# Palate-Tongue Relativity

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## Introduction

Centrally located within the oral cavity the tongue is a powerful muscular organ which has the ability to affect the position of the teeth and surrounding structures. Although its attachments are principally to the mandible and the hyoid bone, its activity in deglutition, mastication, and speech is more closely related to the hard and soft palates.

The palatal vault in its lateral dimension and its apical contour are of great importance in tongue function. Generous vault width and smooth nonfurrowed contours of the mucous membrane enable the tongue to perform swallowing, speaking and chewing motions easily. Conversely, a narrow or constricted palatal vault not only necessitates greater tongue effort to perform its various functions, but also generates tongue hyperactivity and, in its most extreme state, encourages and induces detrimental habits.

Assuming palatal vault width to represent the tongue housing, then Palate-Tongue Relativity (PTR) is a clinical hypothesis which correlates tongue housing and functional tongue size. In other words, the activity of the tongue, whether normal or abnormal, is affected by its relationship to environmental structures. Comparing the physical size of the palate with the activity of the tongue, favorable PTR indicates an adequate palate and a relatively small tongue, consequently, normal tongue activity. Viewed in the opposite manner, a narrow or constricted palatal vault and a comparatively large tongue suggest unfavorable PTR with attendant lingual hyperactivity.

Haas[1] in 1961 reported the efficacy of rapid maxillary expansion in the correction of unilateral and bilateral crossbite. Lebret[2] in 1965 compared palate changes after labiolingual and removable expansion plate therapy and found widening of the palatal vault in response to the use of the expansion screw, but not to labiolingual therapy.

After extensive use of the edgewise appliance, the removable expansion screw appliance, and rapid maxillary expansion for the correction of unilateral and bilateral crossbite, the author selected the latter for this experiment after making certain observations.

In almost all cases, especially those in the lower age range, in which rapid maxillary expansion was used, the crossbite was overcorrected in fifteen days so that response was rapid and positive. There was no jiggling of teeth as buccolingual relations changed. Because cooperation was under parental control, it was excellent, and dependency on the wearing of crossbite elastics was eliminated. Bodily movement of the buccal segments was the rule with very little tipping of the crowns of the maxillary teeth. Soreness was encountered in a very low percentage of cases. When it did occur it was in the upper age range. Most important, however, recontouring of the palatal vault occurred to a marked degree.

From the author's private practice thirty-eight patients with unfavorable Palate-Tongue Relativity were selected for an analytic investigation. The objectives of this study were primarily to increase palate size and alter palatal contours, to measure these changes and their regressions, and to observe the effect of the alteration on tongue activity. Secondarily, measurements of harmful and beneficial side effects were to be recorded.

## Experimental Procedure

Of the thirty-eight patients treated by the rapid maxillary expansion method, twenty-three were females, fifteen were males, with ages ranging from 6 years 4 months to 13 years 4 months, the average being 9 years 4 months; nine were Class I, twenty-eight were Class II, Division I, and one was Class III.

The procedure used was essentially the same as reported by Haas in 1961, but there were two modifications:

1) Each appliance was expanded a similar prescribed amount during a similar prescribed time period. Over a 15-day period the screw was opened eight complete rotations yielding an expansion of 6.4 mm.

2) After removal of the expansion appliance, no retention was employed.

In all cases the first permanent molars and the deciduous first molars or first premolars were banded and joined to a rigid, split-expansion device. The body of the appliance was acrylic enabling forces to be directed to the alveolar and basal bones as well as the teeth.

After the 15-day period the appliance was stabilized by a strong bond of self-curing acrylic placed over the screw and onto each half of the acrylic body. To permit bony union in the midpalatal suture, the appliance remained in position for three months following stabilization at which time it was removed. From that day all patients were free of appliances and retainers and were given no exercises or instructions about tongue activity.

An interval of one month was allowed for the palatal soft tissue to return to normal after having been inflamed from appliance impingement or inadequate oral hygiene. The second lateral cephalogram and a maxillary impression were taken; later the patients returned for observation at 6 to 16 week intervals.

In eighteen cases, an average of 6 months after appliance removal, a third lateral cephalogram and complete impressions were taken. During this period neither appliance therapy nor serial extractions were instituted.

## Materials and Methods

At the following specified times measurements were made on lateral cephalograms and on dental casts:

1) Diagnostic records prior to treatment. (This will subsequently be referred to as Time period 1).

2) One month after appliance removal or 4.5 months after cementation of the expansion appliance (Time period 2).

3) In eighteen cases continuing without appliances or orthodontic interference, an average of 6 months after appliance removal or 9.5 months after appliance cementation (Time period 3).

