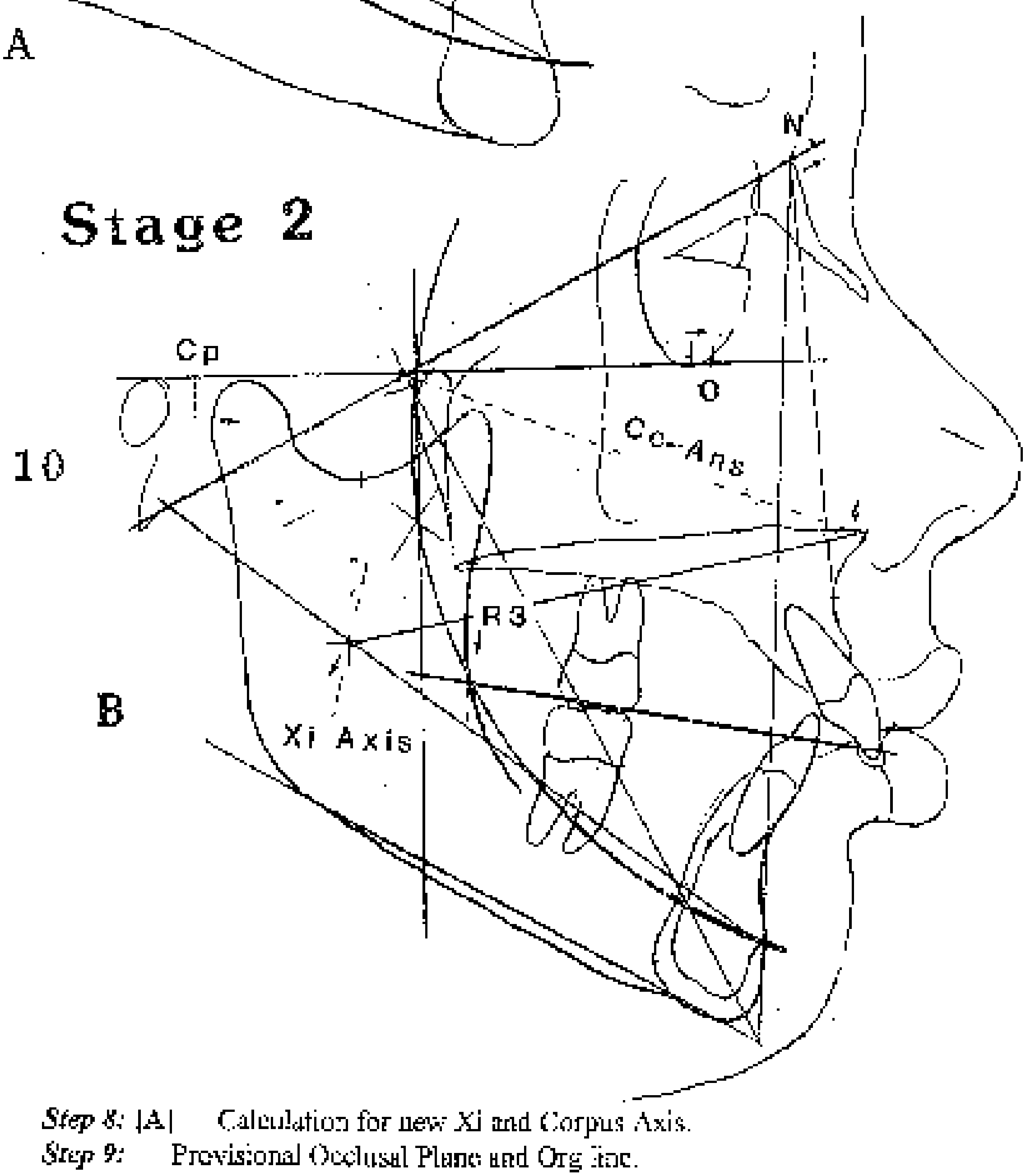


Fig. 7-15A *Step 8:* [A] Calculation for new Xi and Corpus Axis.
Step 9: Provisional Occlusal Plane and Org line.
Step 10: [B] Forecasts of Cranial and Facial Matrix: Condyle (Cp), Nasion (N), Maxillary height (Co-Ans), Xi Axis, Anterior ramal (R3).

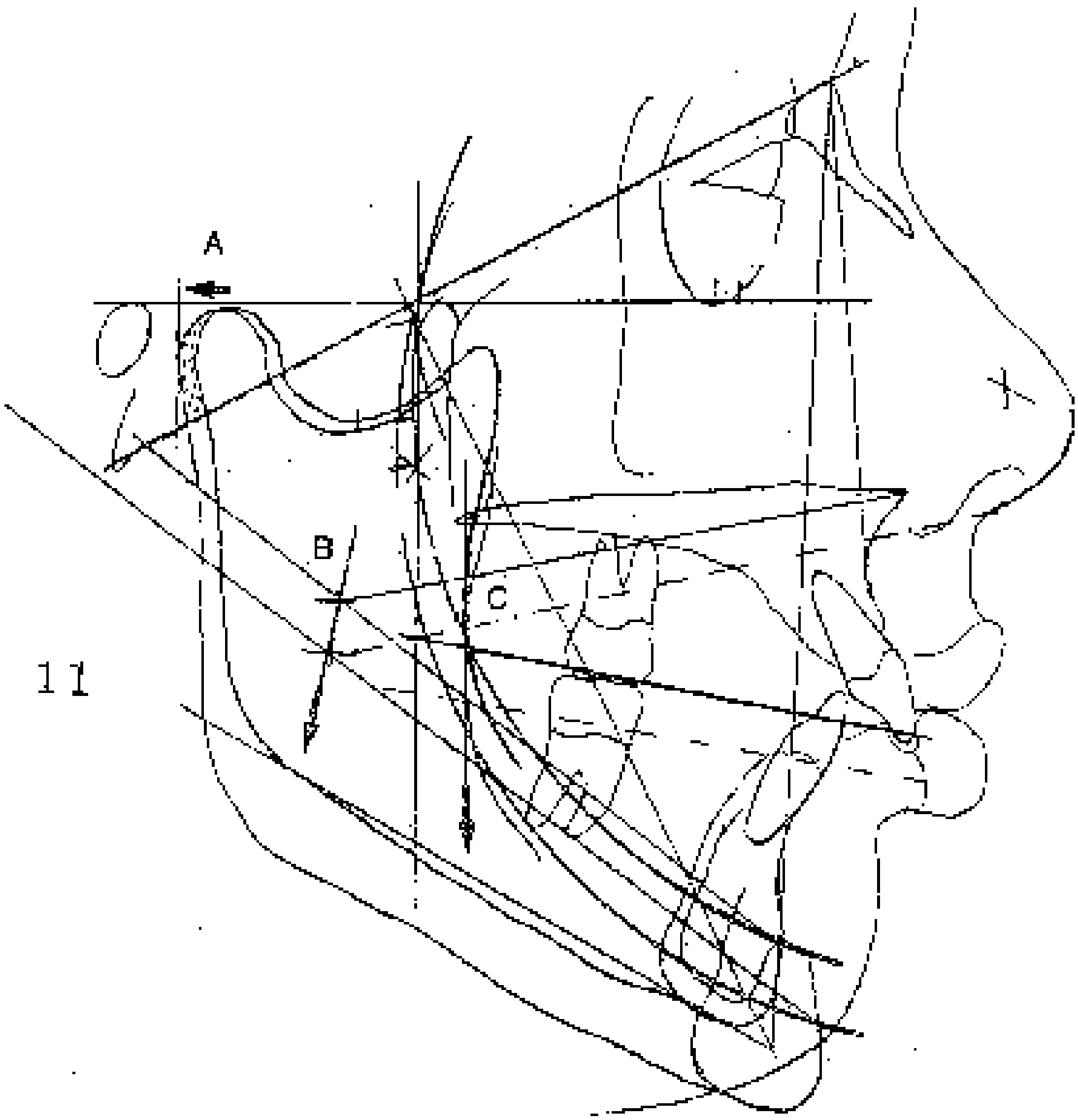


Fig 7-15B *Step 11:* The forecasted mandible as seen in Fig. 7-15A is adjusted to the matrix seen in Fig. 7-15B.

A. The condyle is moved posteriorly to the new Cp position and maintained on the Frankfort Plane unless displacement was detected at 0.5 mm.± per year.

B. The tendency is that the Xi Axis from original Cc will remain stable.

C. The R3 or Rr will tend to move directly vertically.

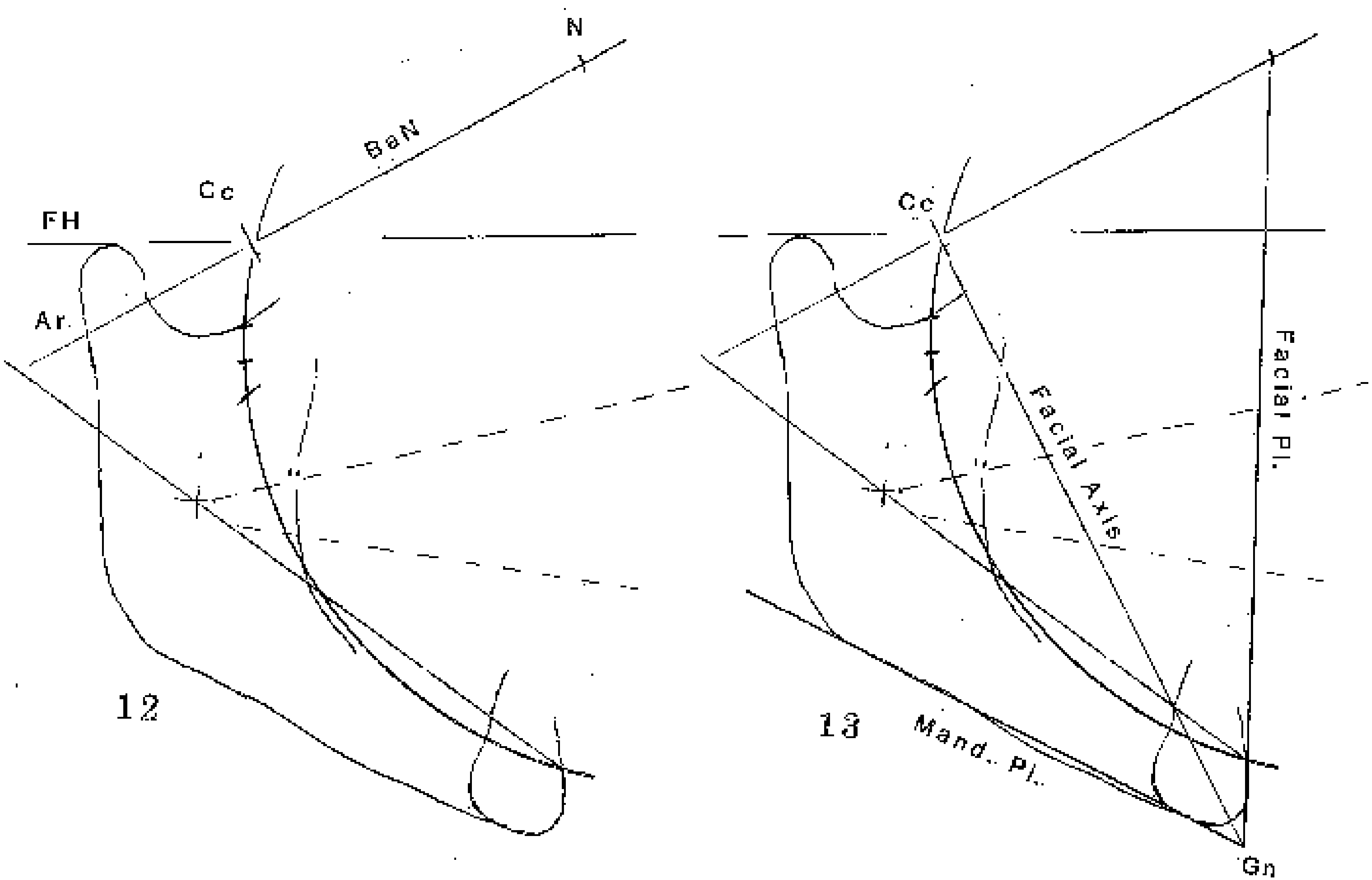


Fig. 7-15C *Step 12:* Copy the Frankfort Plane and BaN Plane. Calculate Cc and N points from Articulare (Ar).
Step 13: Construct the Facial Plane, the mandibular plane, and draw the Facial Axis (Cc to Gn). The cranio-mandibular arrangement now is forecasted.

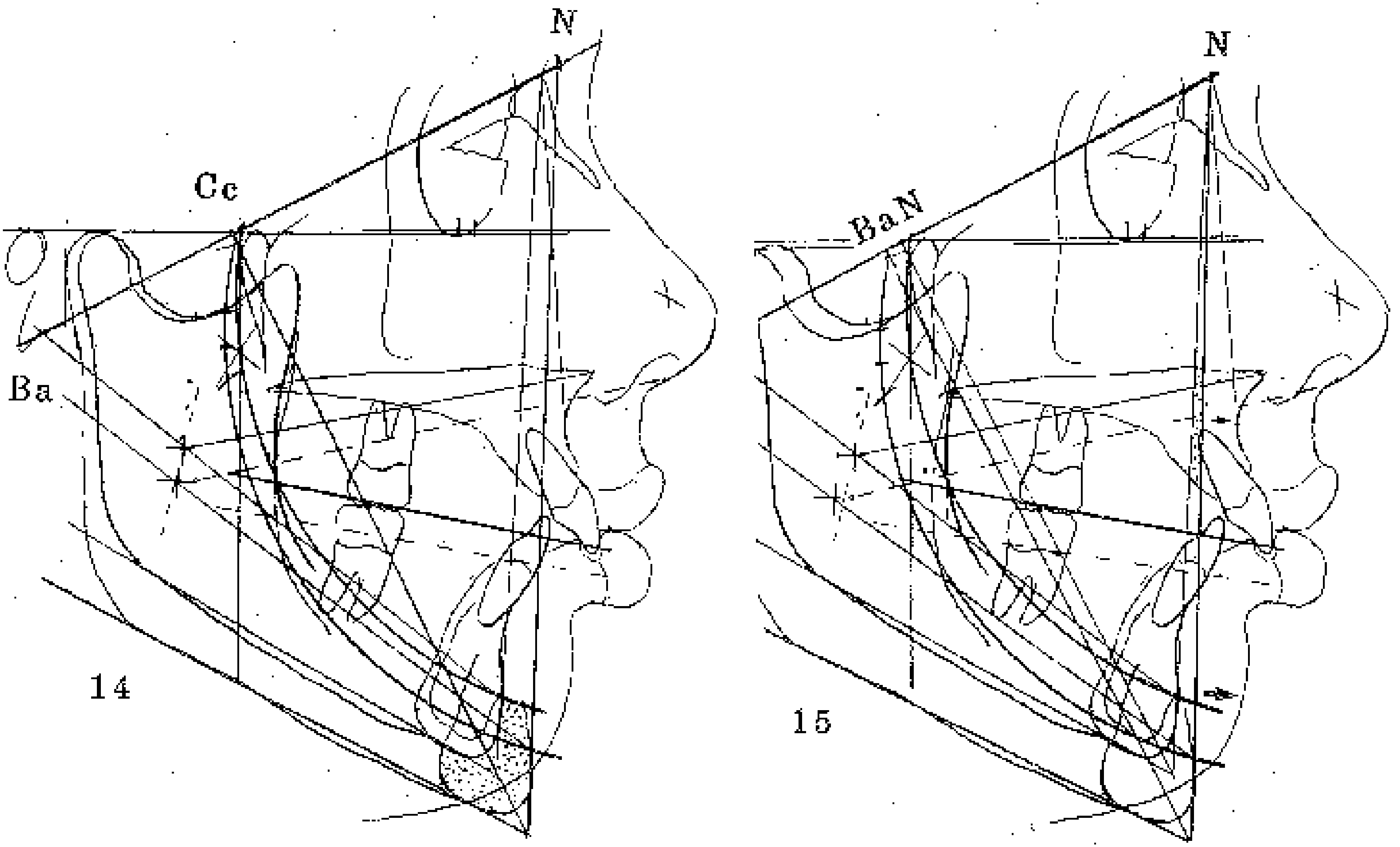


Fig. 7-15D *Step 14:* Resultant view of forecast for chin (dotted) on Facial Axis on BaN at Cc
Step 15: Superimposed Forecast at Nasion shows forward swing of chin reducing the convexity 1.5 mm naturally (dotted change at level of Point A)

Stage 3

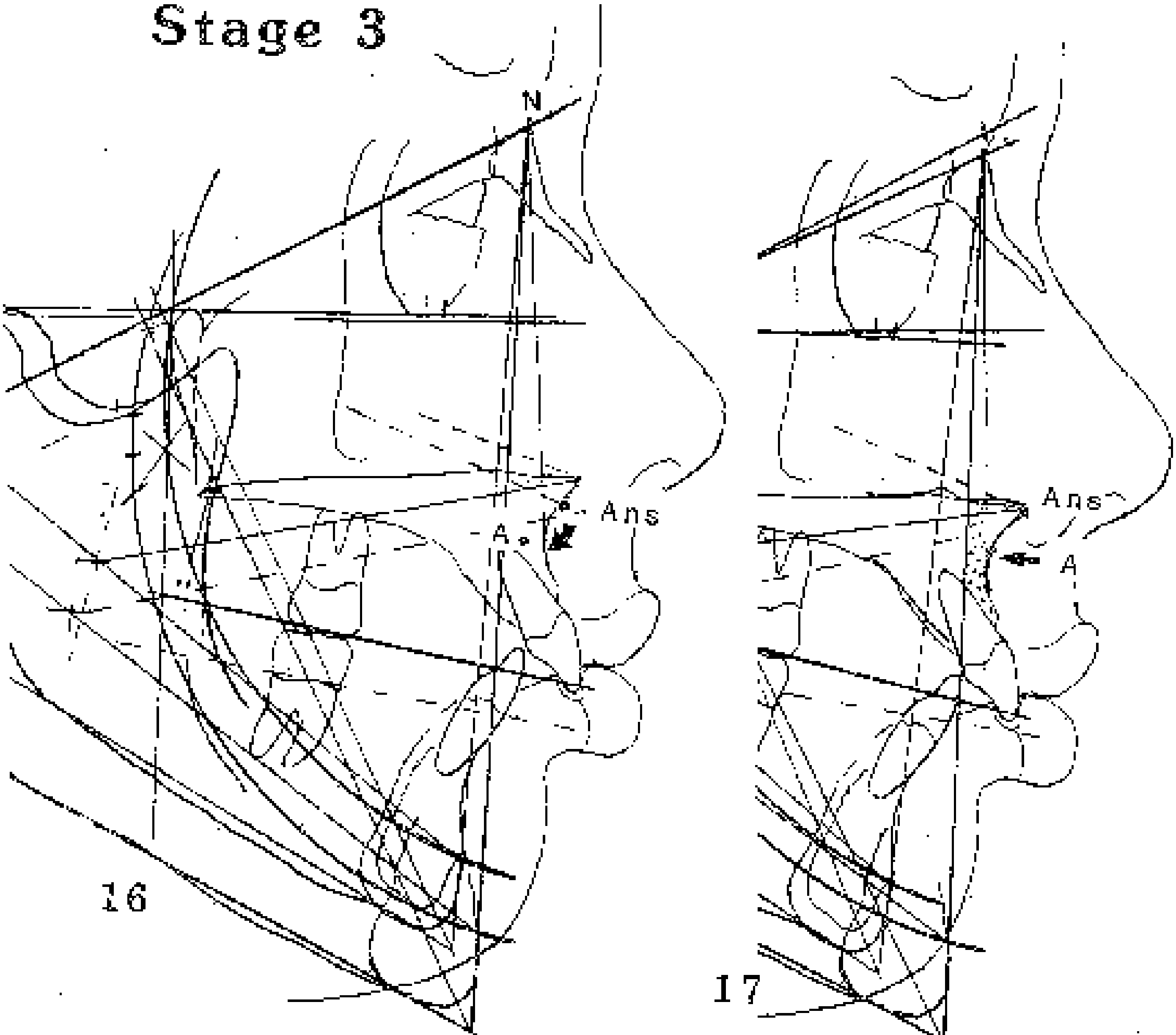


Fig. 7-16 *Step 16:* Superimposed at N for objectivizing Point A and Ans. The natural opening of the N-Co-Ans angle is 0.5° per year. Additional changes up to 6° have been demonstrated with cervical traction. Dots represent treatment goal by age 17.6 years.

Step 17: The reduction of the convexity to 3.0 mm. This was to be produced by orthopedics plus natural forward growth of the chin seen in Fig. 7-15.