In this series, appliance therapy began approximately 3 months after diagnostic records were taken, so that the average time interval between Time period 1 and Time period 2 was 7.7 months for the entire series.

*Casts* — Changes in the palate, maxillary teeth, and alveoli were studied with the Korkhaus symmetrograph[3]. Palatal height and palatal width were measured directly from the casts, whereas changes in vault width were done by superimposition of tracings.

Lebret's[4] method (Fig. 1) was used and is briefly described as follows: Registration point $R$ is a point on the most clearly defined and reproducible ruga which can be reliably identified on successive models for each patient; $R'$ is its projecton on the median raphe.

On the initial cast, point $A$ is the intersection of a line connecting the most posterior aspect of the distal surfaces of the two second deciduous

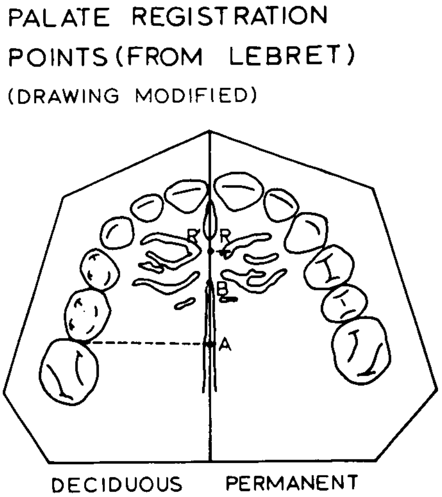



Fig. 1 Palate registration points for symmetrographic measurement. (From Lebret, 1962.)

molars and the median raphe. On succeeding casts location of point *A* is done by maintaining the same distance from *R'* along the raphe as measured on the initial cast. Thus, tooth shifting does not influence measurement of the palate. Point *B* is 10 mm anterior to point *A*.

Direct measurements of mandibular arch width were done by a Boley gauge at Time periods 1 and 3. Since most cases were in the mixed dentition, exfoliation of deciduous teeth produced an inconsistency in the number of pairs.

*Radiographs*

For thirty-eight subjects, lateral cephalograms were taken at Time periods 1 and 2. For eighteen of these subjects lateral cephalograms were also made at Time period 3.

Tracing and measuring were done directly on the radiographic film to the nearest .25 degree and .25 millimeter. Seven angular (SNA, SNB, ANB, Y-Axis, SNP, NS-Mand., NS-Pal.) and eight linear measurements (Fac. Ht., Gn-LI, N-LI, N-UI, N-Pal., SN-ANS, SN-PNS,S-N) were taken. The sella nasion line was selected as the cranial base reference line because of clarity of landmarks. Also, Wei[5], reporting on the comparative variability of five commonly used cranial reference lines, found the sella-nasion line to be the least variable.

Measurements of molars were attempted but discarded because of lack of confidence in the accuracy of tracing the images of maxillary and mandibular molars.

Magnification factors due to the divergence of the x-ray beams and the target-film distance were disregarded. Distances were held constant in all films and, therefore, the values reported are comparative not absolute.

## Effects of Palatal Expansion

*Contour*

Two cases with irregular contours, extreme narrowing, cleftlike anatomy, and furrows are illustrated in Figures 2 and 3, before and after rapid maxillary expansion.

Transverse palatal sections and their negatives at the levels of point *A* and point *B* are shown.

*Size*

Two cases have been selected to demonstrate the magnitude of increase in palatal width and palatal vault width that has occurred as a result of the expansion procedure (Figs. 4 and 5). They are the largest increases in this series.

Along with the cast records are symmetrographic tracings at various transverse levels.

*Tongue Activity*

Eruption of the maxillary and mandibular incisors after the expansion phase of the experiment was taken as evidence of a reduction in lingual hyperactivity and an improvement in PTR. Most dramatic were complete reductions in anterior open bites and their conversions to competent bites or deep overbites. This occurred spontane-

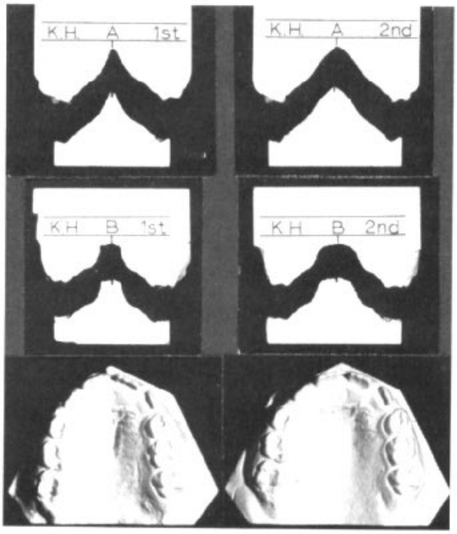



Fig. 2 Case K. H. Transverse sections of the maxillary casts and negatives at point A and point B. On the left, before rapid maxillary expansion; on the right, six months after. Negatives give the same depth perception as impressions. Occlusal views show the cleft-like anatomy at the posterior of the palate. Note the rounding of angular contours.

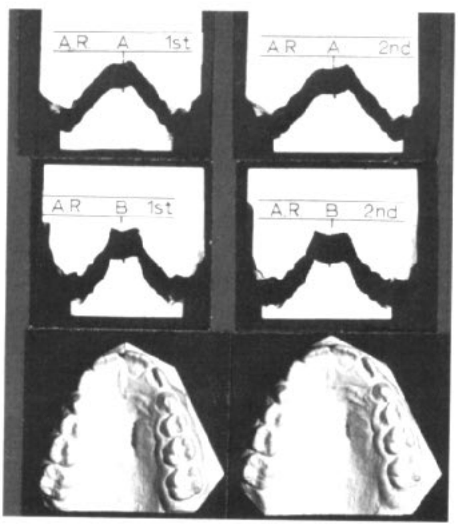



Fig. 3 Case A. R. Transverse sections of the maxillary casts and negatives at point A and point B. On the left, before rapid maxillary expansion; on the right, six months after appliance removal. The furrows in the point B area were partially due to fluctuant soft tissue. The increase in width has aided in making the contours less angular.

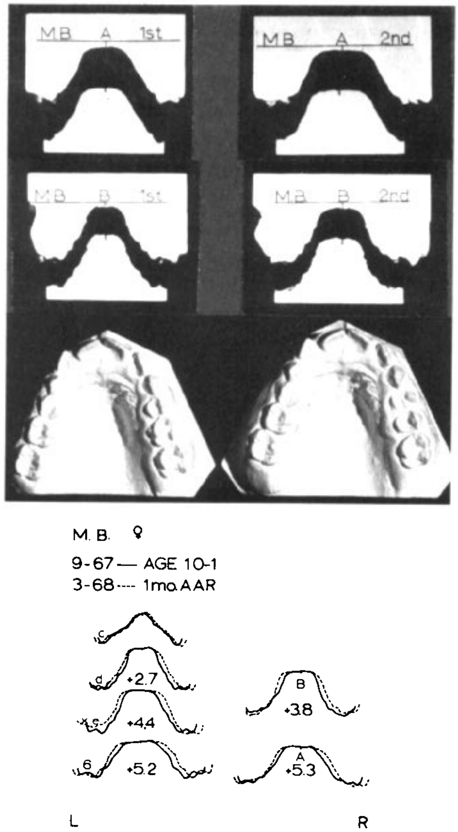



Fig. 4 Case M. B. Transverse sections of the maxillary casts and negatives at point A and point B. On the left, before maxillary expansion; on the right, six months after appliance removal. This case showed the largest increase in palatal vault width in the series. See Fig. 22 for cephalometric changes.

ously without appliances on the anterior teeth.

Two cases are exhibited in Figures 6 and 7. P.C. was followed for a longer interval than the experimental period to test for the possibility of reversion. None occurred.

## Results

Subjects were measured at three time periods, each subject serving as his own control. To determine the changes taking place, three sets of paired "t" tests were calculated.

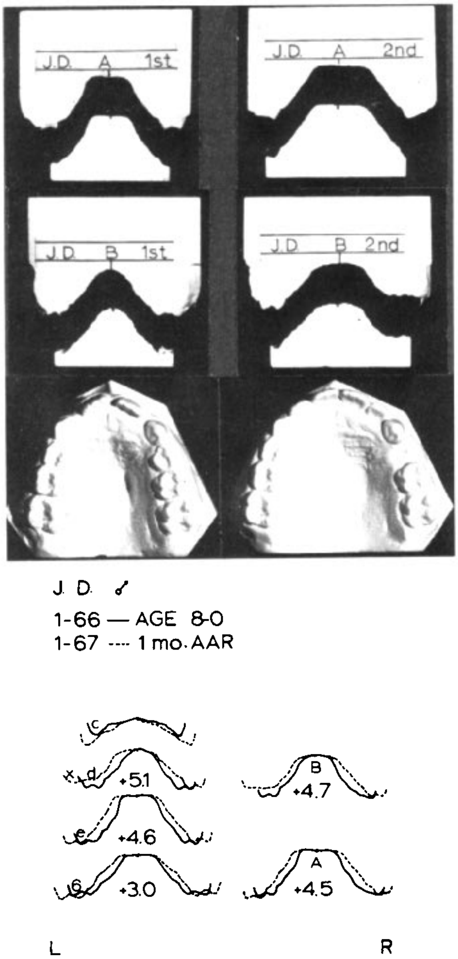



Fig. 5 Case J. D. Transverse sections of the maxillary casts and negatives at point A and point B. On the left, before maxillary expansion; on the right, twelve months after appliance removal. This case showed the next-to-largest increase in palatal vault width. Note the changes in incisal alignment and space closure. See Fig. 19 for cephalometric changes.