Stage 4

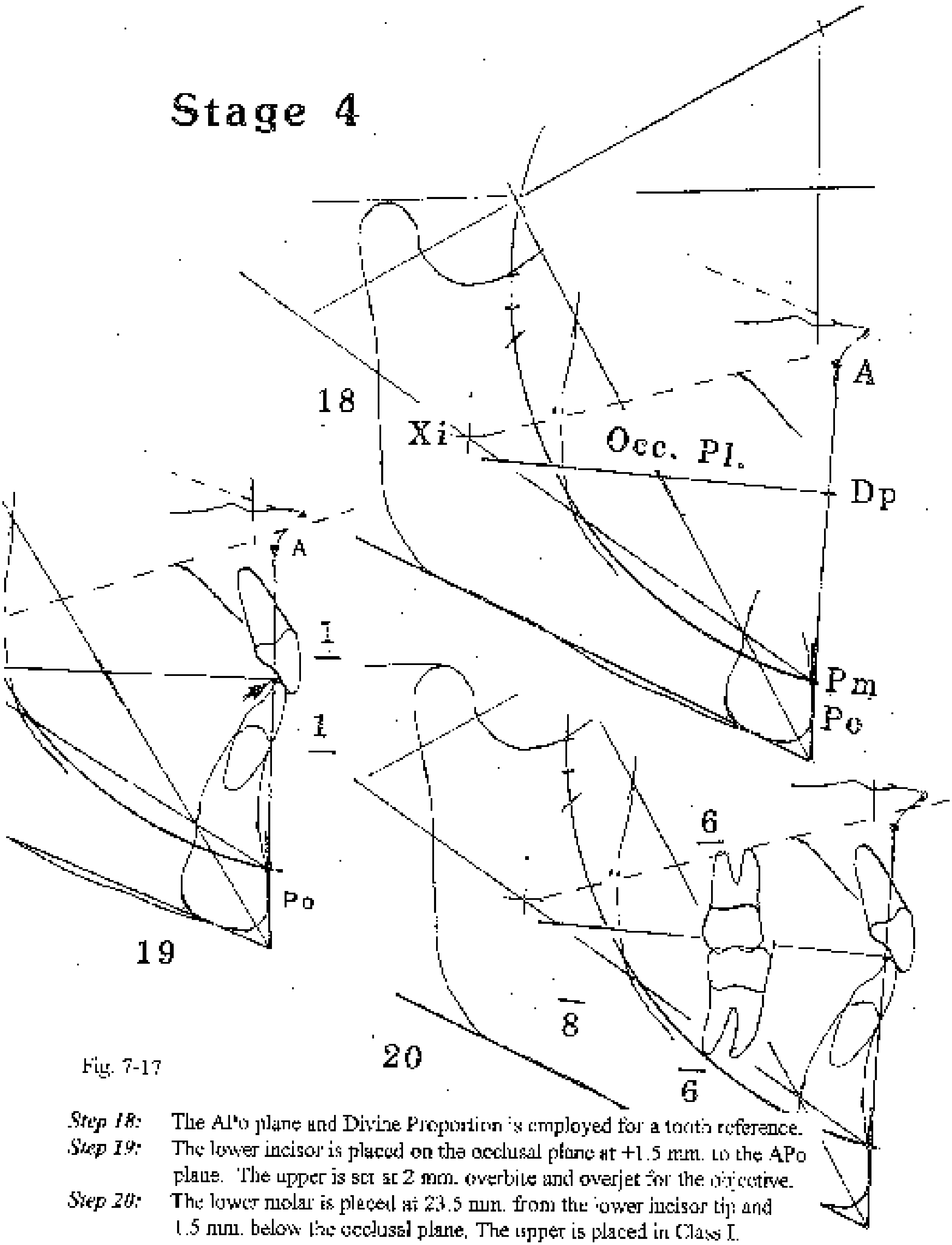


Fig. 7-17

Step 18: The APo plane and Divine Proportion is employed for a tooth reference.

Step 19: The lower incisor is placed on the occlusal plane at +1.5 mm. to the APo plane. The upper is set at 2 mm. overbite and overjet for the objective.

Step 20: The lower molar is placed at 23.5 mm. from the lower incisor tip and 1.5 mm. below the occlusal plane. The upper is placed in Class I.

Stage 5

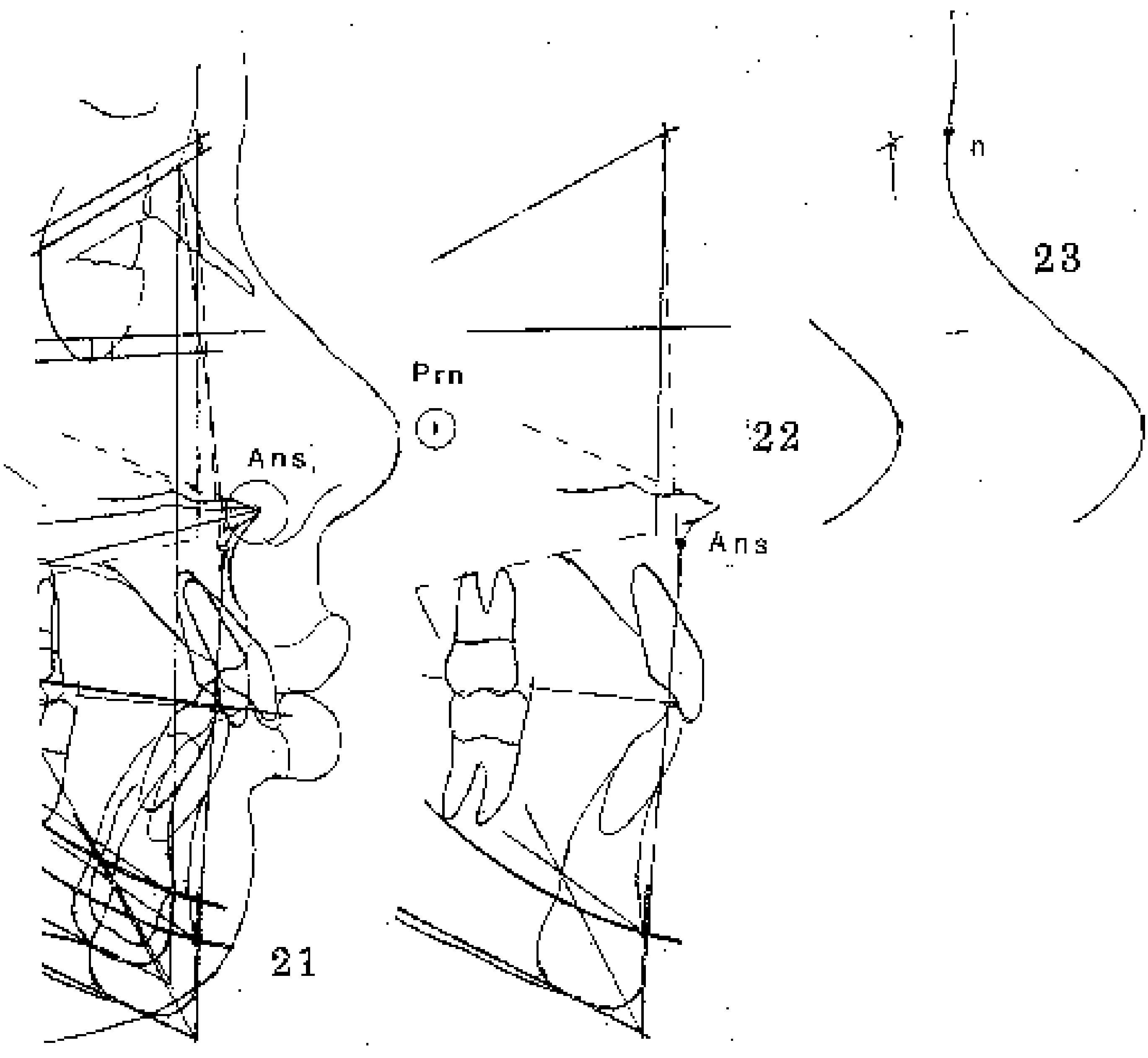


Fig. 7-18A *Step 21:* The nose tip (Prn) is predicted from the anterior nasal spine (Ans) to grow directly forward 1.0 mm. per year. Note dot in circle. Keep org lines parallel.
Step 22: Shift forward and copy nose tip about 2 cm. in both directions.
Step 23: Fill out contour of the upper nose to soft tissue Nasion (n).

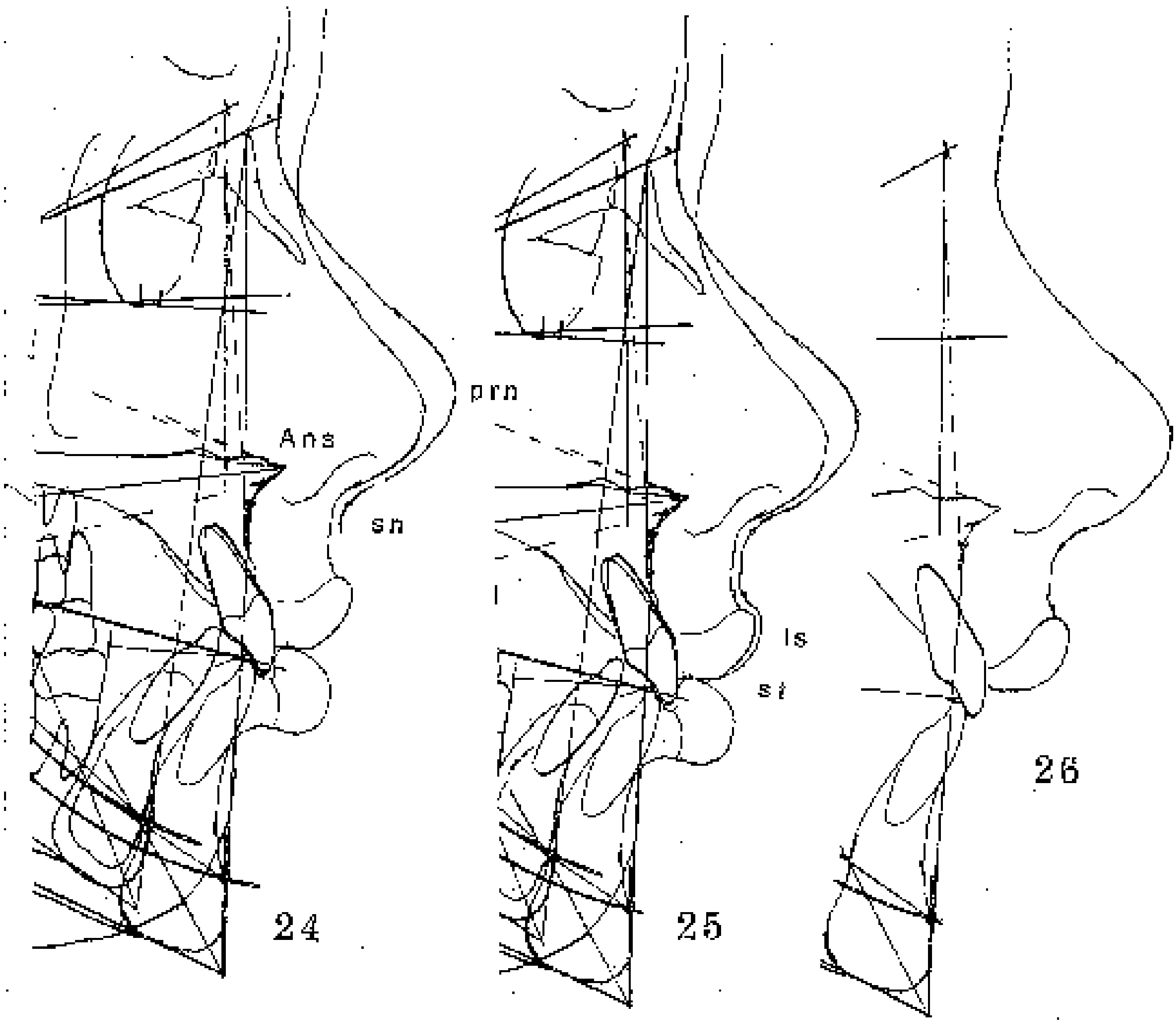


Fig. 7-18B *Step 24:* Subnasali moves downward and forward 0,35 mm. per year from lower Curve of anterior nasal spine.
Step 25: The upper lip, over time, thickens 0,2 mm. per year.
Step 26: The upper soft tissue is shown.

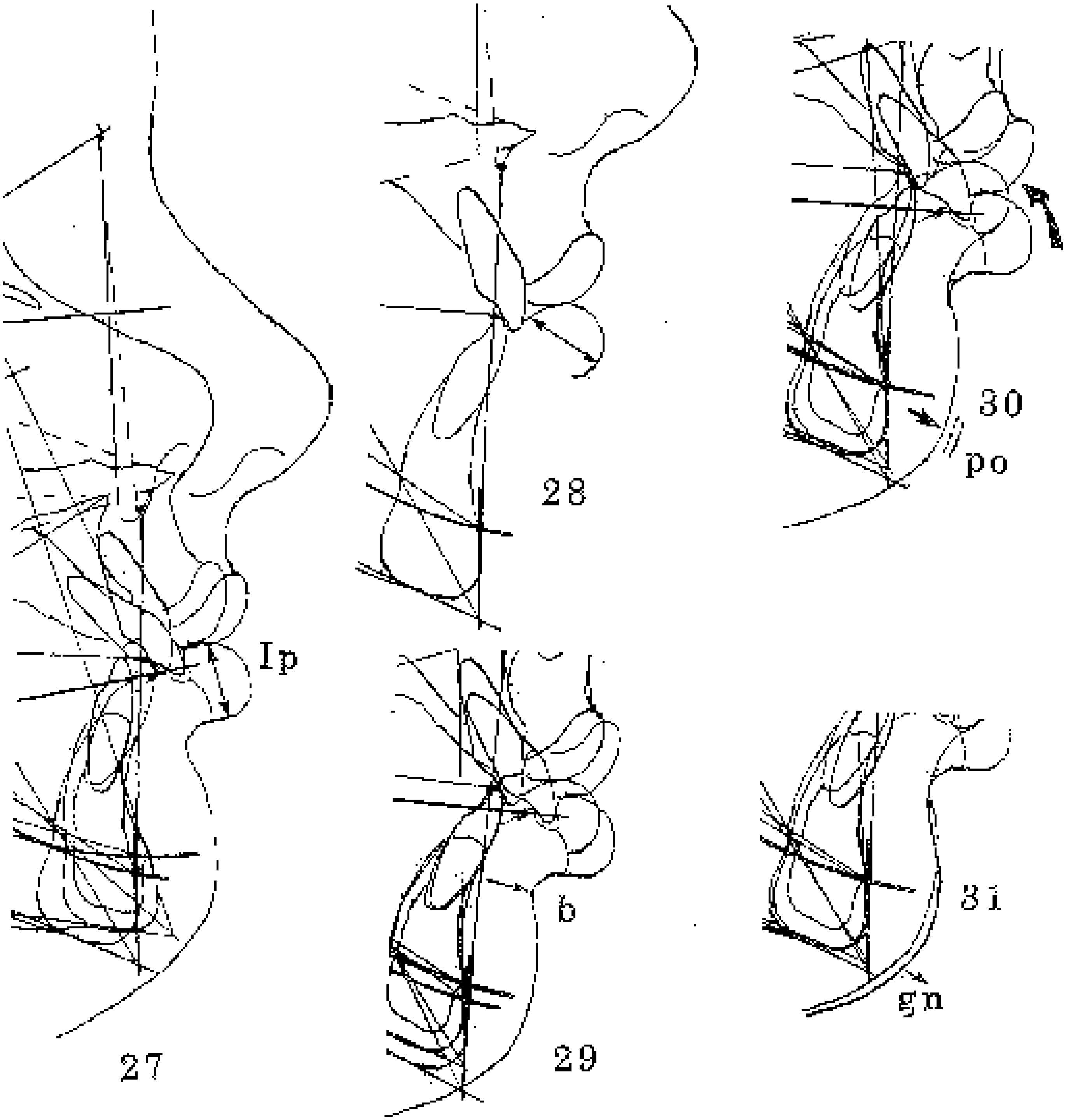


Fig. 7-18C **_Step 27:_** Interincisal point is at the bisection of the overbite-overjet. Superimpose T1 and If on that point which rotates T1 backward to uncurl the lower lip. Note the change in direction of the lower lip at arrows.

Step 28: Note the change in lip position.

Step 29: Superimpose on B Point which changes very little.

Step 30: Two factors for calculation: chin drop and growth.

Step 31: Add to chin 0.2 mm. - 0.25 mm. per year.

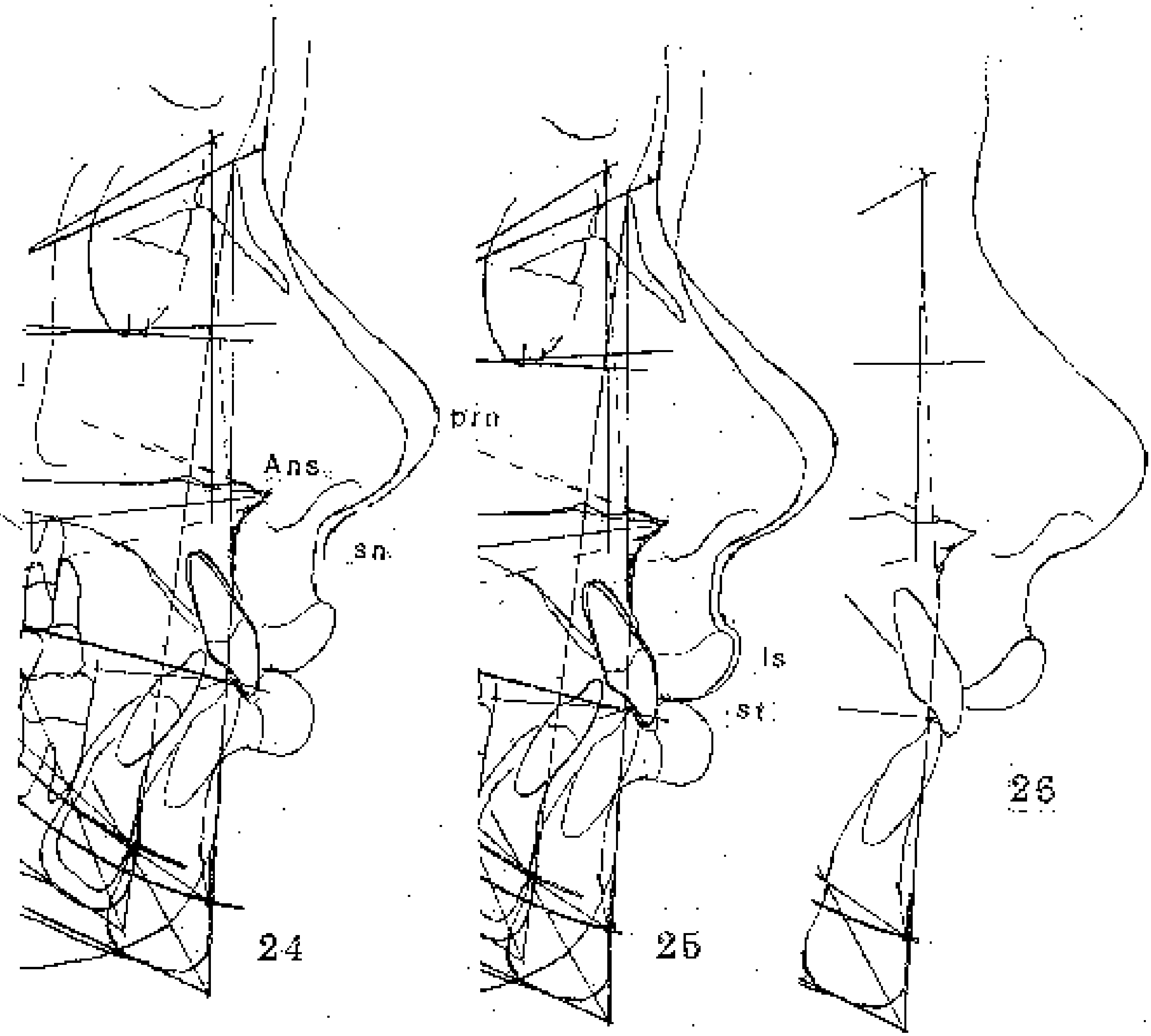


Fig. 7-18B *Step 24:* Subnasali moves downward and forward 0.35 mm. per year from lower Curve of anterior nasal spine.
Step 25: The upper lip, over time, thickens 0.2 mm. per year.
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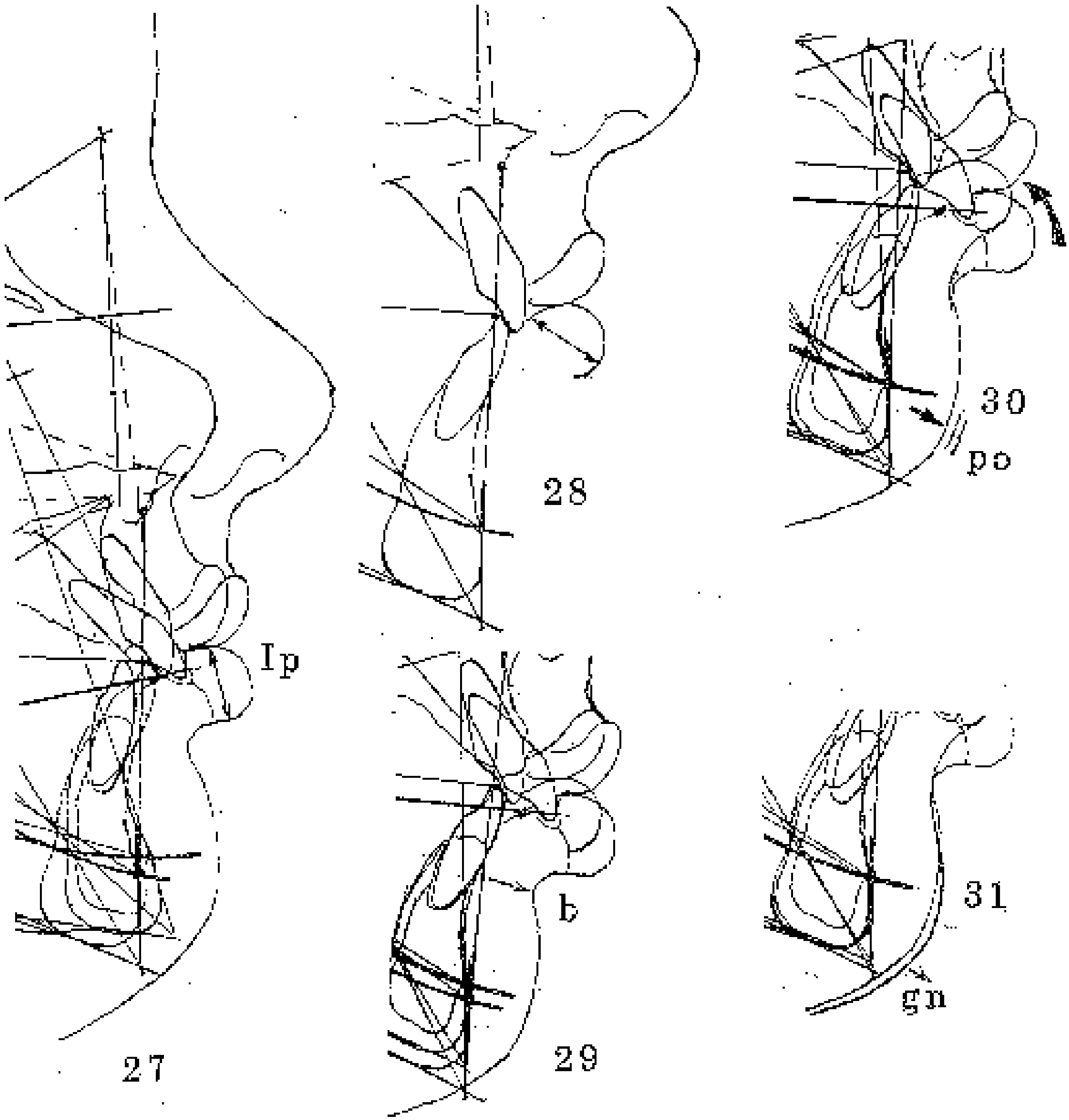

Fig. 7-18C *Step 27:* Interincisal point is at the bisection of the overbite-overjet. Superimpose T1 and Tf on that point which rotates T1 backward to uncurl the lower lip. Note the change in direction of the lower lip at arrows.