Test 1 measured the difference between the first and second time periods. This difference is subsequently referred to as $D_1$. Test 2 was the difference between the second and third time periods ($D_2$). Test 3 measured the over-all change from the initial to the final time period (D).

The rationale for doing three tests was that the author was initially interested in the changes induced by the treatment procedure between Time periods one and two; then between Time periods two and three, when the cases were not retained, to see whether there was a reversal toward the original condition; and finally, to evaluate whether any permanent changes could be detected at the end of the study.

*Palatal width*

Using Lebret's method[4] (Fig. 8) for palatal width or, as she termed it, "Palate breadth", measuring was done directly on the casts with the symmetrograph from the left gingival margin transversely to the right gingival margin. Fundamentally, this is an alveolar-dental dimension in contrast to palatal vault width which is the measure of the paired transverse palatine processes of the maxillary bones at the apex of the vault.

The data for palatal width are shown in Figure 9 in bar graph form with the number of observations, means of the three time periods, "t" values, and the degree of significance for the six dimensions given.

In all instances there was a statistically significant increase in width, followed by a real decrease; the increase in width from the original to the final measurement is also statistically significant.

*Palatal Height*

Again, Lebret's method was used for the study of palatal height. The data are given in Figure 10 and indicate that over-all increases at points *A* and *B* could have occurred by chance, but at the levels of the first permanent molars, first and second bicuspids, and cuspids, or their deciduous predecessors, statistically significant over-all increases occurred.

In the first molar area there is a small and nonsignificant increase when measured one month after appliance removal, but during the ensuing five

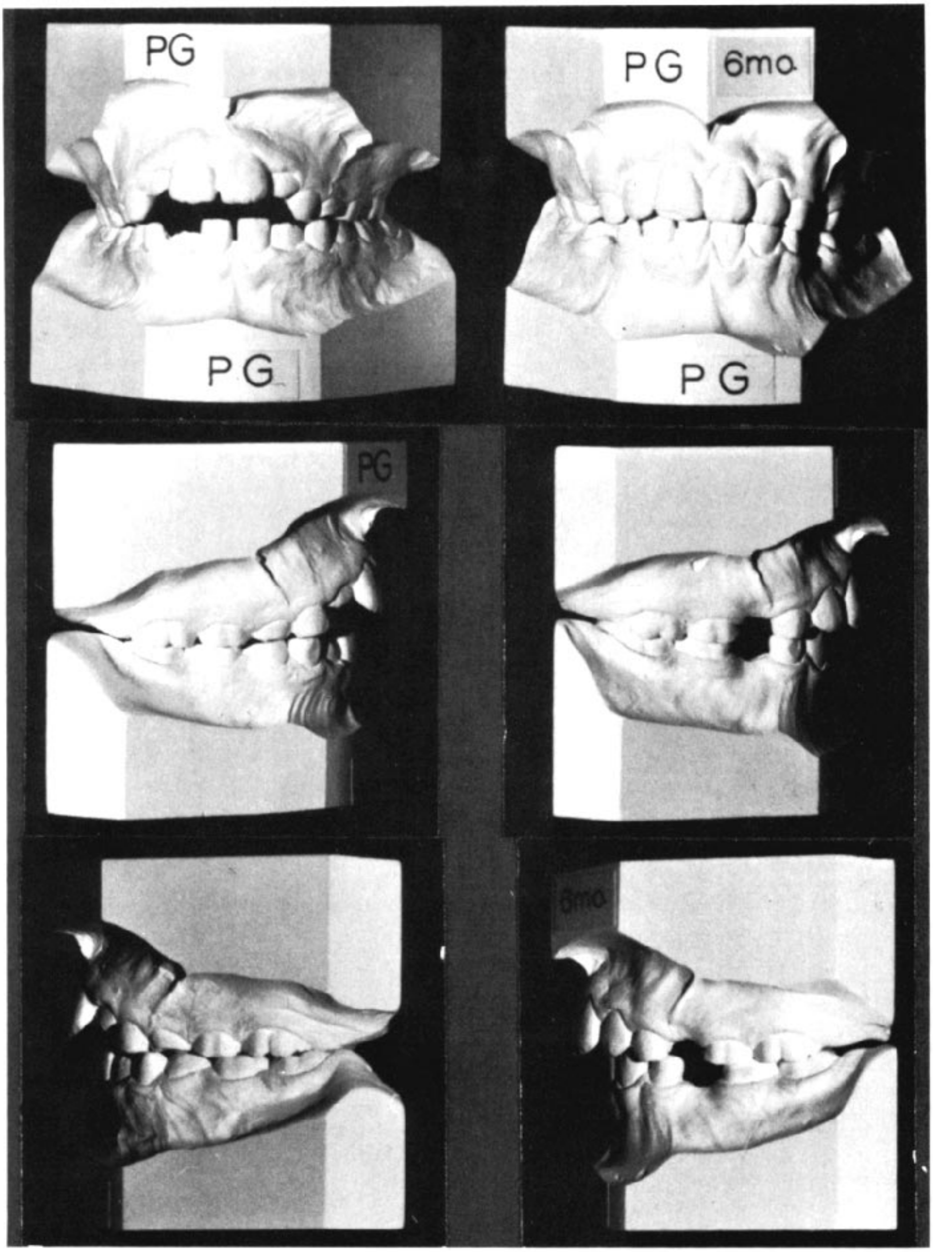



Fig. 6 Case P. G. Casts on the left are before maxillary expansion, and on the right, six months after the removal of the expansion appliance. Incisal eruption has occurred spontaneously. Note slight improvement in the Class II occlusion and midline deviation.