Step 28: Note the change in lip position.

Step 29: Superimpose on B Point which changes very little.

Step 30: Two factors for calculation: chin drop and growth.

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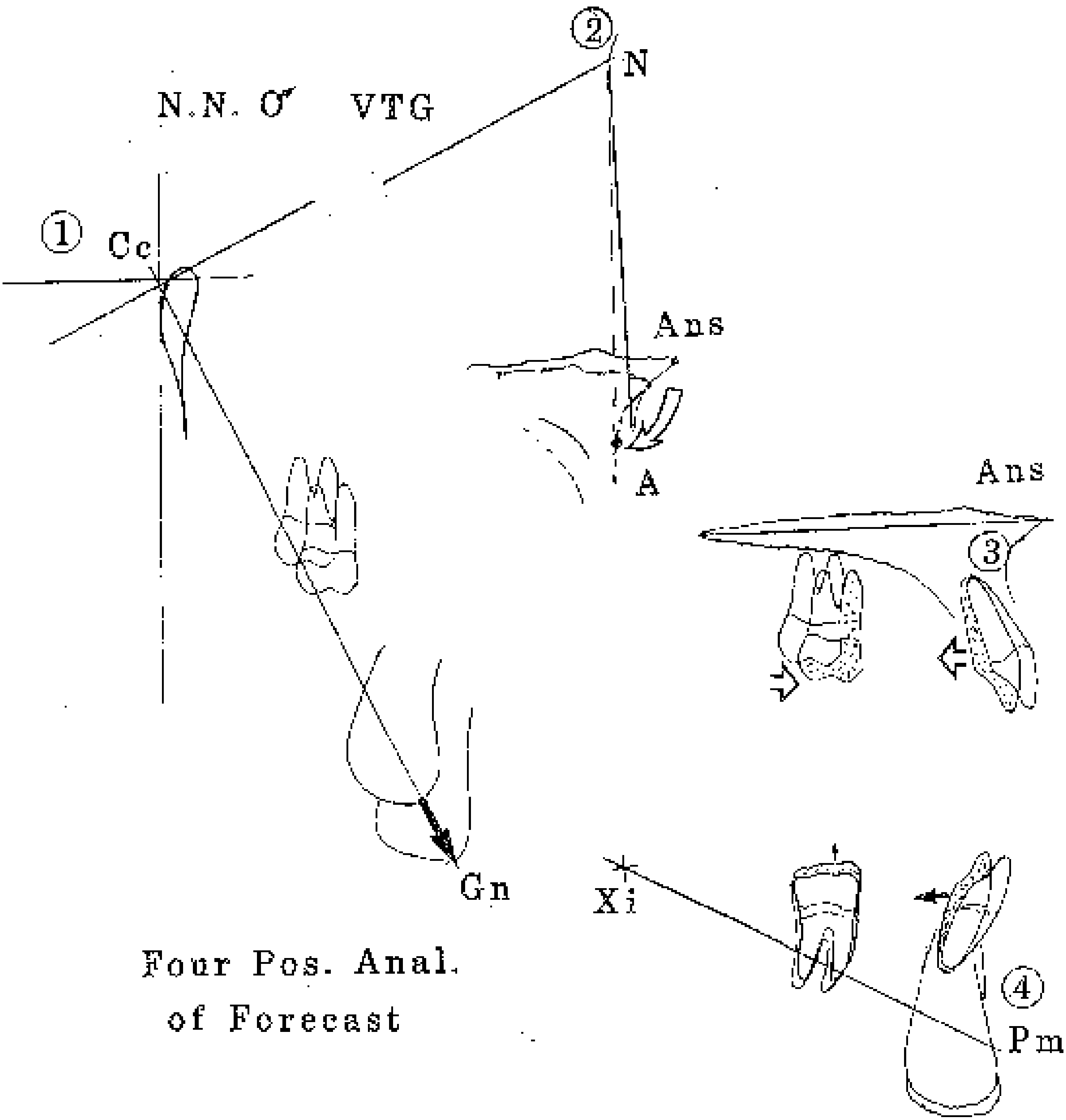


Fig. 7-20B Four Position Analysis of the long-range forecast with treatment: (1) Chin; (2) Mid-face reduction; (3) Retraction of upper incisors; (4) Lingual movement of lower incisors, molar stabilization.

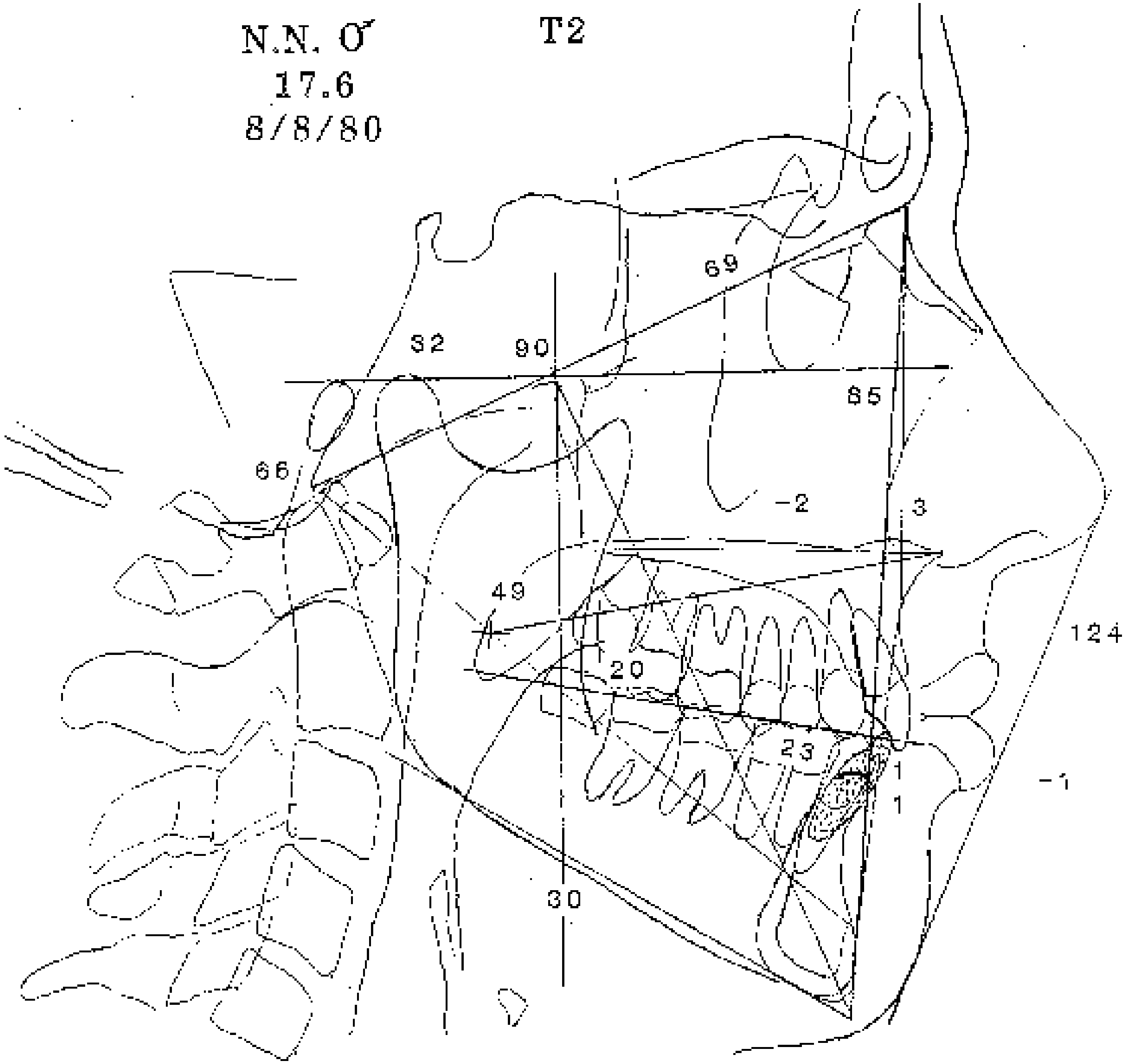


Fig. 7-20C The final actual tracing (T2) for Nicholas five years later. Note the ideal position of the lower incisor and an arch depth of 23 mm. Note the original 90° Facial Axis still exists despite cervical traction for the arch correction. Note in Chapter Eight that at the first stage it was opened 2° but later closed.

Technique for Profile Soft Tissue with Treatment

The predicted soft tissues can be based on the forecast without treatment seen in Figure 7-7. The male N.N. will be employed for the demonstration of steps planned so that tooth changes can be correlated with the forecast in one procedure (see Figures 7-14 to 7-19).

[Note: *Steps 1-20* will be found in the legends for Figures 7-14A through 7-17.]

The Nose

Step 21: Predict the nose tip from the Ans with treatment the same as without treatment (with the Org line parallel at Ans). The predicted Ans will change with Pn (nose tip). The tip is moved 1.0 mm. per year. Place a mark for Pn (Fig. 7-18A).

Note: The nose tip is sometimes pulled downward slightly with upper lip strain and when this is released the nose tip will elevate somewhat. However, the palate with Ans will also be affected.

Step 22: Shift the forecast backward and copy the nose contour.

Step 23: Connect the nose tip to the tissue over the nasal bone from above and extend upward to the Nasion area (see Fig. 7-16A).

Note: The upper one-half of the nose (the nasal bones) will also be affected by maxillary orthopedics. Normal nose growth in the absence of treatment is concentric (see Figs. 5-1 and 5-2). However, from the effects of productive maxillary orthopedic change the contour of the nose will "cross over" the contour of the original outline in Class II. The nose will become more forward in Class III with orthopedic treatment.

The Upper Lip

Step 24: Mark a point for the subnasali area downward and forward from the curve of the nasal spine, the same as for normal growth (0.35 mm. per year). Fill in the lip area anterior to the incisor root (see Fig. 7-18-B).

Conditional Factors: When upper lip strain is witnessed the subnasali point is pulled downward 1 to 2 mm. during lip closure. With treatment, and with subsequent release of strain, it becomes elevated to a normal location.

Stomion position is produced mostly by lip length or conditions of strain of the upper lip. The "smile line" is also a particular consideration for establishing Stomion.

Step 25: Forecast the thickness increase of the upper lip (ls) by adding 0.2 mm. per year in long range (see **Fig.** 7-18B).

Conditional Factors: The short-range prediction of the upper lip thickness with treatment is contingent on the amount of movement of the upper incisor. In a protrusive state of the upper incisor, the lip will be thinned as it is stretched in function. **When the incisor is reduced in short range the lip will thicken in a working hypothesis of a ratio of 1 mm. for each 3 mm. of incisor retraction.** Thus, a 9 mm. retraction will witness a 3 mm. increase in the lip, as seen from the closed mouth position. However, during **retention readaptation occurs.** The lip tends to establish a normal thickness and contour within four to five years.

Step 26: The upper lips (ls), stomion (st), and nose (pm) are now revealed (see Fig. 7-18B).

The **Lower Lip**

Step 27: (1) Superimpose the original on the **Interincisal** Point and the Interincisal Point of the forecasted corrected condition (as in Class II, Division 1) (Fig. 7-18-C).
(2) Copy the thickness of the lip at the downward and forward cut.

(3) Add 0.2 mm. per year to that lower lip thickness for growth change.

Conditional Factors: This step is perhaps the most difficult for clinicians to perceive. During treatment of Class II, Division 1, the lower lip is reversed from under the upper incisor to a position above and anterior to the tip of the upper incisor. The **placement of the upper incisor** thus affects **the outcome of the lower lip.**

As the lower incisor is moved forward the sublabial area is affected. The best way to learn this behavior is to study good tracings of many patients before and after treatment.

Step 28: The lower lip is now revealed.

Step 29: (1) Copy the original thickness of the sublabial furrow area (soft tissue B)

(2) Add 0.1 to 0.15 mm. per year to the thickness (see Fig. 7-18C).

Conditional Factors: Depending upon the amount of protrusion reduction and the amount of mandibular growth behavior the soft tissue at Point B sublabially will **move up or down**. Ideally, in conditions with a severe sublabial contraction, the teeth may be moved forward to help release the need for mentalis adaptation. Either lip stretching exercises or **quadratus inferioris-inciscvus-transversaris** surgery may be employed. **This** area is remarkably influenced by positions of the lower incisor due to the small amount of growth change in integumental thickness at sublabiales.

The Chin

Step 30: Recontour the chin as forecasted with the proposed treatment, and add 0.20 mm. per year to soft tissue pogonion for females and 0.25 mm. for males.

Step 31: The contours of the chin are now completed (see Fig. 7-18C).

Conditional Factors:

If the denture height (Ans-Xi-Pm) has been increased, lip strain may be increased as well. The soft tissue chin contour will therefore not improve. Also, if greater dental protrusions are produced the **chin will** remain elevated for purposes of lip closure. However, if denture height is maintained or **reduced,** and a protrusion is reduced, the soft tissue chin contour will drop down and be more evenly distributed. **Prediction of chin change is contingent, therefore, on treatment success.** Refer to results of the two patients.

It is common to witness residual mentalis elevation of the chin even after successful treatment. Physiotherapeutic assistance here is not to be ignored.

* * * * *

The **Complete VTG** Forecast (Figs. 7-19-A, 7-19-B, 7-19C and Figs. 7-20-A, 7-20-B, and 7-20-C)

The nose, as described, is predicted from the anterior nasal spine, as influenced by (1) natural growth and (2) changes produced by treatment. The soft-tissue chin is positioned and increased by the amounts described. This becomes the reference points for the **Esthetic line**.

The more difficult part, for the soft tissue forecast, is the prediction for the submasali and Stomion. The release of mentalis function for releasing of the mentalis of the chin is also difficult. Total response to treatment may take months or years.

* * * * *

Making the Sale

Complete renderings, or images, made in long range, provide something tangible to show a patient (see Fig. 7-19 and Fig. 7-20). Such imaging, when done well, can help dramatically with communication to the patient. But, of greater significance, it also indicates to the orthodontist the steps that will be required for the production of the beautiful face and ultimate smile. The analysis of the forecast and a prospective mechanical treatment regime are described in Chapter Eight.

Success with the procedure is a tremendous confidence-builder to both doctor and patient. The rewards do justify the effort.

* * * * *

The Dilemma -- Mechanical Objectives and Growth Superimposed

As stressed before, the natural growth matrix is the starting base for both the VTO and the VTG. But the resulting effects on the matrix of the mechanics to produce the objective, such as that for needed skeletal change or for tooth movements, are then superimposed over that natural growth expression. The mechanical changes required for execution of a plan are thus made evident.

The "cephalometric setup" (VTO or VTG) means adding the effects of mandibular physiologic rotation resulting from arch levelling, the additional use of elastics, or the proven behavior from a specific modality employed for arch and bite correction. In long range (VTG) the forecast becomes further a matter of anticipation of rebound.

In other words, the prediction of the ultimate chin position becomes the principal target. It is the product of normal growth plus the influence of the method employed for bite management and the effects of a particular mode of traction for the maxillo-mandibular arch and the skeletal correction.

The Processes with the Cybernetic Circle

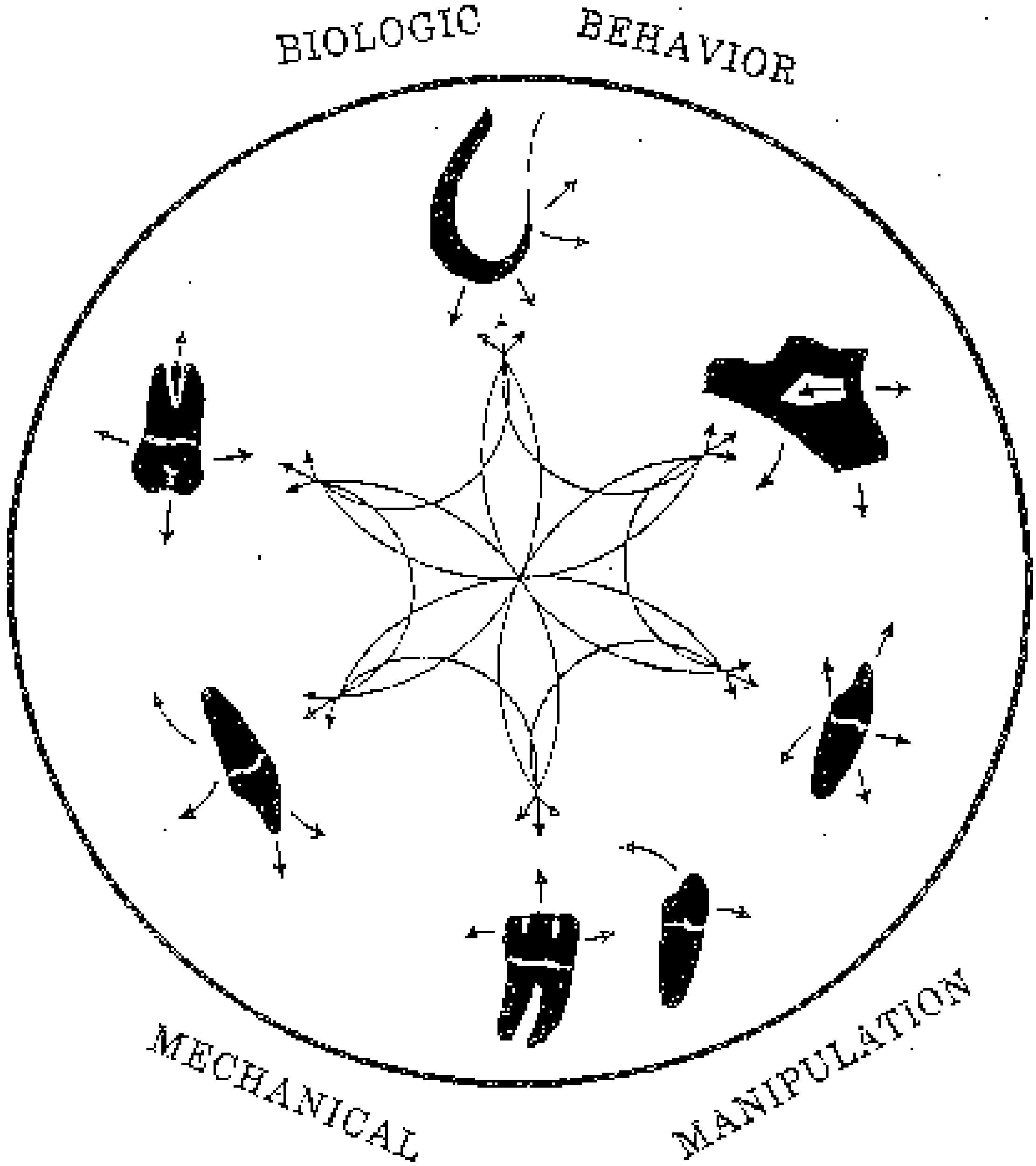
As the whole process in a logical sequence was recognized it was programmed for the computer. There arose the working of cybernetic feedback as a process in the VTO construction. This was explained and exhibited by the construction of a six-factored cybernetic circle. It is such an important concept that it needs to be reviewed again (Fig. 7-21).

Factor 1: The position of the chin became the first point of reference (Fig. 7-21). The chin is influenced by desired orthopedic changes taken into account in the mid-face. This was determined after growth of the mandible was accounted for. The "feedback" for the chin could relate to tipping, bodily movement or intrusion of the upper anterior teeth. In turn, these could affect the planning of the skeletal alteration of the palatal plane and Point A. Three planning processes are therefore involved. The first is the planning of objectives. The second is the planning of the mechanics to satisfy those objectives. The third may be to simply anticipate the results of a standardized clinical technique.

Factor 2: The second in the sequence involves the planning of maxillary orthopedics for the reduction of severe convexity or concavity of the face. It is further concerned with the correction of open bite. This step constitutes a significant contribution to the clinician's comprehension of orthopedic-orthodontics.

The mechanics needed for skeletal corrections in young patients is scrutinized. If the mandible is severely rotated open (more than 2°), the convexity problem is worsened. When unrestrained mandibular opening rotation occurs with some techniques, including the high-pull headgear off the upper molars, the problem of maxillo-mandibular skeletal reduction for Class II is increased, even doubled. However, mandibular rotation is the salvation in the treatment of some Class III conditions without surgery.

Factor 3: The third area for planning mechanics is concerned with relative denture emplacement within the predicted maxillo-mandibular skeletal relationship (see Fig. 7-21). In order to reduce dental protrusions, or prevent them from developing with older expansion techniques, much extraction came to be deemed necessary. The movement with Bioprogressive mechanics was to control mandibular rotation, utilize natural growth, employ orthopedics to the midface, and prevent unnecessary tooth extraction and essentially circumvent orthognathic surgery.



CYBERNETIC CIRCLE
FOR PLANNING OBJECTIVES

Fig. 7-21 See text

Factor 4: The fourth interest lies with the **esthetics** of the profile. How will a specific technique influence the lips and affect the facial attractiveness? The VTO-VTG process has been likened to "simulation" as employed in the space industry.

The main thrust of the VTO-VTG exercise is to provide a basic framework for aid in the **selecting of the mechanics to be used.** The aim is to choose a method to most practically achieve a result which would most closely satisfy the objectives. The idea is to work **toward** those objectives. An absolute replication is not to be expected because a "prediction" or forecast does not need to be absolute to be of benefit. The main idea is to accomplish the most cogent objectives and to have a method to monitor progress and assess results.

The comparison of the forecasts to the actual is made (see Fig. 7-29 and Fig. 7-20).

Orthodontists occasionally will encounter a patient who goes into an open bite or opens drastically on the Facial Axis during and after treatment. In the past these patients were dismissed as simply vertical growth problems. However, experience with routine joint X-rays in all patients has led to perhaps a different point of view.

Three possibilities exist for explanation for a Facial Axis opening of 6° to 8°. First is a direct or indirect condyle compression. This can be due to an absence of posterior tooth support, a clenching habit, or a severe mandibular rotation from the mechanical therapy. The second possibility is an injury to the cartilage. The third is a degenerative disease of the condyle. Some similar behavior has been associated idiopathic aseptic chondrolyasis.