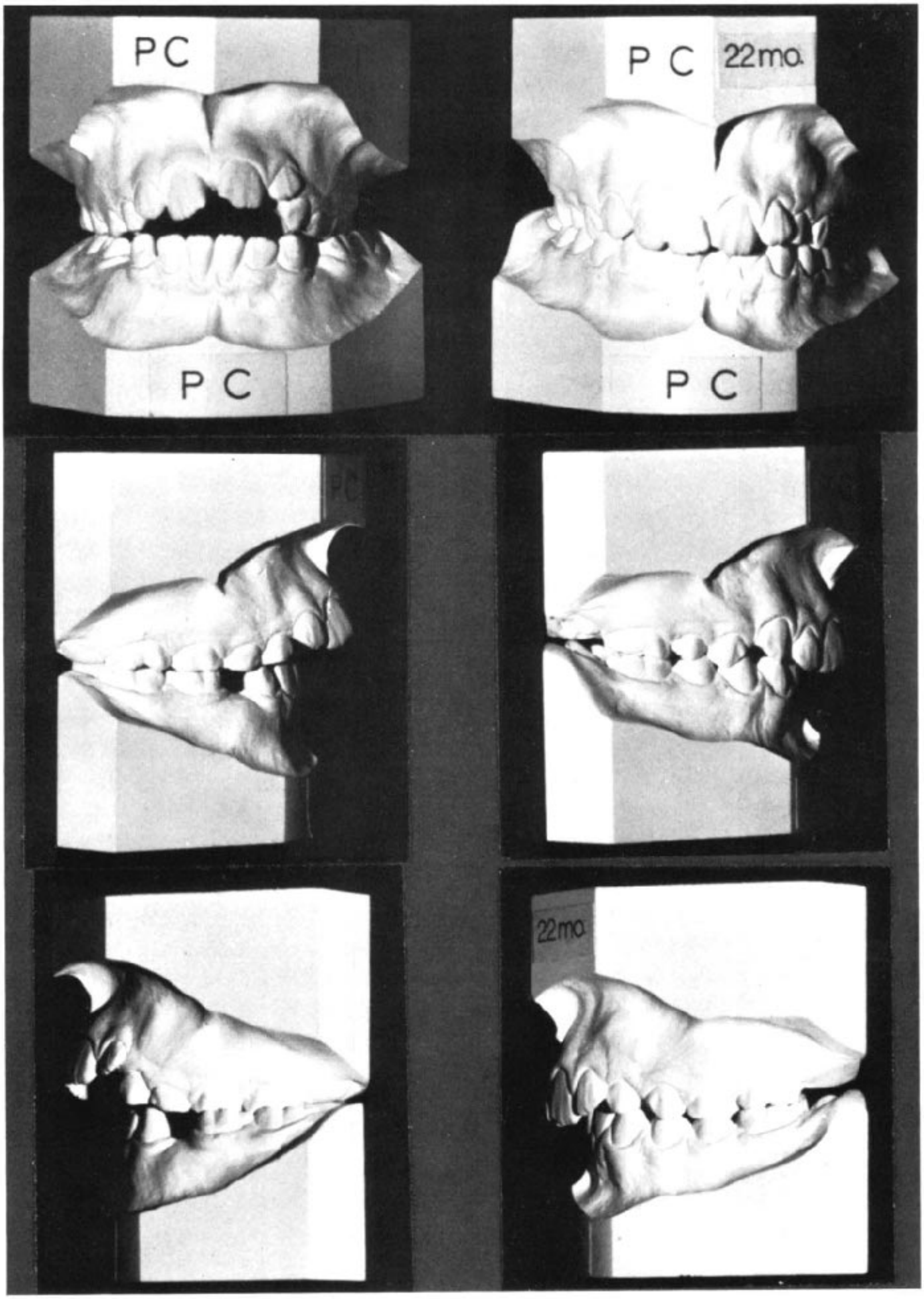



Fig. 7 Case P. C. Casts on the left are before maxillary expansion; on the right, twenty-two months after appliance removal. Midline space closure and incisal eruption have occurred spontaneously. Observe the depth of the overbite in the latter casts.

# PALATE DIMENSIONS (FROM LEBRET)

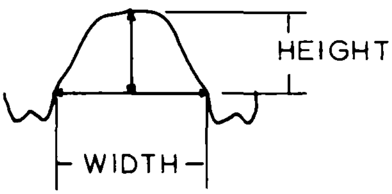
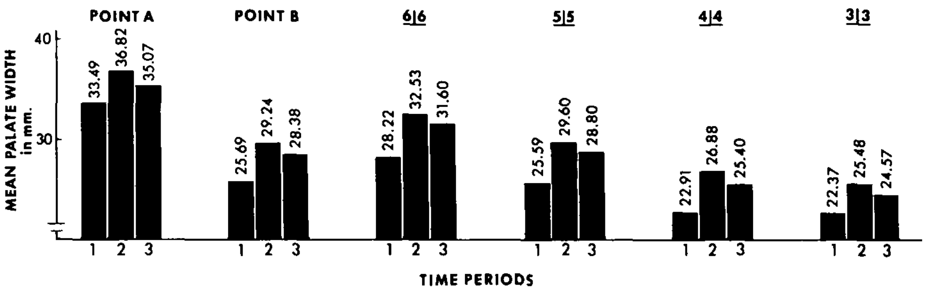



Fig. 8 Palate dimensions. Lebret used the term "palate breadth" instead of width; it is a dento-alveolar measurement.



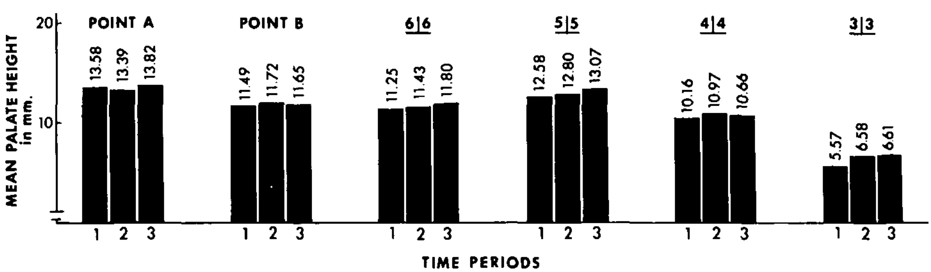

| | | | | | |
|---|---|---|---|---|---|
| $t_{37}(D_1) = 11.66$*** | $t_{37}(D_1) = 12.05$*** | $t_{36}(D_1) = 16.58$*** | $t_{36}(D_1) = 18.15$*** | $t_{34}(D_1) = 15.92$*** | $t_{29}(D_1) = 10.31$*** |
| $t_{37}(D_2) = 6.51$*** | $t_{37}(D_2) = 3.31$** | $t_{36}(D_2) = 4.78$*** | $t_{34}(D_2) = 3.81$*** | $t_{29}(D_2) = 4.09$*** | $t_{26}(D_2) = 3.69$** |
| $t_{37}(D) = 6.36$*** | $t_{33}(D) = 8.66$*** | $t_{35}(D) = 15.68$*** | $t_{32}(D) = 16.36$*** | $t_{20}(D) = 8.71$*** | $t_{20}(D) = 5.15$*** |

$D_1$ = DIFF. TIME PERIOD 2 MINUS TIME PERIOD 1
$D_2$ = " " " 3 " " " 2
D = " " " 3 " " " 1

* = P < .05
** = P < .01
*** = P < .001
N.S. = NOT SIGNIF.

TIME PERIOD 1 = MEAS. BEFORE TREATMENT
" " 2 = " 1 MO. A.A.R.
" " 3 = " 6 MO. A.A.R.
(A.A.R. = AFTER APPLIANCE REMOVAL)

Fig. 9 Mean palate width by specific measurements and time period of measurement.




| | | | | | |
|---|---|---|---|---|---|
| $t_{37}(D_1) = 1.60$ N.S. | $t_{37}(D_1) = 1.56$ N.S. | $t_{36}(D_1) = 1.20$ N.S. | $t_{36}(D_1) = 2.20$** | $t_{34}(D_1) = 6.66$*** | $t_{29}(D_1) = 4.36$*** |
| $t_{37}(D_2) = 3.47$** | $t_{37}(D_2) = 0.94$ N.S. | $t_{36}(D_2) = 4.19$*** | $t_{34}(D_2) = 1.65$ N.S. | $t_{29}(D_2) = 2.09$* | $t_{25}(D_2) = 0.82$ N.S. |
| $t_{37}(D) = 1.70$ N.S. | $t_{33}(D) = 0.56$ N.S. | $t_{36}(D) = 4.78$*** | $t_{33}(D) = 3.20$** | $t_{21}(D) = 2.52$* | $t_{21}(D) = 3.48$** |

$D_1$ = DIFF. TIME PERIOD 2 MINUS TIME PERIOD 1
$D_2$ = " " " 3 " " " 2
D = " " " 3 " " " 1

* = P < .05
** = P < .01
*** = P < .001
N.S. = NOT SIGNIF.

TIME PERIOD 1 = MEAS. BEFORE TREATMENT
" " 2 = " 1 MO. A.A.R.
" " 3 = " 6 MO. A.A.R.
(A.A.R. = AFTER APPLIANCE REMOVAL)

Fig. 10 Mean palate height by specific measurements and time period of measurement.

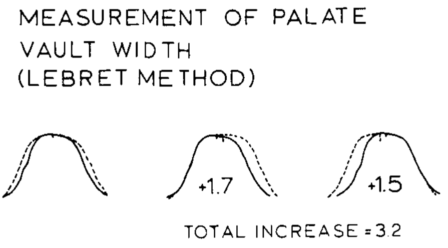



Fig. 11 Measurement of palate vault width (Lebret method). Left palate contour is superimposed and the distance between the midline hatches measured. Tracings then are shifted so that right palate contours superimpose and the distance between midline hatches is again measured. Total increase in vault width is the sum of the two increments.

months a marked increase in height is highly significant as is the over-all increase.

Interestingly, at the level of the other anchor tooth of the expansion appliance, the first deciduous molar or first bicuspid, a highly significant increase occurred during the first time period.

*Palatal Vault Width*

Since Lebret's method[2] of superimposing tracings measures only the differences in palatal vault width at the apex (Fig. 11), the data are presented in Figure 12 as the means of the differences.

Increases are large and real in all areas. The reversals that took place between one and six months after appliance removal are slight and not significant, except at point *B* where the decrease is barely significant at the five percent level of confidence. Thus, the gain in width at the apex of the vault could be considered permanent for the experimental period.

Configuration of the vault is so gradual and characterized by so many rugae in the cuspid area that comparisons could not be made with accuracy and were not computed.

*Mandibular Arch Width*

Figure 13 reveals the data for intra-arch width. Where deciduous teeth were succeeded by permanent teeth, the distances between the lingual surfaces of the teeth were compared. When similar teeth were present, the most reproducible points were used to plant the sharp tips of the Boley gauge.

Statistically significant increases in intra-arch width took place six months after appliance removal at the poster-

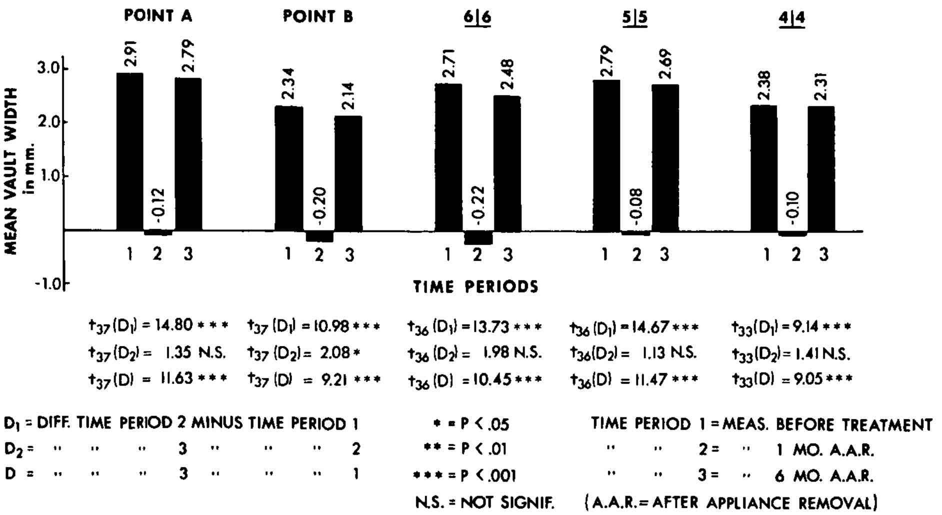



Fig. 12 Differences in mean palatal vault width by specific measurements and time period of measurement.