These opening types of growth cases have been submitted by some investigators to show the inadequacy of forecasting. However, disease states and catastrophic accidents should not be counted as a part of the forecasting theory because such events are without forward notice. We have diagnosed some of these by early signs in the joint X-rays.

A patient is shown (Fig. 7-22-A) in whom the deciduous lower teeth were lost early and clicking was already present by age 9-4 years. The patient, in addition, was serially extracted. The records reveal that degenerative joint disease ensued (Fig. 7-22-B).

Such patients demonstrate the use of a normal forecast as a diagnostic tool. In

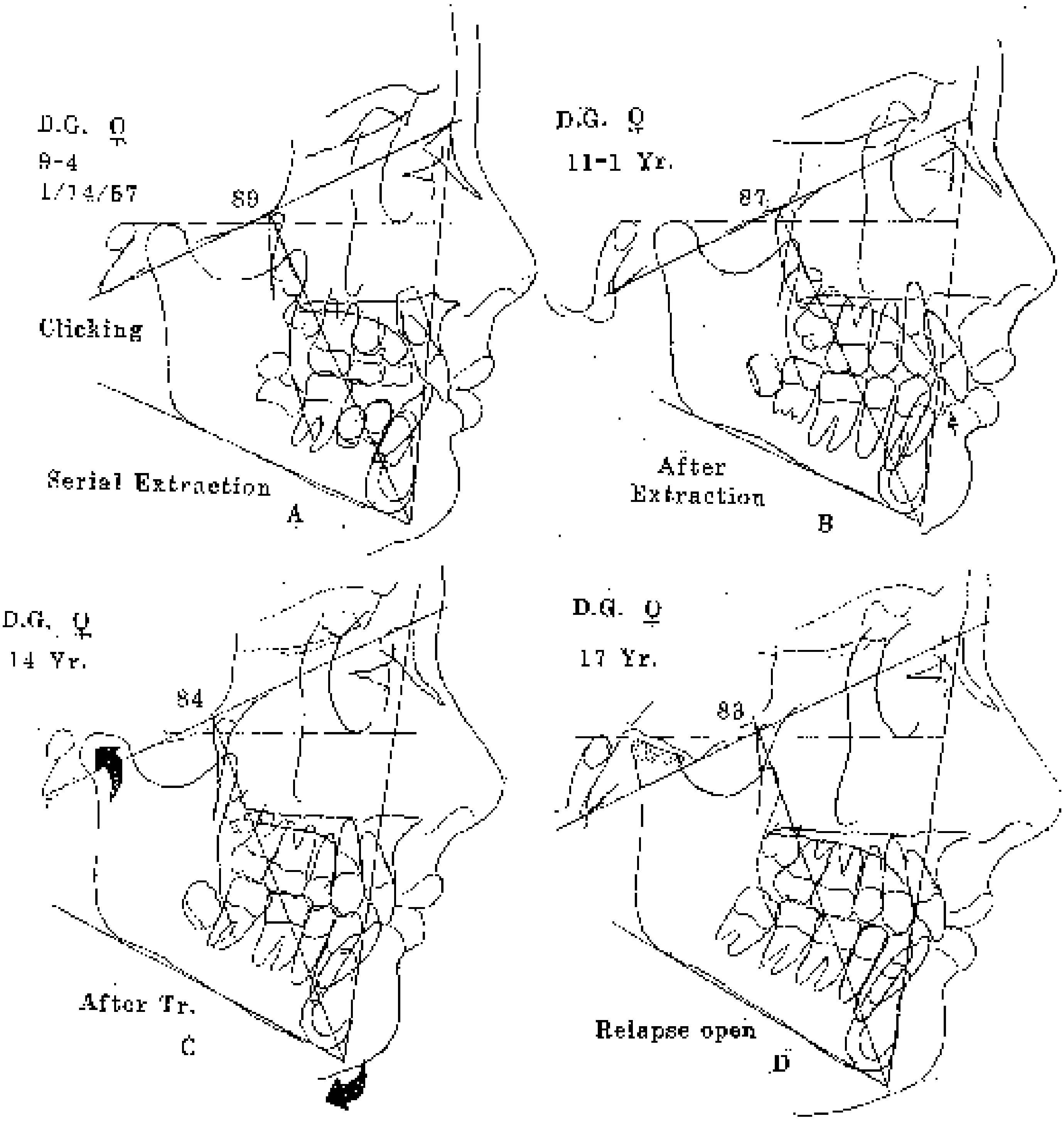


Fig. 7-22A **A.** A female planned for progressive extraction due to severe crowding, but early loss of lower deciduous buccal teeth.
B. The bite deepened with early extraction of first premolars.
C. After treatment the mandible had opened further.
D. The deep bite relapsed into open bite.

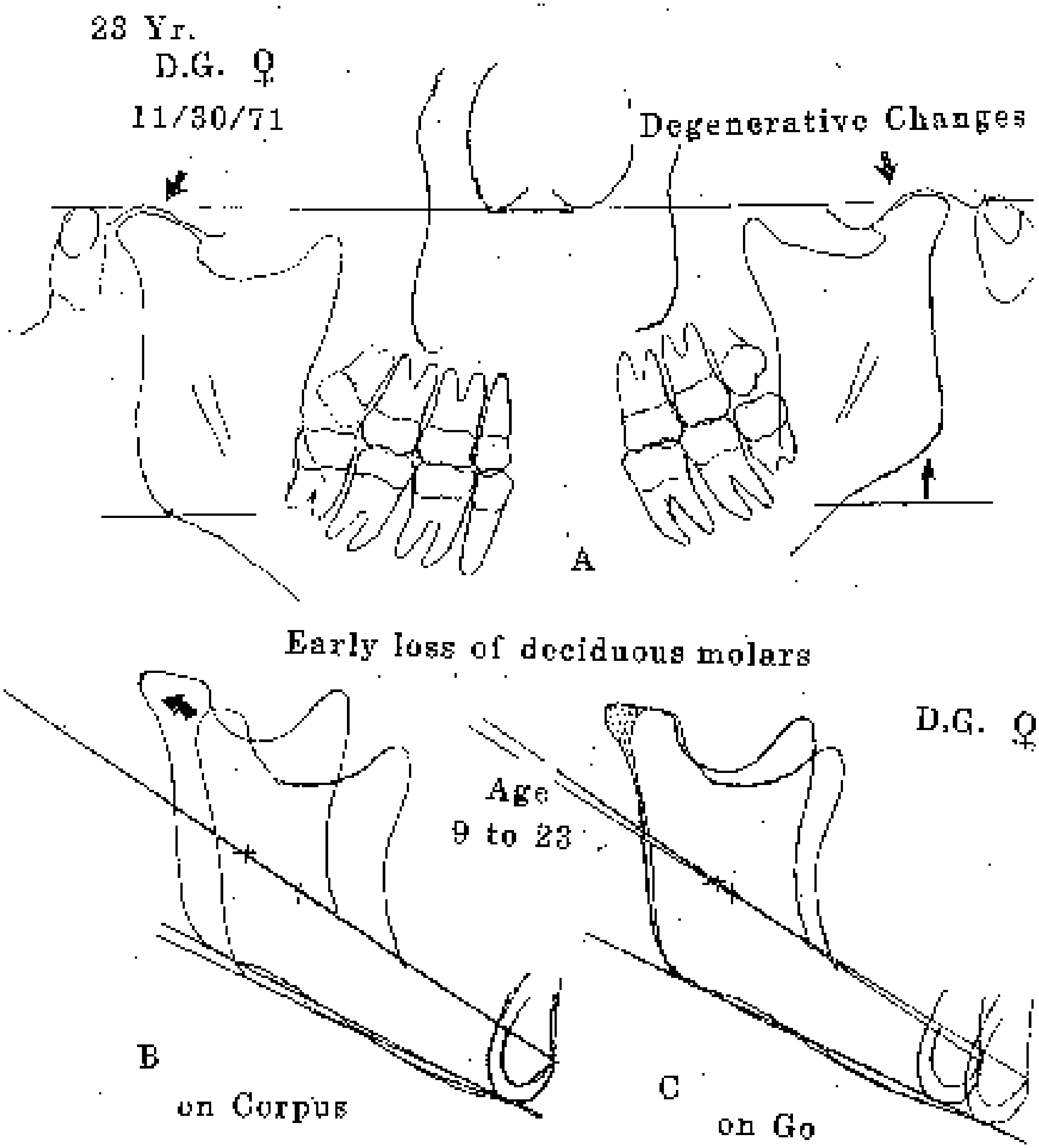
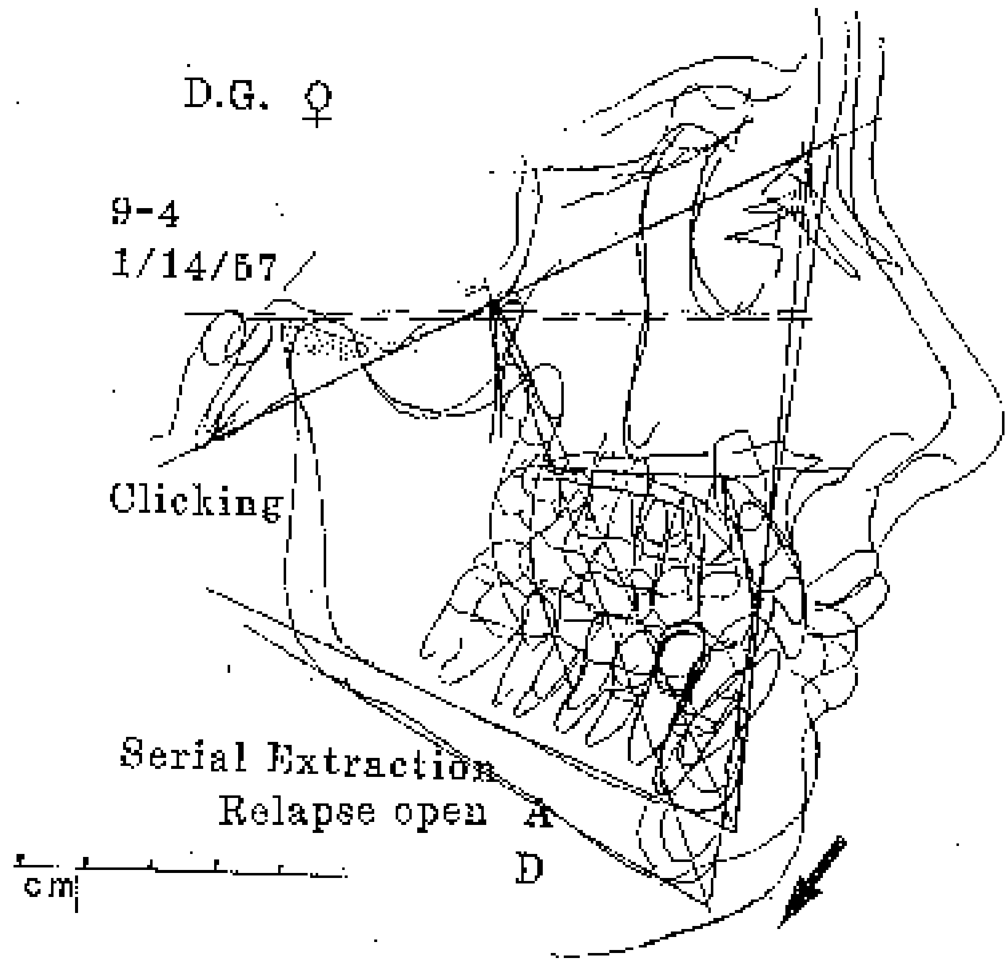


Fig. 7-22B A. Both joints are flattened, irregular in shape, and joint space is void.
B. Superimposed on the corpus shows flattening and posterior condyle bending.



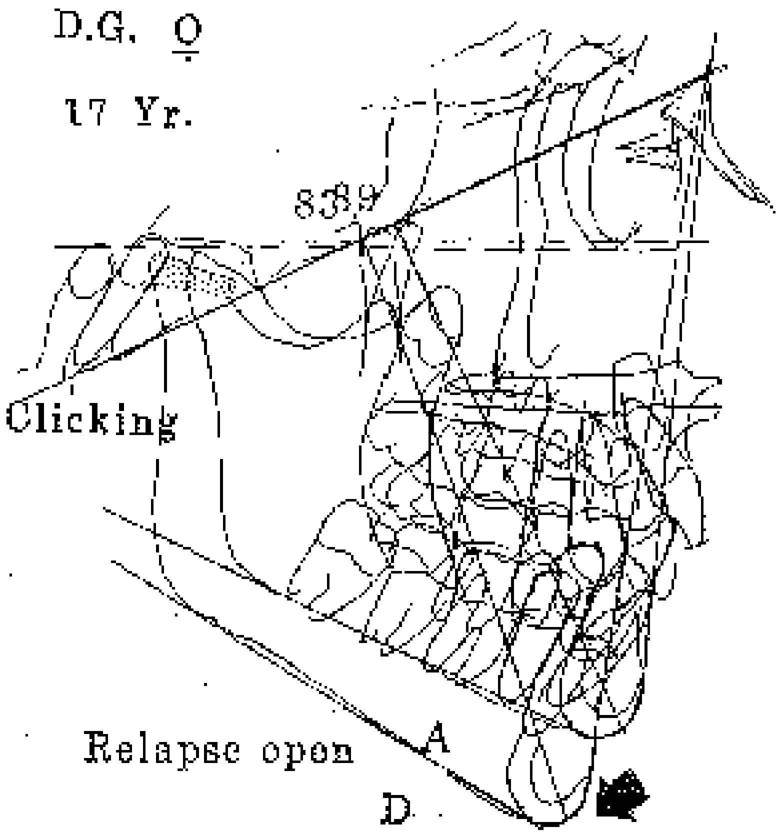


Fig. 7-22C Patient D.G. superimposed on Position I shows opening of 6° and registered at Nasion (below) shows a recession of the chin.

other words, when the forecast is grossly in error, there must be a cause which the clinician may seek the explanation for. No patients without a diseased joint or a nasal blockage have been noted to express this growth behavior (Fig. 7-22-C).

SUMMARY AND CONCLUSIONS

The construction of an image for the visualization of orthodontic-orthopedic objectives may appear to be complex. However, **if each component is learned separately** it becomes less complicated and ultimately quite easy. It is a rewarding clinical experience to plan in detail and reach essentially the perfection sought.

Making choices in objectives is based on the belief of treatment possibilities or limitations. Those possibilities, in turn, are inherent in the selection of appliances and the manner in which they are employed.

There are eight perplexing predicaments that have characterized issues in orthodontics for the past century. These concern (1) the ability to produce skeletal change permanently (or orthopedics), (2) the capability of moving molars distally, (3) the possibility of intrusion of teeth and (4) the wisdom of forward displacement of the lower arch. This in turn is related to the safety of (5) either the expansion of arches for the creation of space or for the adherence to the original "ridge". Further confusions lie with the capacity to (6) alter the muscular oral environment.

The final two dilemmas are related to (7) early treatment and (8) the faculty to produce reliable forecasts of the future either with or without treatment. The present thesis declares that this is possible, feasible, and **in fact is the state of the art.**

All the foregoing dilemmas are connected in the exercise to "begin with the end visualized". All these elements are factors in the synthesis of the individual parts concerned in the treatment and growth process. While absolute predictions are unrealistic, a forecast need not be perfect **in order to serve as a guide and point the better way toward respectable objectives.**

The profession, the specialty of orthodontics, can be enhanced and improved by the sophistication offered through use of the visualization methods proven through the last half-century. The profession should go beyond model analysis and model planning even if mounted on an articulator.

Each clinician can perceive biologic truth and can recognize the glorious majesty of Nature through the use of this tool. All can benefit as knowledge, skill and advances in technology continue to progress toward the betterment of society.

PREDICTION, PLANNING, CONSTRUCTION and MECHANICS

CHAPTER EIGHT
MECHANICS FOR EXECUTION OF THE VTG -- THE NEW PARADIGM

INTRODUCTION -- A New Paradigm for Mechanics

The rendering of the required dental and skeletal corrections for the VTO, and the goals to maturity for the VTG, go unappreciated if the orthodontist is mechanically inept. Until the 1950s orthodontic graduate schools consisted of a one-year curriculum. One bracket, one tube and one arch wire and the use of intermaxillary elastics were said "to do it all" with the Edgewise mechanism. Times have changed.

Current orthodontic and orthopedic "possibility" rests with the understanding and mastery of **several treatment modalities**. This is because **all appliances do not produce** the **same result**. Ironically, even the same appliance when used differently may produce different reactions. Also, the use of a given appliance at different ages will produce still different effects. Consequently the specialist in orthodontics, for the new millenium, has not only a new paradigm for progressive communication with cephalometrics but also a new paradigm for mechanics.*

TREATMENT MECHANICS AND RESULTING EFFECTS

The anticipation of specific treatment mechanics on mandibular physiologic rotation was built into the first VTO (short range). This was based on data, clinical experience, intuition and **with forethought of the mechanical influence by the method to be chosen.** It is shown that the effect of chin behaviors is related to

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*See Robert M. Ricketts, *Progressive Cephalometrics: Paradigm 2000* (1996) and Robert M. Ricketts, *Concepts of Mechanics and Biomechanics* (1997) and *The Wisdom of Sectional Mechanics: Intermaxillary Traction in Non-Extraction Therapy* (1997).

behavior of the lower molar relative to reference of the Pterygoid vertical and Facial Axis (Fig. 8-1).

For the programming of mandibular rotation, very simply, the more major the Class II relation, the deeper the bite, and the more extensive the chosen convexity change, the longer was the time required for the mechanics to operate. In other words, the actual goal of treatment **established the degree of difficulty**. This was the thought behind Dr. Carl Gugino's "zero base" idea.

Prevention of Rotation with Bioprogressive Mechanics

When the VTO was first conceived, the factors for bite levelling with premolar extrusion (reversed curve) and arch correction with elastics were thus **superimposed on an individual two-year growth matrix**. Incisor intrusion was considered impossible at that time (1950). A sample of deep bite Class II, Division 1 patients treated with classic Edgewise non-extraction revealed a mean of a four-degree (4°) opening rotation of the Facial Axis. This was not anecdotal! Some rotated as much as seven degrees (7°) within one year (Fig. 8-2A and Fig. 8-2B). Such findings exerted a powerful influence on the author toward the development of the Bioprogressive Philosophy.

These same findings led practitioners in the Tweed school to employ directional headgear to "J" hooks off the maxillary arch. Research revealed that the **high pull off the molars was not nearly** as successful as theorized (for the behavior of the chin).

The question may be asked, "Would the large body of orthodontists be able to extract as low as 10% of their patients without the aid of Utility Arches, segmented mechanics, and extraoral traction?"

The Bioprogressive philosophy consists of intrusion mechanics, transformo anchorage, and cortical anchorage. Thus, **opening rotation**, resulting from bite-leveling and proximal anchorage, has been eliminated! (See Chapter Seven) **Cortical anchorage** and **sectional** or segmental **mechanics** dramatically **changed the effects for inter-arch correction rotations with elastics.** Cervical headgear, used properly, has been shown to intrude lower molars, and helped temporarily at least in some patients to stimulate vertical condylar and ramal growth, and a subsequent forward growth rotation of the chin.

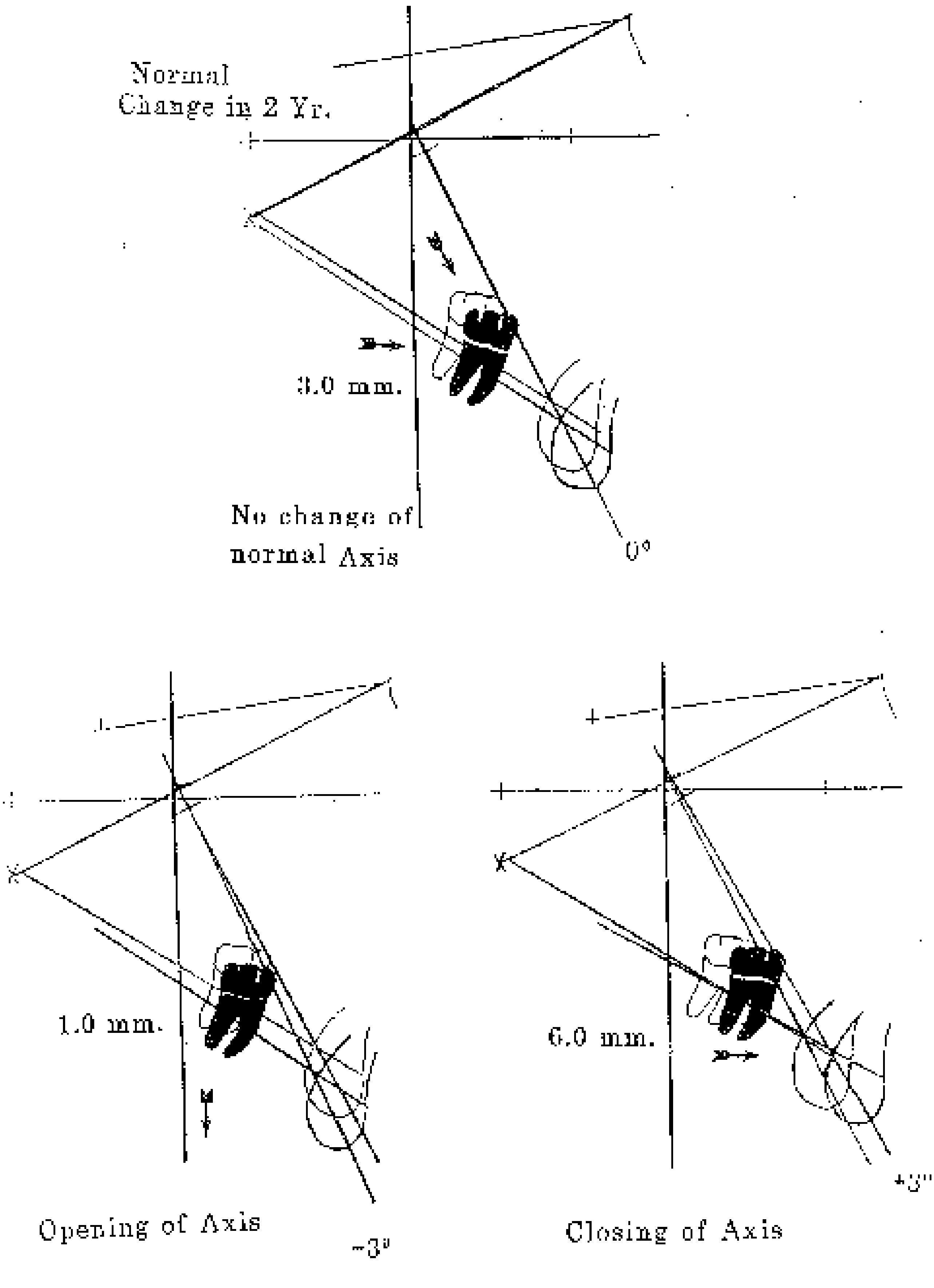


Fig. 8-1 A. With normal growth in a normal face, and normal eruption of the lower molar, the molar will move forward 3.0 mm. in two years.

B. An opening of 3° reduces effective forward movement to 1 mm.

C. Closing of the axis 3° (if possible) would increase the forward movement to 6 mm.

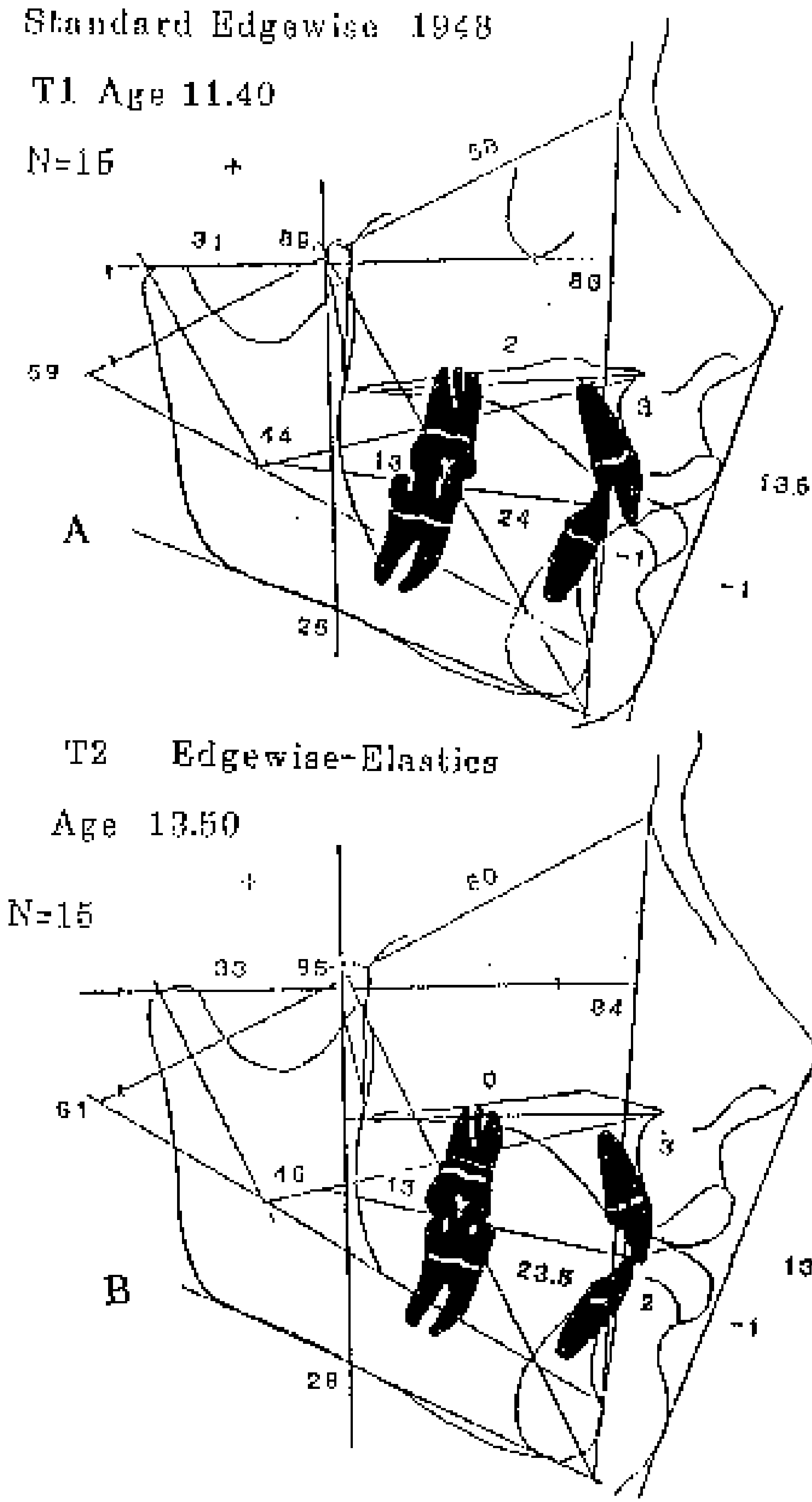


Fig. 8-2A Edgwise in 1948: Composites of group of patients with T1 beginning and T2 at retention. Note mean opening of Facial Axis and facial height even after 6 months of "anchorage preparation".

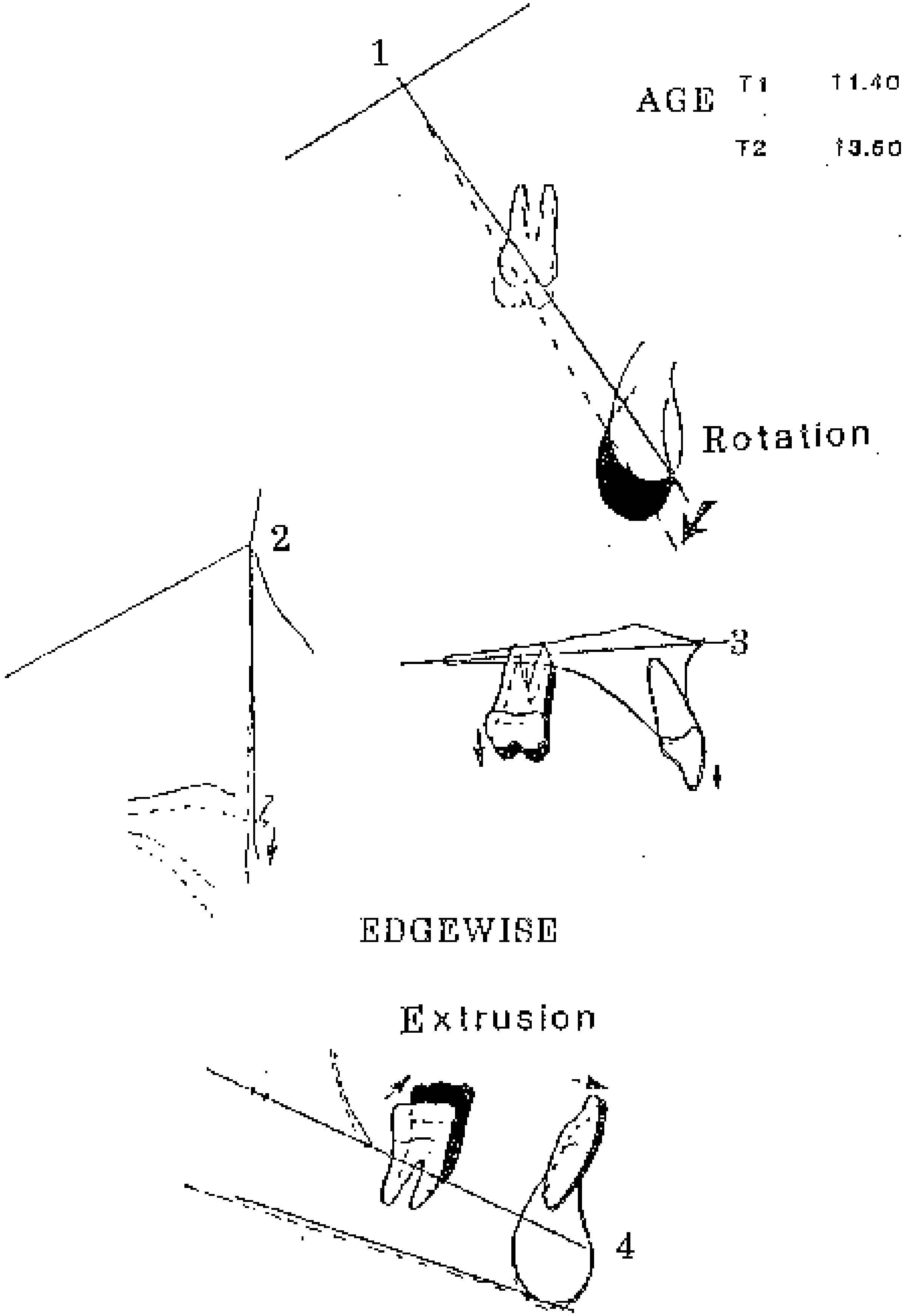


Fig. 8-2B (1) Opening chin rotation, (2) limited orthopedics, (3) continued forward molar incisor position. (4) Loss of lower anchorage.

CALCULATIONS FOR MANDIBULAR AUTO-ROTATION

Treatment Programs Designed for the Computer Need to be Understood!

Value judgments cannot be made by a computer. Consequently, values -- **depending on difficulty** -- had to be factored by the author in 1970. Each 1 mm. of Class II molar adjustment required was weighted 0.25° for opening of the Facial Axis (or the Condyle Axis). Because the typical Class II is 6 mm. discrepant in the molar, the correction result (0.25° X 6) would lead to 1.5° of likely effect on the Facial Axis **excluding other factors.**

In addition, excessive bite depth was at that time corrected by arch levelling. This method when employed **introduced a second factor for rotational calculation.** Each millimeter of excessive deep bite to be corrected was weighted also for 0.25° of opening on the Facial Axis. With a 6 mm. deep bite this would add another 1.5° opening on the Facial Axis. Thus, **deep bite Class II would average about 3°-4°, as was found.**

But a third factor to be programmed was for the amount of reduction of Point A contemplated. Before maxillary orthopedics was recognized, this was related to a **palatal torquing action on the roots of the upper incisors.** This also meant a greater anchorage requirement. As this need was added, correspondingly more rotational opening of the Facial Axis could be expected and, hence, even greater rotation tendency with mechanics.

Pain

But there was a fourth factor most difficult to anticipate. In patients with very severe Class II, a very **low pain threshold** was also associated with extreme openings. The **proprioceptive aspects** and pain were difficult to pre-assess.

By 1981 findings indicated by Baumrind et al. that high pull headgear off the molars could produce condylar growth inhibition through what is theorized to be the process of condyle compression caused by loss of posterior occlusion (even with activators). High-pull in many patients **actually produced an opening rotation which it was theoretically designed to prevent!** (Fig. 8-3).

The Dangers of Incisor Interference

Most orthodontists assume that mandibular rotation is caused essentially by molar extrusion. This is probably overstressed and may be not the most essential factor. For the author's original investigations in the 1940s, progress headplates were

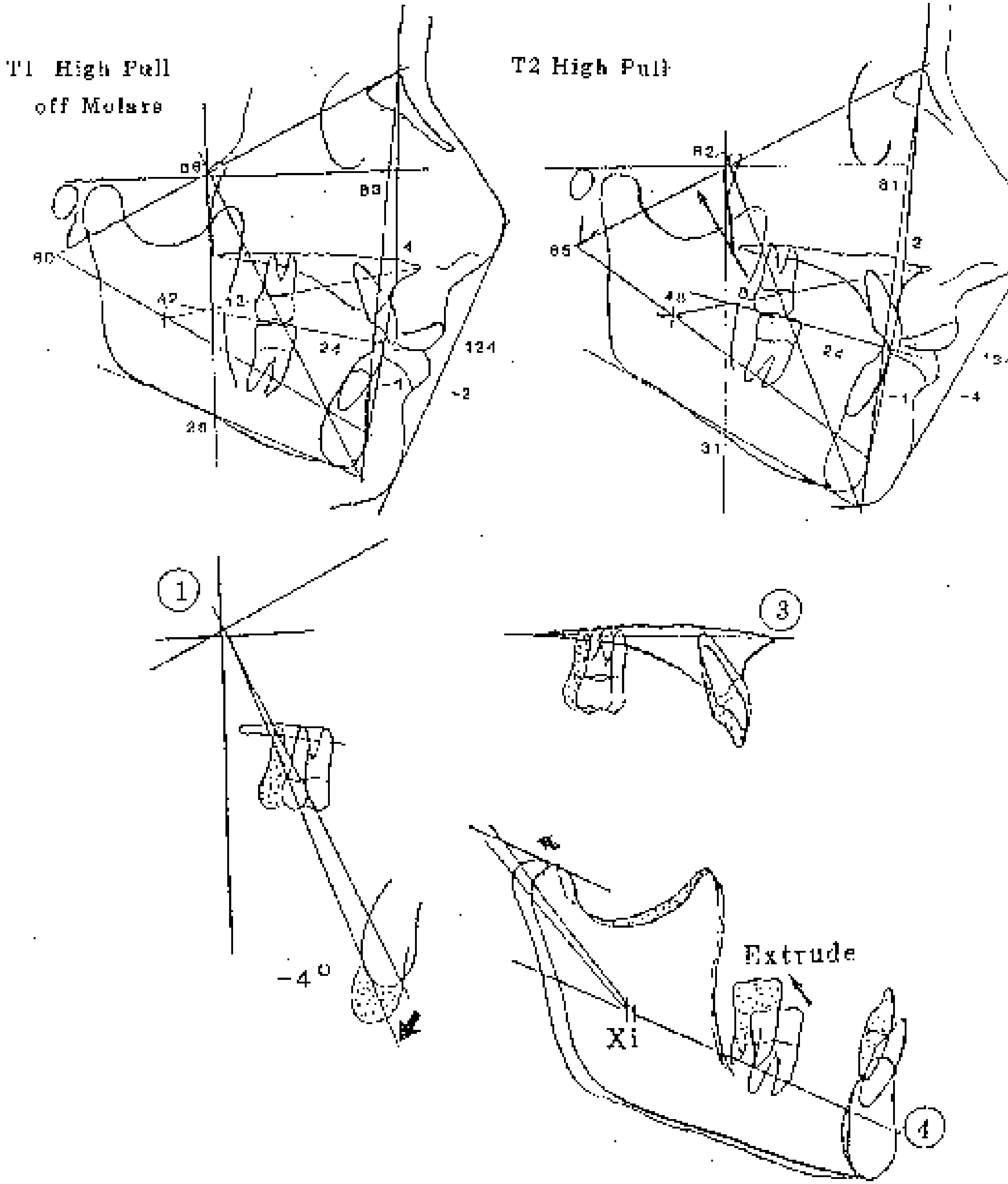


Fig 8-3 The analysis of a case in the literature in which the upper molar was intruded with high pull headgear. Notice that despite high pull the mandible was rotated open, possibly due to the extrusion and interference of the upper incisor. Notice the inhibited growth vertically in the ramus, and the eruption of the lower molar following the intrusion of the upper molar. Also, note no increase in the area of the nasopharynx which may inhibit airway space.

made regularly at three-month intervals in order to measure changes. It was noted that **the most dramatic amount of mandibular rotation occurred when the incisors were placed into interference** and while the reduction of the Class II was still incomplete (see Fig. 8-2). This finding gave rise to the admonition to **treat the overbite before the overjet. It** further brought forth research for the improvement of mechanics for **the control of mandibular auto-rotation.**

* * * * *

Rationale of the Original Computer Cut-off Programmed at a Two-Degree Rotation

By 1970 other modalities had entered into use in the profession at large. Uni-arch extraction had long been employed for severe Class II or Class III cases. Utility Arches became popular. Intrusion of incisors with Utility Arches became a more widely employed objective. Segmented mechanics, together with lower buccal cortical anchorage, prevented lower molar extrusion. **Bioprogressive orthodontists, using the computer service, were thus taught** that **a cut-off of 2° on the** Facial Axis **was programmed** (Fig. 8-4).

The rationale was that **informed** orthodontists would **monitor their treatment.** When 2° or more rotation was to be experienced, students or clinicians using the computer service were advised that **other mechanical devices should be employed** for that patient in order to avoid worsening of the Class II relation. In other words, when more than 2° rotation occurred, **the treatment regime should be changed!**

This principle was not understood by the group from Baylor University who unfairly tested the laboratory service, after the fact, with patients from a Texas practice which did not employ lower incisor intrusion. Thus the computer program was falsely condemned by colleagues not knowledgeable of the computer 2° provisional cut-off. The misses were found in patients where abnormal rotation appeared to be **iatrogenically** produced (Fig. 8-5).

The Short Range, or VTO

In Chapters Five, Six, and Seven the long range was emphasized. The construction of **a** VTO (for two years' duration) constitutes an effort to provide the orthodontist with a **simulation** of the individual to active treatment's end. It is a process to enable the operator to weigh the mechanical prospects. It is thus "Prospective", as suggested by Dr. Michel Langlade.

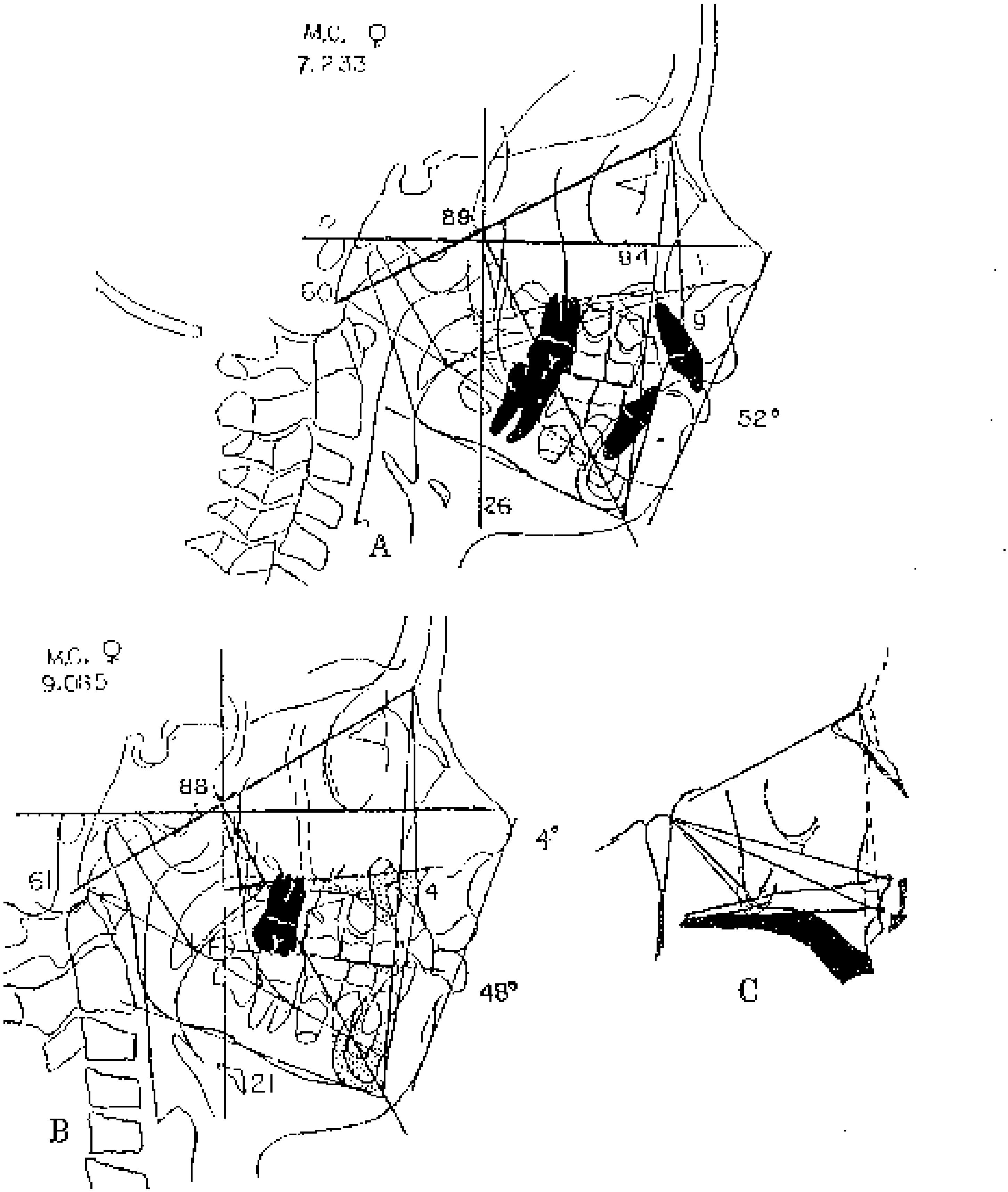


Fig. 8-4 Patient M.C. age 7.2 years, open bite, Class II. Treated with cervical traction. The VTO was programmed for 2° opening but only 1° occurred (89° to 88° Facial Axis). This was despite a major orthopedic change in the maxilla [N-Co-Ans change 9°].

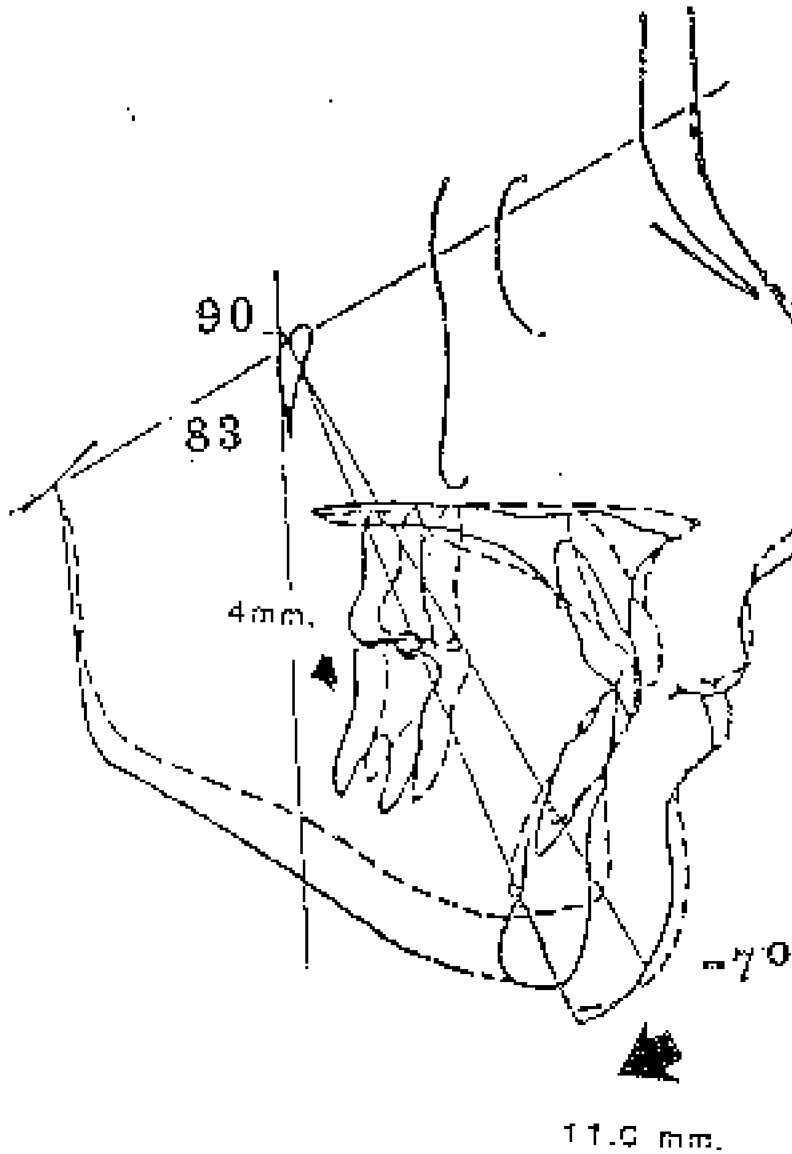


Fig. 8-5 Patient taken from a publication, also treated with high-pull as seen in Fig. 8-3. The computer was condemned for missing the prediction on this case. The computer, however, is programmed to cut off at a 2° rotation of the Facial Axis. This is 7° and 11 mm. at the chin.

Note the downward and backward tipping of the palate and extrusion of the upper incisor. It would appear that possibly condyle compression and interference in the interior segment has inordinately rotated the mandible backward.

In females at age 12 to 13 the VTO (2 years) and the VTG (3 or more years) are the same because of growth cut-offs. However, rebounding may occur later.

For demonstration of the short range (VTO) the deep bite Class II high convexity is shown in patient N.N. used throughout this manual (Fig. 8-6).

SEMANTICS REGARDING MECHANICS

In order to apply physical science to clinical orthodontics twenty-one terms are recognized. The definitions are important to help understand and communicate on a clinical basis and for purposes of education.

Definitions of Importance:

1. **Force** - a push or a pull, is likened to weight and is so measured on a clinical basis.

2. **Mechanics** - is the science of building and using machines. It is the abstract idea of force, motion and stress. Dynamics = movement or kinetics. Statics = still bodies.

3. **Torque** - The product of force times the lever arm is called torque or also the moment of the force.

   Torque = Force X Lever Arm

   To increase torque, the force can be increased or the lever arm can be increased. The word is misused in orthodontics for "torque" in a bracket, but it is understood nevertheless.

4. **Work** - The product of the force exerted and the distance the body moves.

   Work = Force X Distance

   No work is accomplished unless movement is attained.

5. **Power** - Power is restricted to time rate of work.

   $$\text{Power} = \frac{W}{T}$$

   In effect it is movement achieved divided by the time it is placed.

6. **Efficiency** -

   $$\frac{\text{Useful output work}}{\text{Input work}}$$

7. **Friction** - Frictional forces oppose motion, depend upon the surface, and are directly proportional to the force pushing one surface against the other.

(K) Coefficient of friction - R Resisting force of friction
N Force normal to the surface

8. **Newton's Laws**

First law: A body persists at rest or in motion until acted upon.

Second law: The force required to accelerate motion is proportional to the product of mass and the acceleration produced.

Force = Mass X Acceleration

Third law: **Action and reaction are equal and opposite.** This is a profound law for clinical mechanics.

9. **Energy** - is the capacity for doing work. Kinetic energy is motion, all other is potential.

10. **Impulse** - the product of a force and the time it acts in accelerating a body.

Impulse = Force X time

11. **Moment**

a. Tendency to cause rotation about a center or axis.
b. A measure of this tendency.
c. The product of a specified force, mass, volume, and its perpendicular distance from its axis, fulcrum, or plane (torque).

12. Hooke's Law - Until the elastic limit is reached, strain is proportional to stress, deflection of a coil is proportional to force applied; principle of spring scale.

13. **Proportional Limit** - Point of deflection in a wire at which permanent deformation occurs -- same as elastic limit.

14. **Load Deflection Rate** - force divided by deflection; load to produce a unit deflection (spring constant) (until limit is reached).

15. **Allowable Working Load** - Maximum load - greatest load without deformation.

16. **Centroid** - Center of gravity (center of movement).

17. **M/F Ratio** - Moment force ratio: a quantity for evaluation of a lever arm.

18. **Sources of mechanical advantage** - levers, spring, screws, incline plane, wheel. (Hydraulics is a separate case.)

19. **Types of levers - rigid** beam turning about one axis or fulcrum:

    a. Class I - Fulcrum in the middle with power and weight on each end (balanced scale).

    b. Class II - Fulcrum on one end with weight in middle and power on the opposite end (wheelbarrow) (heel).

    c. Class III - Fulcrum on one end with power in the middle and weight on the opposite end (elbow joint).

20. **Couple, in mechanics** - Two equal forces producing rotation by moving in parallel but opposite directions.

21. **Pressure** - Force distributed over a surface measured by force per unit area (thrust).

* * * * *

Force and Pressure Controversies

In communicating regarding mechanics there has been a large void. Orthodontists talk about force, but apply pressure. Primarily, the force amounts employed relative to common references such as light and heavy were never agreed upon. Also, controversies still rage over intermittent, continuous, interrupted or constant use. In addition, daytime or nighttime or full time application is debated. Finally, the direction of a force or a pressure needed to be taken into account. All the dilemmas became confusing to the student. Consequently, a particular technical scheme tended to be accepted by the student or clinician under the label of "mechanics" or an author's or inventor's "technique".

Force Classification

In an effort to help establish grounds for communication, a chart was proposed by the author and was presented to and accepted by both Reitan and Storey in the early 1960s. These levels regarding force (not pressure) are seen in Chart VI.

Pressure

However, when understood in a concrete manner, in the final analysis the orthodontist must deal with the evaluation of pressures. Over what area of bone or connective tissue is a given force placed against? Is it spread out over a broad suture or is it confined to the root of a single lower incisor. In other words, the same force may be applied, but a vast difference in pressure may result.

CHART VI

CLASSIFICATION OF FORCE

Relationship of Grams to Ounces

Ounces		Grams	Force
0.5		14.17	Very light
1		28.3495	
2		56.6	Light
3		84.9	
4		113.2	
5		141.5	
6		169.8	Intermediate
7		198.1	
8		226.4	
9		254.7	
10		283.0	
11		311.3	Heavy
12		339.6	
13		367.9	
14		396.2	
15		424.5	
16	(1 lb.)	453.6	Very Heavy
32	(2 lbs.)	907.2	
48	(3 lbs.)	1,360.8	

For rounding out for clinical use, one ounce is considered roughly 30 grams. Thus, three ounces for intermaxillary traction, for example, is nearly 100 grams, and five ounces is considered about 150 grams. Rounding out in this manner makes it easier to calculate.

Differential Force or Differential Pressure?

Differential force is a misnomer. This is because action and reaction are equal, as proposed in Newton's Third Law. But differential pressure is a reality. This idea also pertains to orthodontic biomechanics because resistances are present on a biologic basis. Hence, a teaching manual, *"Concepts of Mechanics and Biomechanics"* was formulated by the author to help explain the relationships of applied mechanics to the living patient.

Root Rating Scales

For ordinary **medullary bone** a pressure of one gram (1 gr.) per square millimeter of enface root surface was advocated for tooth movements in 1970. **It has** since been generally accepted (Fig. 8-6A) for root rating in the vertical.

But for **modification of the alveolar plates (the ridge)** for expansion one-half gram (0.5 gr.) of force per millimeter of surface area was advised (see Fig. 8-6B).

For the differential **building of anchorage**, forces of two to four grams (2-4 gr.) per $mm.^2$ were recommended against cortical bone and when possible they should be interrupted in nature. (See Root Rating Scales, Fig. 8-6C.)

Suture Rating

As a matter of interest, the maxillary suture areas were grossly analysed and estimated in an adult female skull (Fig. 8-7)

Suture	Area Per Side in $mm.^2$	Total
Maxillary-palatine-sphenoid area (buttress)	60	
Zygomatico-Sphenoidal	50	
Zygomatico-maxillary	[transmitted to other sutures]	
Mid-maxillary palatine complex	100	
Maxillo-frontal	25	
Zygomatico-frontal	75	
Zygomatico-temporal	25	335

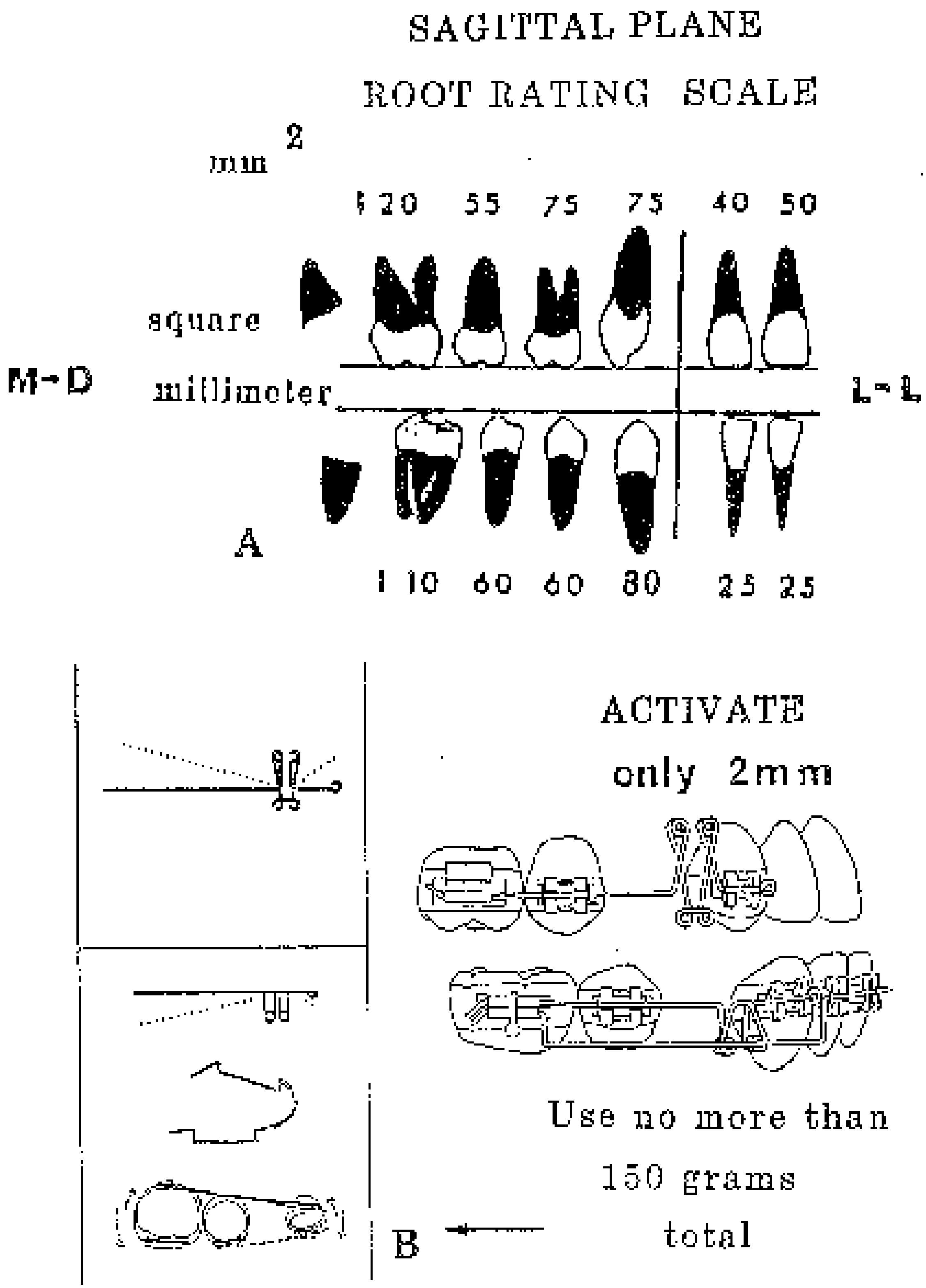


Fig. 8-6A **Above:** The enface mean sizes of roots in the line of sagittal movements in mm. The one gram per mm.² value applies to movement between the alveolar walls. For anchorage the forces are increased two to four times and the plates are engaged. For modification of the ridge the force is reduced to 0.5 grams per mm.² **Below:** the application demonstrated -- retraction sections exert 75 grams per mm. activation.

BONE ENGAGEMENT

A 1 gram per $mm.^2$

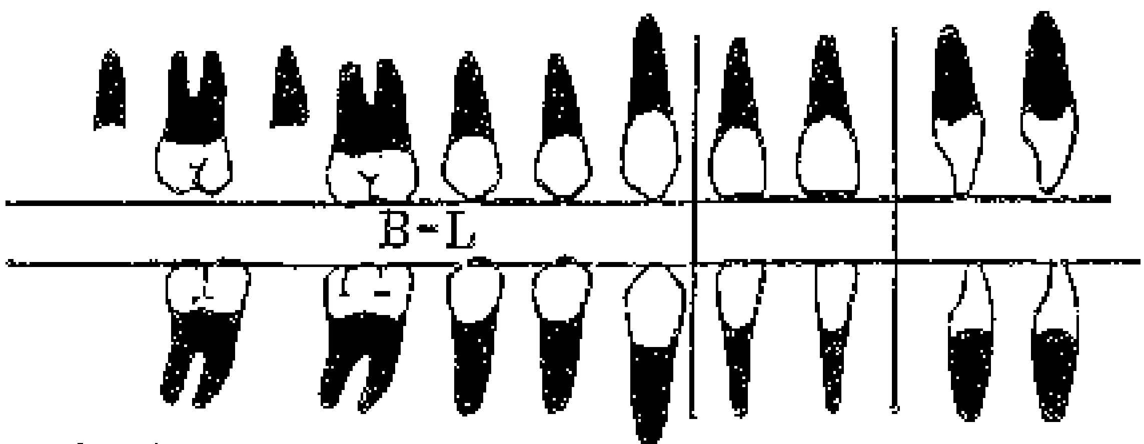
B For Sclerosis × 2 or × 3 grams

C For cortical change 1/2 gram

B 200 300 150 2 to 3 grams

C 50 75 25 25 40 20 25 1/2 gram

A 105 135 50 50 70 40 50 65 70 1.0 gram



A 100 105 60 60 70 25 25 50 50

C 50 55 30 30 35 15 15

B 200 200 150

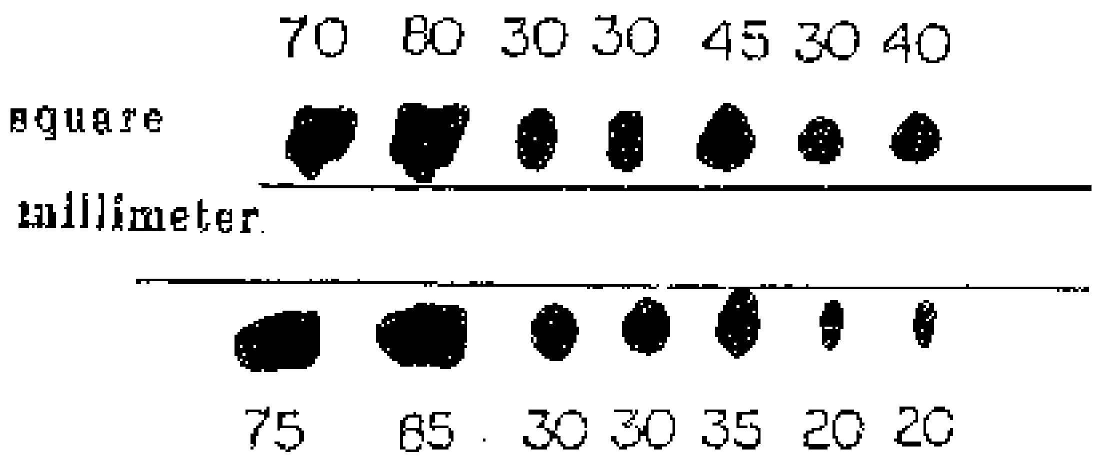
Fig. 8-6B **Transverse Root Ratings:**

A. For movements in cancellous bone. 1 gram per $mm.^2$ Is a standard reference.

B. Forces for anchorage 2 to 4 times the standard.

C. Buccal-Labial expansion 0.5 pr ½ gram per mm^2 (for ridge modification).

INTRUSIVE PRESSURES



1 gram per $mm.^2$

Fig. 8-6C The mean calculations as a working value for one square mm. of enface root surface in the vertical plane. Note molars can be intruded with 80 grams of continuous force while lower incisors require only 20 grams or less.

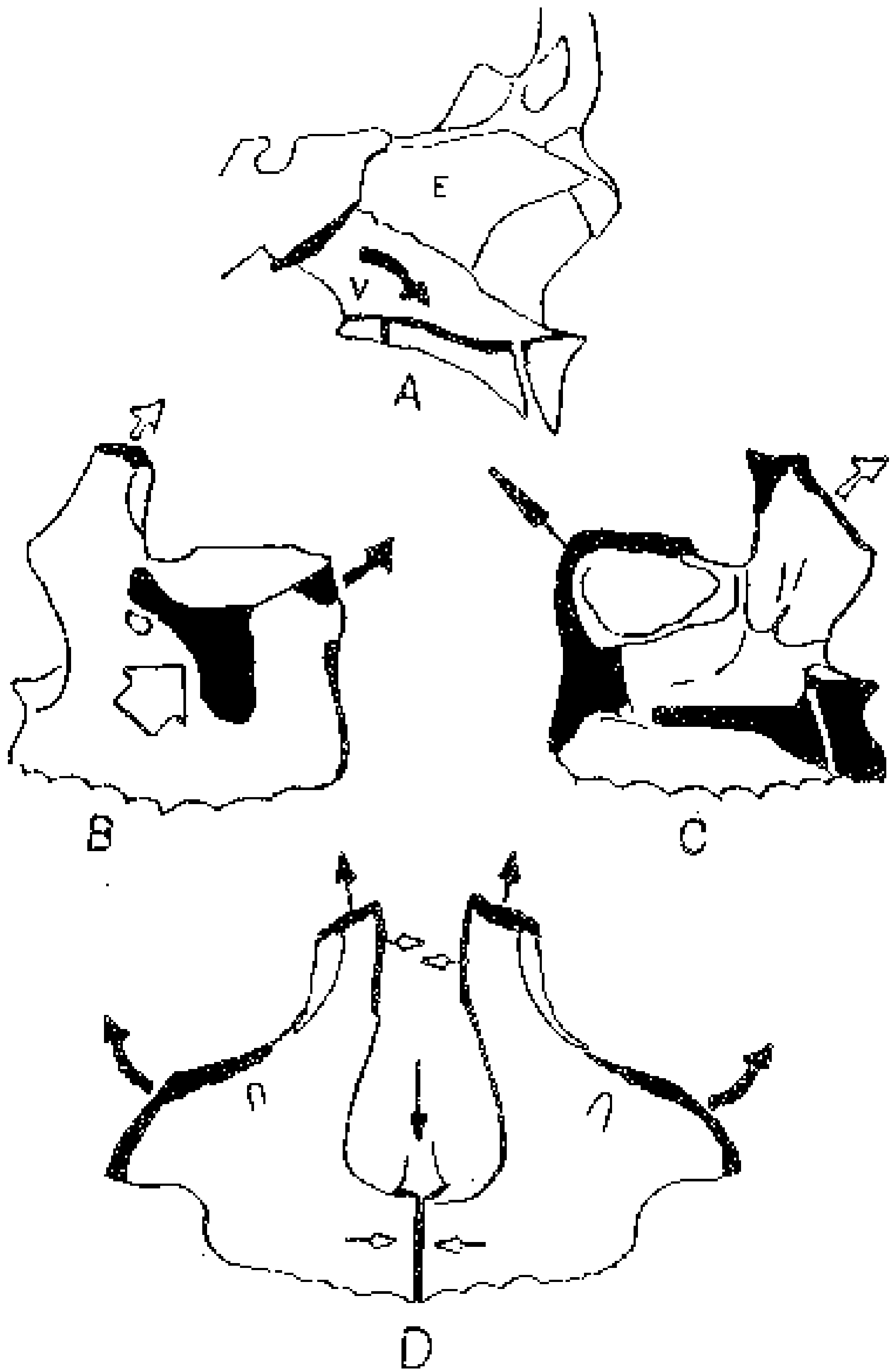


Fig. 8-7 Sutures connecting the maxilla to the upper jaw complex are darkened. See text for calculations.

In addition, the area must be estimated for surface presentation in the different directions. For instance, the resistance in palatal widening, the areas involved with high pull headgear anteriorly or posteriorly, or the areas in cervical traction and the pull of intermaxillary elastics Class II and Class III.

Estimates of resistant areas in the maxillo-zygomatic area were roughly 335, or to be more workable, ranged from 300 to 375 sq. mm. of surface area.

In the younger child patient with deciduous teeth an extraoral face bow with 300 grams (150 per side) moves the midface complex. At the mixed dentition it is 500 grams (250 per side). At the young permanent dentition a force of 700 grams (350 per side) is adequate. This matches the above calculation.

COMMON MODALITIES

Orthodontics to the technique-oriented clinician may be a matter of fitting the patient to a technique. It has even been likened to **fitting the diagnosis to the treatment technique**. The essence of the entire VTO is that it indicates to the individual clinician the more detailed nature of the mechanical treatment problem. With the use of the four-position analogy of the forecast, orthodontics becomes rather **the determination or design of a specific technique based on the individual's needs and** individual objectives.

When accepted as the goal, the VTO becomes the framework for selecting the actual mechanics. Thus, **two plans are conceived**. One is planning the **objectives** (the VTO). The second, the analysis of the VTO, is planning by using the objectives to **calculate anchorage** requirement.

The staging procedure is used for the sequence of appliance application. These objectives are fulfilled by the selection of mechanics from at least 20 modalities currently employed.

Each of the modalities listed (and more) can be selected for the achievement of specific objectives. Each appliance or procedure is learned and mastered separately. These are synthe**sized into a concrete individualized plan** in order to produce the effects and results sought with the individual VTO. (The most commonly used are noted by asterisks.)

* 1. Extraoral -- cervical or facial
* 2. Quad Helix -- Bi Helix
* 3. Utility Arch (several variations)
* 4. Sectionals (8 types)
5. Bumper-Bar
6. Crickett
7. Fixed Lingual (4 types)
8. Upper Incisor Intrusion
9. Posturing Mechanisms (6)
* 10. Straight Wire (Ricketts classic)
11. Elastics
12. Threads
13. Squeeze Treatment
14. Myofunctional Procedures
15. Biotemplate Management
16. Ligation Methods (4)
* 17. Wire size .016" x .016" Elgiloy Blue (loop bending concatenation) §
* 18. Intraoral Regulation
19. Simple Surgeries (4)
20. Orthognathic Surgeries

Certain of the modalities listed can produce changes in skeletal maxillo-mandibular relations. Both the Quad Helix and extraoral devices when employed correctly, for that purpose, can produce three-dimensional skeletal change in the maxillary complex. Cervical traction by way of an extrusive action on the upper molar is thought to induce a temporary stimulation of condylar and vertical ramal growth of the mandible in some patients. **Intermaxillary elastics applied vigorously can produce a distal bending of the mandible as do mandibular posturing devices** (in the short term).

Pressures employed in a range of 1 gram per mm.^{2} cross section of the roots is successful in intrusion of teeth. Sectional mechanics has been shown to accomplish changes in arch correction not achieved by straight-wire levelling and elastic traction off full arches.

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§ Note: The .016"^{2} or .041 mm.^{2} Eb wire (Elgiloy blue) is adaptable for almost any mechanical objective clinically when wires are employed.

Respect for growth, cortical anchorage and work with muscle resistance also can be a strong influence on the outcome of mechanical therapy.

Thus each of the twenty major and minor modalities listed can be selected for the achievement of specific objectives. Each when applied separately or synthesized into a plan will produce the effects and results sought with the VTO or VTG (which is based on proven possibilities to start with).

CLASSIFICATION OF ORTHODONTIC TECHNIQUES

A further classification of orthodontic appliances, or techniques, is basic to the selection for fulfilling of the objectives set forth. The acceptance of the use of the VTO may be contingent on agreement with the possibilities presented therein. The author, for instance, has been approached by other clinicians with such statements as "I cannot achieve the results proposed by the computer with the mechanics I employ."

This prompts the author to reply, "That is the reason the programs for VTO designs for doctor preferences were originated."

Therefore a clinician must set his or her own limits! Patients are to be planned with different schemes when the outcome is in doubt. The patient can be offered different options. Therapies are to be accomplished for patient satisfaction. This is the state of the art!

Seven General Types of Appliances Employed in Bioprogressive Philosophy

The types or groups of appliances may be listed under Orthopedic, Orthodontic, Auxiliary, Stabilizing, Shielding, Conditioning, and Surgical classifications.

A. Orthopedic

Definition: orthopedics is taken to mean a change in maxillo-mandibular skeletal relation that would not have occurred in the absence of treatment.

Technically, however, orthopedics is not concerned with just bone, but is involved with joints, muscles, nerves, connective tissues and epithelium. In orthodontics we may accept the idea of orthopedic appliances that effect skeletal changes in any of the three dimensions (horizontal, transverse and **vertical**). Appliances can be used in different ways. Some may appear to affect only the teeth but, as described before, even a vertical rotation of the mandible not occurring naturally is "orthopedic".

Modalities for Orthopedics

1. Extraoral Traction
   a. Cervical
   b. Facial (mask)
2. Quad Helix -- fully expanded (600 grams)
   a. Rapid palatal splitter -- Jackscrew
   b. Bars -- expansion arch (.045)
3. Orthotics
   a. Biotemplate (splints)
   b. Bite plates
   c. Overlays
4. Levelling with "proximal" anchorage (may rotate mandible) (Vertical)
5. Intermaxillary traction (may rotate the mandible and may effect a palatal change) (above 300 grams)
6. Squeeze treatment for open bite
7. Posturing Devices (6 types) (both removable and fixed)

The records of a female patient (M.C.) are shown for demonstration of orthopedics and short-term planning (see Fig. 8-4).

The male patient N.N. used throughout this manual is now shown in short term (2 years) in order to demonstrate the VTO and its execution for orthopedic change (Fig. 8-8).

B. Orthodontic

Definition: Orthodontics is taken to mean alteration of the teeth and the alveolar bone or the alignment of teeth from one or all of the seven positions of malocclusion described by Angle (mesioversion, distoversion, buccoversion, linguoversion, supraversion, infraversion, torsioversion).

It is often not recognized how the extrusion of incisor teeth may influence the position of the mandible. An appliance that appears innocuous can be of orthopedic consequence if it rotates the mandible open.

Ten modalities usually considered orthodontic are:

1. Very light Straight Wire (non-bent)
2. Continuous wire (concatenated)
3. Crickett appliances
4. Lingual arches (springs)
5. Quad Helix (below 150 grams)
6. Extraoral traction (below 150 grams)
7. Intraoral traction (below 150 grams)
8. Intrusion mechanics
9. Sectional mechanics
10. Retraction sections (less than 150 grams)

An adult female patient (H.M.) Is shown to exhibit only orthodontic change following extraction (Fig. 8-9). The plan for an adult in the absence of growth is called the ATO (Adult Treatment Objective).

C. Auxiliaries

Definition: An auxiliary is additional or supplementary to a main principal. In orthodontics there are numerous aids and often necessary adjuncts which are keys to the success of the whole procedure.

Modalities:

1. Intermaxillary elastics
2. Intra-arch elastics
3. Steel ligature ties
4. Plastic ties or chains
5. Blockers -- stops
6. Seperators
7. Push coils
8. Pull coils
9. Spurs or hooks on wires or brackets
10. Finger springs

D. Stabilization

Definition: Stabilization is taken to mean a procedure or mechanism to keep something from changing or possessing a resistance to change. In orthodontics, aids to fixing or to producing a resistance to a drag are pertinent to success.

Resistance sources:

1. Cortical Bone engagement

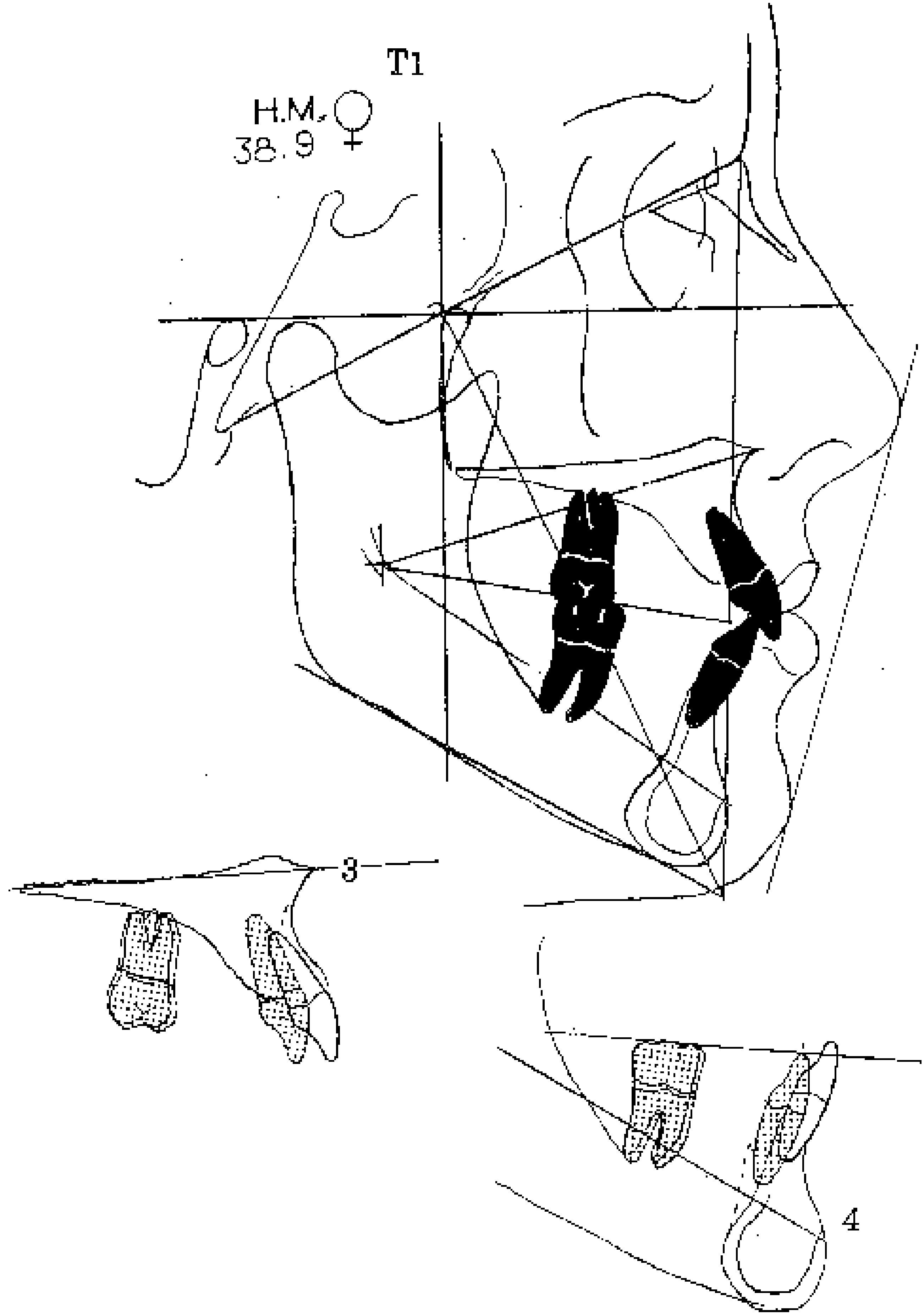

Fig. 8-9A T1 - Female double protrusion with severe crowding planned for extraction ATO -- Position 3 on maxilla and Position 4 on mandible for intrusion and retraction requirements in ATO.

2. Muscle complexes
3. Osseointegrated implants
4. Palatal Buttons
5. Quad Helix
6. Palatal Bars
7. Lingual Arches
8. Extraoral anchorage
9. Bumper Bars
10. Overlay or plates
11. Fixed retainers

Cortical anchorage is exhibited in Nicholas (see Fig. 8-9).

E. Shielding

Definition: Shielding is taken to mean to guard or to protect or to screen against some force.

In orthodontics, shields are employed to obtain relief from pressure on teeth -- not just to resist a push; however, they further place a pull on muscle attachments and periosteum. In this connection, any obstruction to the tongue, lips or cheeks may be included.

Modalities serving this function are:

1. Extensions on activators (Frankel)
2. Lip Bumpers
3. Labial Bars (High labials on Crozats)
4. Dental Arch on Face Bow
5. Tongue traps
6. Horizontal loops on arch wires
7. Oral screens (not often used)
8. Monoblocks
9. Twin Blocks
10. Splint retainers

F. Conditioning

Definition: Conditioning is taken to mean the production of a better state of health by affecting, modifying or influencing behavior of a part.

In orthodontics, abnormal oral environment problems are encountered. Conditioning appliances or procedures play a role for successful conclusions in eliminating habits.

Modalities and procedures:

1. Thumb or finger blockers
2. Tongue spurs
3. Myofunctional training
4. Posture training
5. Breathing training
6. Monoblocks or posturing devices of many kinds.

A relapse in a patient in which a sinusitis and rhinitis was not corrected is shown in Figure 8-10.

G. Surgical

Definition: Surgery is taken to mean treatment by manual or instrumental operation. In orthodontics it involves both soft tissue and hard tissue.

Types of Surgery:

1. Lower lip release (quadratus inferior or buccinator)
   Upper lip release (periform aperture release)
2. Gingivoplasty
3. Fiberotomy
4. Corticotomy
5. Impactions
6. Implantology
7. Genioplasty
8. Mandibular modifications
9. LeFort procedures
10. Segmentation
11. Cleft repair
12. Transplants
13. Replantation
14. Glossectomy

A patient is shown to demonstrate the benefits of a surgical release of the lower lip (Fig. 8-11), which can be built into the adult treatment objective (the ATO) or the surgical treatment objective (the STO).

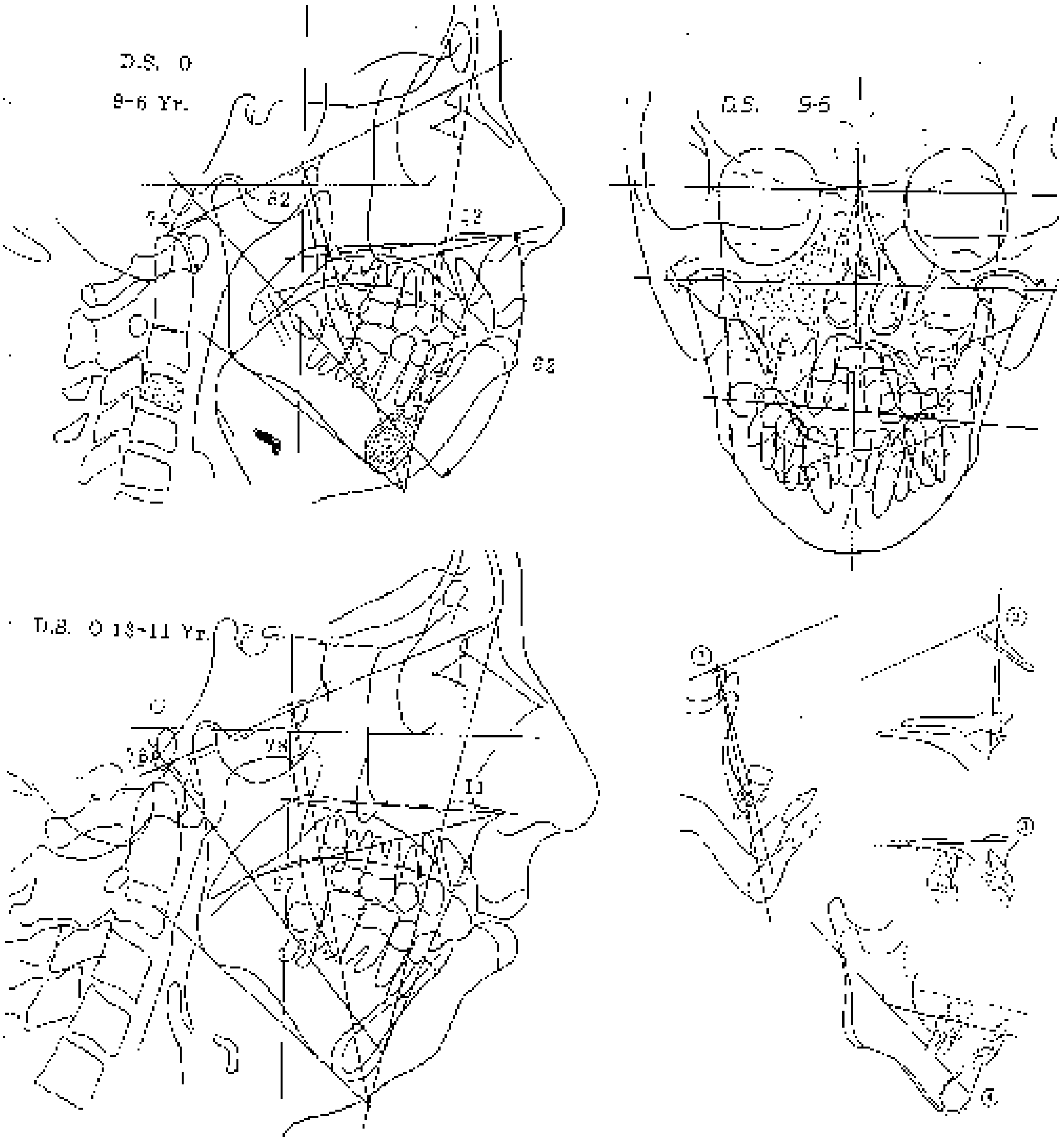

Fig. 8-10 Patient with a chronic breathing problem was unsuccessfully treated orthodontrically. Note the vertical growth behavior in the Four Position Analysis over a ten-year period

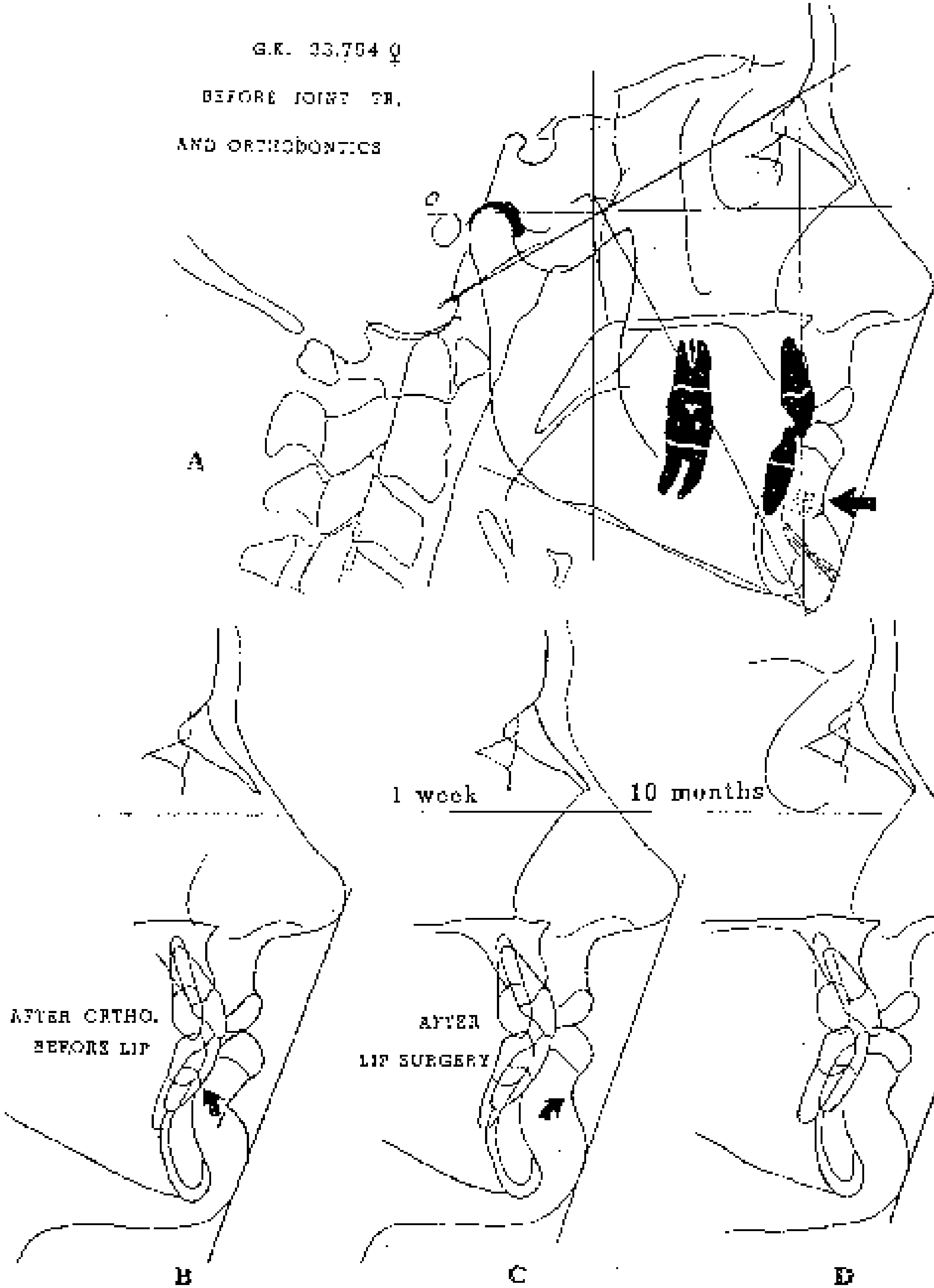

Fig. 8-11 A. TI for female patient G.K. Note the very tight lower lip associated with distal displacement of the condyle
B. Treated orthodontically and orthopedically, C. Lower lip release surgery (see arrow with release), D. Ten months post op

SUMMARY

The amount of growth to expect during treatment has always been a question in clinical orthodontics. The application of growth has been sensibly resolved by using a module or a standard unit of measurement which is the mean of one year's growth as derived from research data. The typical growth expression is the basic forecast for two years. The objectives and the likely effects of mechanics are superimposed on this two-module expression (the VTO). A forecast of long-range behavior and goals to maturity (the VTG) is employed to modify the short-range objectives.

Before a treatment design (VTO) can be appreciated the clinician needs to know the probable effects of a given appliance and technique employed in a given manner and where the possibilities lie. Computer composites clearly demonstrate differences in results using different appliances. Perhaps these findings should be better known by practitioners.

One of the factors found detrimental to the result was **overopening of the mandible** which was in the past, and still often is, confused with natural vertical growth phenomenon. The different conditions associated with resultant behavior were suggested to be factored so that the clinician can at least establish a working hypothesis. These are concerned with: (1) depth of the bite, (2) the amount of abnormal rotation, and (3) the extent of maxillo-mandibular skeletal dysplasia. Specific intrusion techniques were recommended in order to avoid "incisor interferences" and "control" the usual rotation.

Despite the assumption of sophistication in the profession, the semantics and classification of orthodontic forces has, in general, not been employed. But, more importantly, the idea of **pressure** and its calculation has indeed been very long in coming. This fact led to the development of root rating scales. These values were modified when objectives vary. The values were calculated for anchorage for orthopedic changes and cut significantly for promoting alveolar ridge development during expansion. Mechanics has thus become more scientific.

Orthodontic appliances vary extensively. Often clinicians become enamored with a particular appliance, claiming, "It will do it all." But for the satisfaction of objectives, different techniques will accomplish movements of teeth or bone that others will not. It is advised that the operator learn each modality. He can then assemble them for the performance of the individual needs, rather than fitting the patient to a perhaps biased technique.

Seven general types of appliance with categories of objectives were classified and described. The same appliance can be employed for orthodontic change or orthopedic change, depending upon how it is used. Thus, tooth change with alveolar remodeling is contrasted to basal bony changes.

Auxiliaries were described as a necessary part of most appliances.

Three general categories of modalities often not recognized as such were described. These were for stabilization, shielding, and conditioning.

When no growth is to be expected (in adults) then the planning of objectives is termed the ATO (adult treatment objective).

When desired changes are beyond the capacity of orthodontics or orthopedics, surgical intervention is employed. The surgical treatment objective (STO) arrived at through application of the Divine Proportion planning method is a separate case and requires a special manual.

The essence of this chapter was to try to tie together the actual treatment plan with the objectives set forth in the design for the individual at any age, whether it be growth, employment of orthopedics, straight orthodontics, or surgical augmentation.

PREDICTION, PLANNING, CONSTRUCTION and MECHANICS

CHAPTER NINE

GENERAL SUMMARY

BEYOND IMAGINATION

There are two parts to a treatment planning process. The first is the planning of what to do. The second is a plan of **how** to carry out the objectives set forth in the first instance.

Most orthodontists seem to use imagination or envisage a result in the mind alone in making treatment plans. This is all right as far as it can be carried out. But such plans, in general, by their very nature are loose and often flippantly conceived without proper respect for the individual patient's total needs. Such a plan may often be dictated by techniques or mechanics that a clinician may prefer or is trained in and/or is capable of managing.

In order to be more precise in objectives and for the selection of detailed mechanics for its specific production, the idea of the VTO, or the formulation of a treatment design, was conceived originally by Dr. William Bertram Downs. The procedure was accomplished by incorporating or integrating cephalometrics with proven mechanical possibilities. After all, orthodontics is a specialty, and the state of that art should be applied for practice by the specialist.

PROPOSITIONS

But one fact must be faced. Decisions are made on the **basis of belief** in the orthodontic **possibility** or the conviction of orthodontic limitation. Six different propositions in planning exist. The first two concern natural growth changes, which occur during the time of treatment (short-range forecast - SRF) or in long range to maturity (long-range forecast - LRF). These were described in Volume I, Chapter Four.

The third is the VTO which is a visualization, on paper, of the outcome of short-term objectives (practically two years). This is also referred to as an architectural "treatment design" as was developed by the author in 1950 (Fig. 9-1).

* * * * *

The fourth proposition is the VTG, or visualized treatment goals. This pertains to objectives planned for the individual at the age of maturity and resulted from the discovery of an arc of growth of the mandible in 1971. A long-term patient is demonstrated from age 4 to 19, or a period of 15 years (Fig. 9-2 to Fig. 9-7).

The fifth proposition is for the adult patient, who often is not imaged sufficiently. Workup for the adult was called the ATO or Adult Treatment Objective (see Chapter Eight, Figure 8-9).

The final and sixth proposition which is for surgical measures, termed the STO (Surgical Treatment Objective), was also started in 1950. This requires a separate manual.

Thus the symbols, employed for convenience, are: SRF, LRF, VTO, VTG, ATO, and STO.

INTERPRETATION

One of the problems experienced in teaching this "imaged" plan on paper is the difficulty of some clinicians to understand the logic and the sequences required for achievement or production of the goals. The four-position analysis has been so helpful in communicating the idea and its benefits that it is recommended to the whole profession and allied disciplines. This evaluates the mandible (chin) (**Position One**), the maxilla (Point A) (**Position Two**), the upper teeth from the palatal plane (**Position Three**) and the lower teeth from the corpus axis (**Position Four**). **Differences between the desired positions and those achieved with growth alone become the basis for determining anchorage needs and therefore selection of appliances** (Fig. 9-8; see also Fig. 9-1).

New findings, new points of reference, and new possibilities of treatment led to an evolution of orthodontic concepts. Among these were **cortical anchorage, orthopedic changes** in the child, **intrusion of teeth**, safe methods **of expansion and a three-dimensional realization**, together with a **holistic view** of the patient.

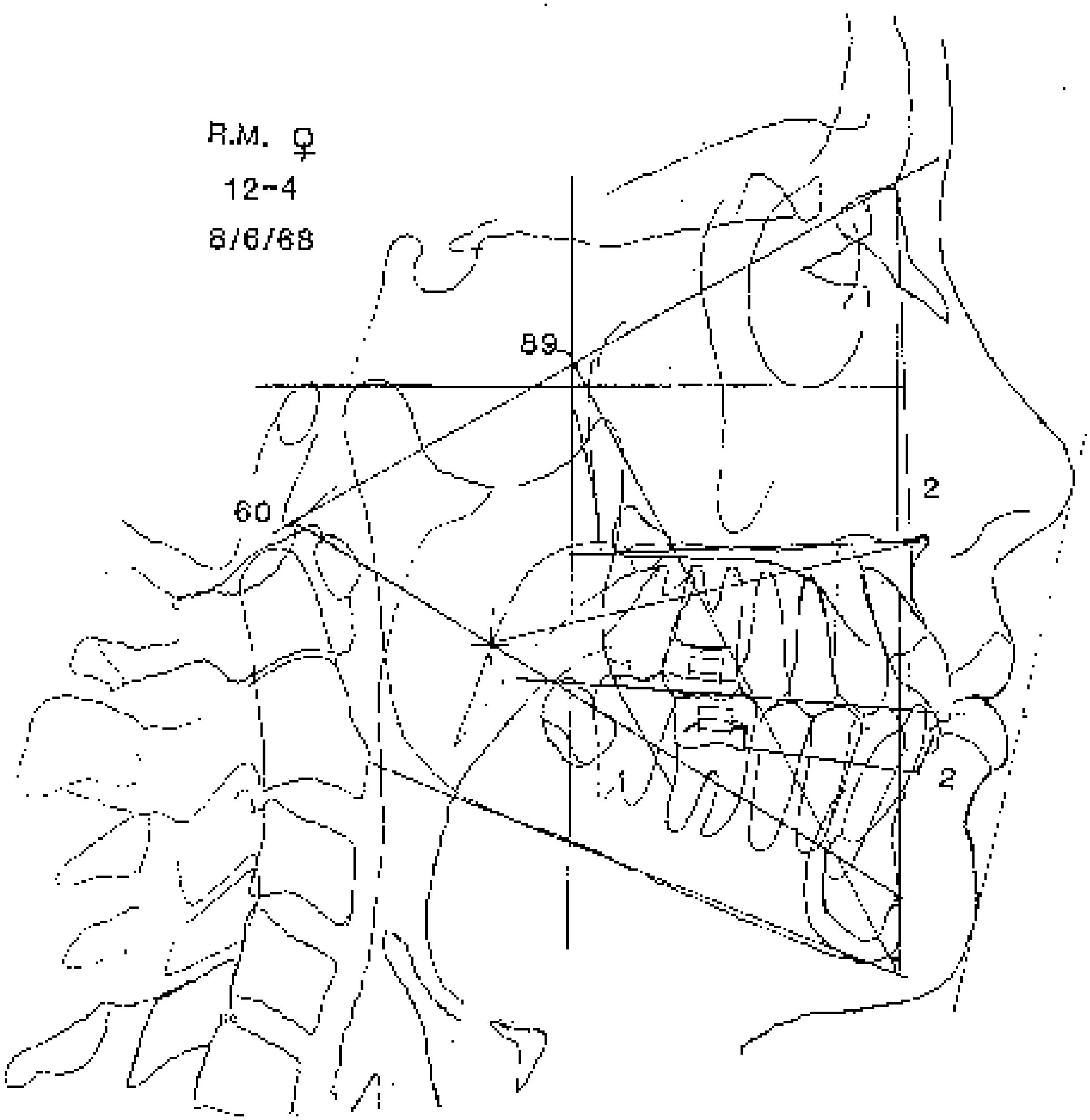

Fig. 9-5 (R.M.) Second phase for detailing only at age 12.4 years, an upper buccal bar and lower Utility Arch were employed.

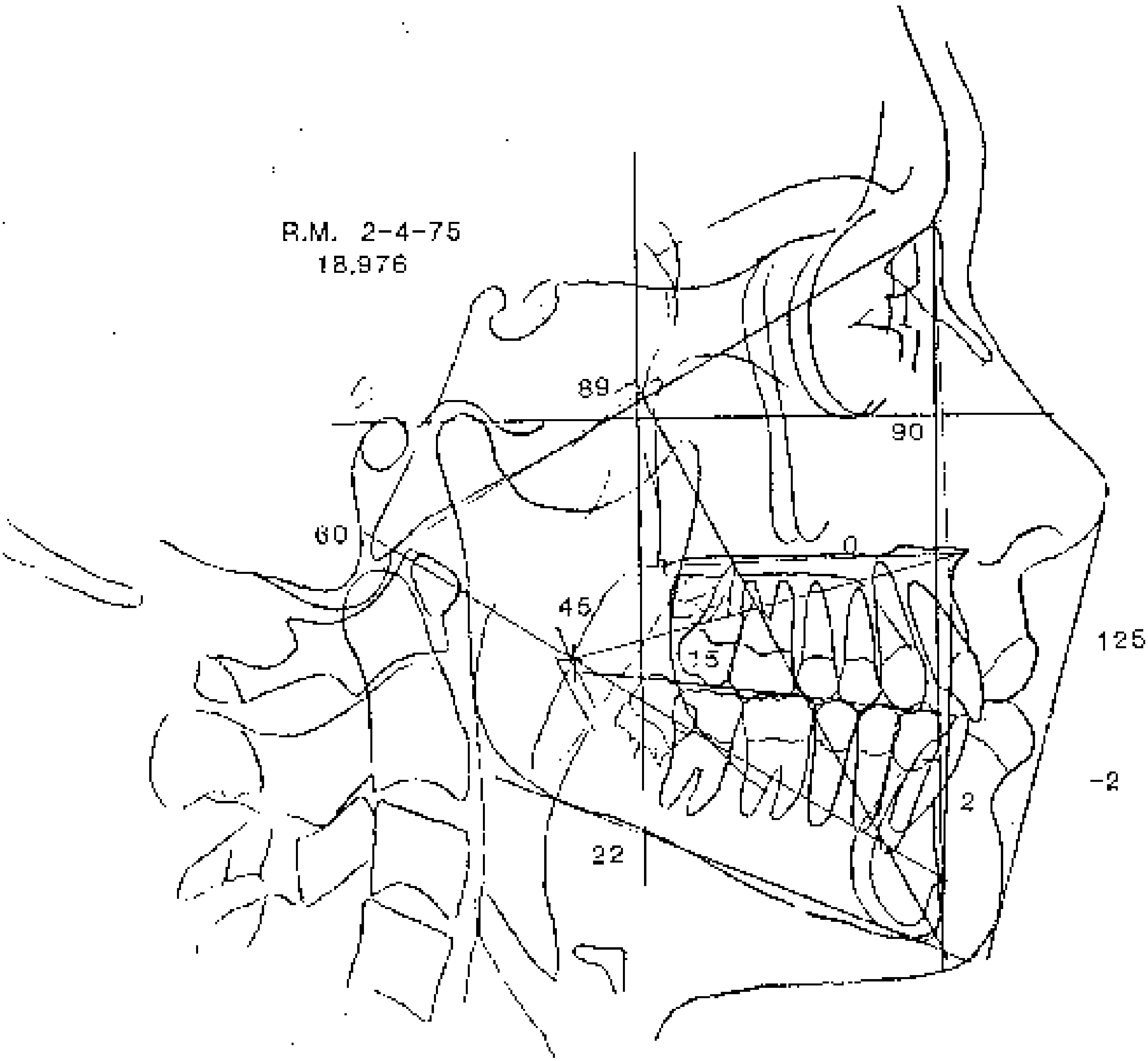

Fig. 9-6 (R.M.) Status after retention at age 19 years. Note the third molar impaction that was predicted and the almost ideal profile that was achieved.

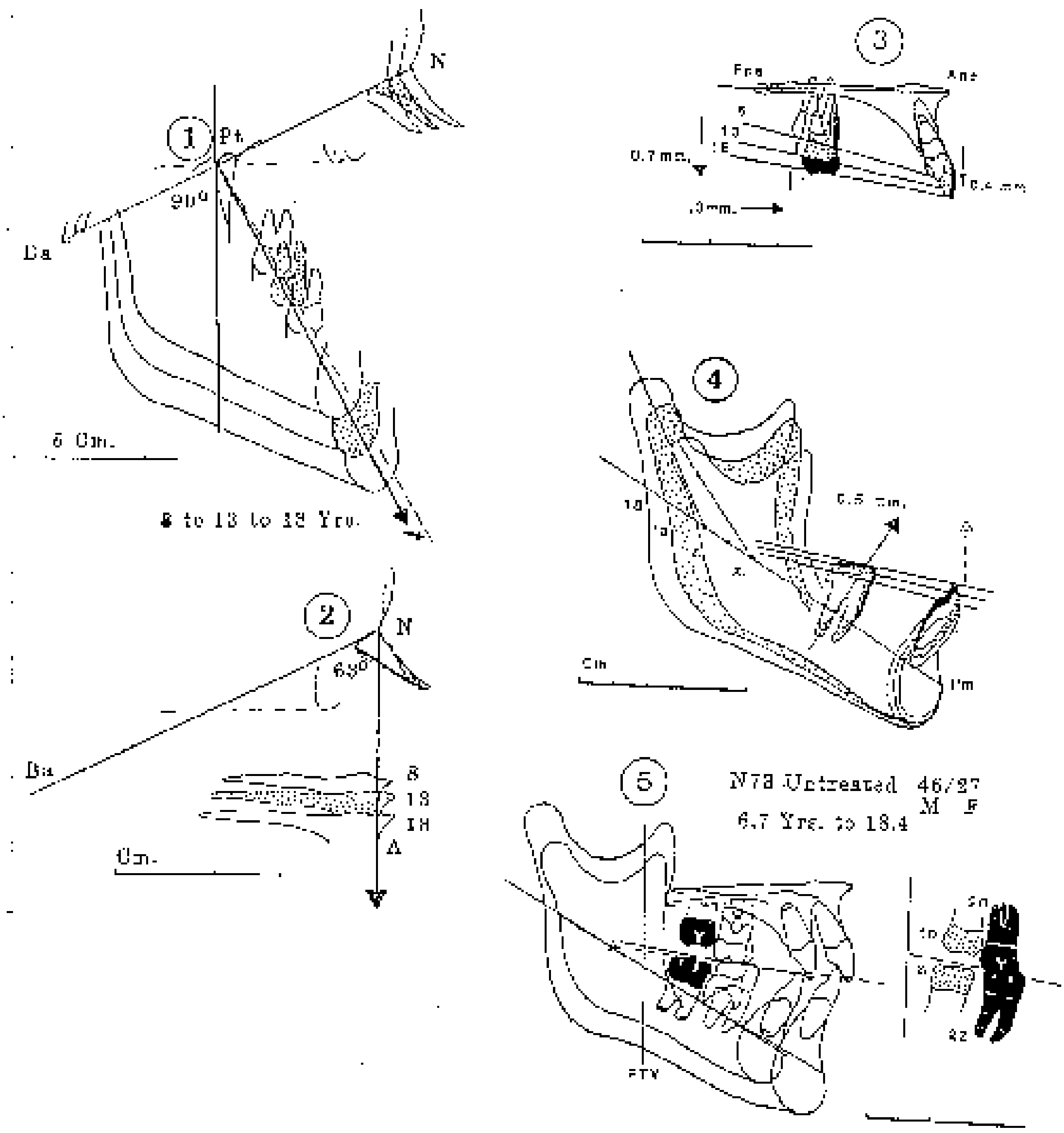

Fig. 9-8 The four-position analysis for the skeletal behavior and teeth. Note another option [5] on the Pterygoid vertical to show the differential in upper to lower molar behavior.

DENTURE EMPLACEMENT IN PLANNING

Arguments regarding the best "emplacement of the occlusion" have become diminished following findings from computer composites and from larger and longer-term samples.

The construction for the visualization of orthodontic or surgical objectives may appear to be complex. **However, if each component is taken separately** it becomes less complicated and is learnable. It is a rewarding clinical experience to plan treatment in detail and essentially reach that perfection (Fig. 9-9).

Making choices in objectives is based on the belief of treatment possibilities. Those possibilities, in turn, are inherent in the selection of appliances and how and when they are employed.

PREDICAMENTS

There are eight perplexing predicaments that have characterized issues in orthodontics for the past century. These concern (1) the ability to produce skeletal change (or orthopedics), (2) the capability of moving molars distally, (3) the possibility of intrusion of teeth, (4) the wisdom of forward displacement of the lower arch. This in turn is related to (5) the safety of expansion of arches for the creation of space or for the idea of adherence to the original "ridge". Further confusions (6) lie with the capacity to alter the muscular oral environment.

The final two dilemmas are related to (7) early treatment and (8) the faculty to produce reliable forecasts of the future either with or without treatment. **The present thesis declares that forecasting and planning from the goals at adulthood is both possible and feasible, and should be routine.** In fact, when the procedure doesn't work, it becomes diagnostic and a search is needed to uncover the reason for its missing the mark.

LONG-RANGE VISUALIZATION

The emergence of a long-range method and the technique of construction of the VTO and the VTG were described in the appropriate chapters.

As described, the skeletal cranial matrix was performed first. The axial prediction of the mandible was second. Either could be constructed first, however. The cranial and mandibular forecasts were then fitted together, the teeth were arranged, and the soft tissue was added for a complete imaging process.

By 1971, long-range forecasting of the mandible had become a practical tool. Patients were visualized for goals at maturity. The methods were proven and even more refined in 1990. Not only a long range forecast was possible, but making corrections for the malocclusion in the youth to be most fitting for the mature face was also forthcoming (see Figs. 9-2 to 9-7).

FACTORS IN THE FORECASTING

The mandibular growth arc was established as a basic growth phenomenon. Averaged over a period of years (five years or more), the mean values work for forecasting amazingly well. In fact, when the process has been demonstrated it has been so exact that students and clinicians have been momentarily overwhelmed, dazed, and speechless. When the extremes in size and form and variation are presented they are considered to be "conditional statements" for the programming of a computer and "correctional factors" when performed manually.

The differences in sexual dimorphism are obvious and are generally accepted. The length of the condyle, the form of the gonial angle, the relative thickness of the ramus and form of the symphysis are also factors to be weighted in the forecast. When misses occur it is more often in a case where growth does not reach the normal potential. This, in non-treated subjects, is hypothesized to be factors of inhibition with muscular and functional dominance to the genetic pattern. **Studies are not yet completed on the possible long-term iatrogenic effects of orthodontic therapy.** Rebounding, in other words, is often taken for granted, and when the damaging effects continue that finding should be an alarm signal.

Studies suggest that slight local and regional changes in the joint are possible with extraoral traction. From analyses in short range -- one to four years -- joint changes are suspected. Some of the temporal bone changes seem to be present in samples followed as long as ten years. This possibility complicates prediction because the effects and rebound also need to be taken into account. It is, in fact, the forecasting idea that has led to the analytic sophistication implicit in this presentation.

THE LOGIC OF THE SEQUENCE

The original method was one of extension of the cranial base triangle drawn from information available in 1950. The mandible was then projected on that base as growth and treatment effects were combined in the original VTO.

By 1967 new points -- namely Pterygoid point, Xi point and Pm point -- led to the use of the Facial Axis, the Condylar Axis and the Corpus Axis. From computer findings by 1970 relations of the occlusal plane to the Corpus Axis were discovered. Several other points and planes for the morphologic and growth analytic methods were verified. Still the sequence was one of building the mandible onto the cranial base and adding the midface, the teeth and profile soft tissues, in that order

However, with the development of the arc interest in the mandible came first. The mandible tends to dominate facial morphology. New points such as Eva, Murray (Mu), Posterior condylion (Cp), superior condylion (Cs), Ramus reference (Rr) and Pm were necessary for the procedure. The objective was to grow the mandible and then build the cranium, face, teeth and soft tissues around it. This meant often thinking backwards and was difficult to teach and to understand. Therefore a two-stage procedure was developed. It consisted, for the cranial matrix, of one tracing paper depiction of new points and the construction of reference lines on the cranial and facial matrix. The predicted mandible was secondly fitted to that new configuration and the cranium was copied.

Size-Gain Concepts

Dating probably from 1966, when the idea of size-gain relationships was emphatically discounted, there has been a reluctance to investigate this phenomenon. However, some truths need to be recognized:

1. The polar phenomenon works by less growth (gain) closer to the center and more growth at more distant sites (size) so that facial proportions are essentially maintained.

2. When consistent divine proportions were discovered, one shorter dimension (the mean) grew in proportion to the larger dimension (the extreme) so that order and proportion was maintained.

3. When dysplasias were encountered they did not, as a rule, self-correct, sustaining their original proportions.

4. The whole theory of neurotrophism supports a size and gain relationship as seen in some syndromes.

Thus, certain aspects of the mandible are subject to general size-gain principles. Likewise, in the cranial base, certain modifications are to be considered as related to size, form, and relationship, particularly in extreme Class III conditions.

MECHANICS

Mechanics is needed to produce the planned results. Mechanics was approached from the aspect of combining it with the contributions of growth and avoiding problems involved with **control of the mandible** and **production of orthopedics** in the young growing child. Sectional mechanics permits an ease of management and possibilities of results that straight wire does not provide.

SEMANTICS

Semantics in mechanics has proven to be a problem. Force and pressure are confused. Several aspects of mechanics are employed for communication and need to be known and were therefore defined.

MODALITIES

The most common modalities were listed and techniques were classified for organization and order. Each modality is a separate case unto itself, and do's and don't's should be recognized for each treatment technique. Separate manuals have been prepared for the major appliances.

Certain of the modalities can produce changes in maxillo-mandibular or skeletal relations. Both the Quad Helix and extraoral devices, when employed correctly for that purpose, can produce skeletal change in the maxillary complex. Cervical traction is suggested to induce a **temporary** stimulation of vertical ramal growth in the mandible (in some patients). Intermaxillary elastics applied vigorously can alter the behavior of the mandibular bend on a temporary basis as do mandibular posturing devices.

Intrusion mechanics employed in a range of 1 gram per mm^2 cross section of the roots is successful.

Respect for growth, cortical anchorage, and work with the muscles also can be a strong influence on resulting possibilities.

ADVANCING THE PROFESSION

All these procedures are connected in the exercise to begin with the **end objectives visualized** (actually executed on paper). Each factor in sequence is employed in the synthesis of the individual parts concerned for the growth and treatment process. While absolute predictions are unrealistic, a forecast need not be perfect in order that it may serve to guide and point the way toward respectable objectives and sensible mechanics.

The profession, the specialty of orthodontics, can be enhanced and improved with the sophistication offered through use of the visualization methods proven through the last half-century.

Each clinician can perceive biologic truth and can recognize the glorious majesty of Nature through the use of this tool. All can benefit as knowledge, skill and advances in technology continue to progress.

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