ior of the mandibular arch, but changes in the cuspid area could have occurred by chance. Maximal increments in the first permanent molar, second deciduous molar, and first deciduous molar areas were 2.3, 2.8, and 2.6 millimeters, respectively.

*Radiographic Tests*

The influence of palatal expansion on angles SNA, SNB, ANB, and SNP is shown by the data in Figure 14. SNA decreased slightly from $D_1$ to $D_2$, and then reversed from $D_2$ to $D_3$ but not to its original level. However, the changes were not statistically significant.

Both SNB and SNP showed a real decrease, followed by a real increase, with no real change as the final result. Angle ANB increased, then showed a real decrease, and no real change overall.

Using SN line as a base, three linear measurements (SN-ANS, SN-PNS,

CHANGES IN MANDIBULAR ARCH WIDTH

| | NO. PAIRS | MEAN DIFF. | STD ERROR | P |
|---|---|---|---|---|
| $\overline{6\|6}$ | 35 | 0.73 | 0.19 | <0.001 |
| $\overline{5\|5}$ | 31 | 0.86 | 0.18 | <0.001 |
| $\overline{4\|4}$ | 29 | 0.48 | 0.22 | <0.05 |
| $\overline{3\|3}$ | 22 | -0.29 | 0.27 | N.S. |

**Fig. 13 Specific measurements of intramandibular arch width.**

N-Pal) were made to the palatal line. In all instances there were strongly significant increases in these distances as the palate descended after appliance therapy. These data are shown in Figure 15.

Figure 16 (left) reveals the data for the inclination of the palatal plane to the NS-line. Very slight change was detectable and is statistically nonsignificant.

A constant finding in all cases was

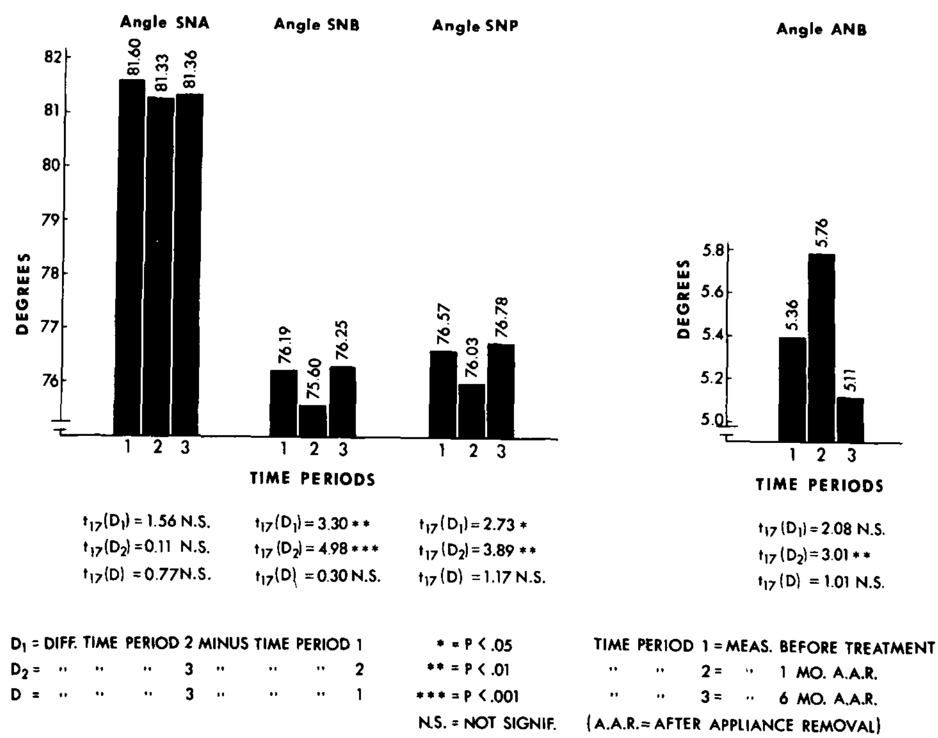
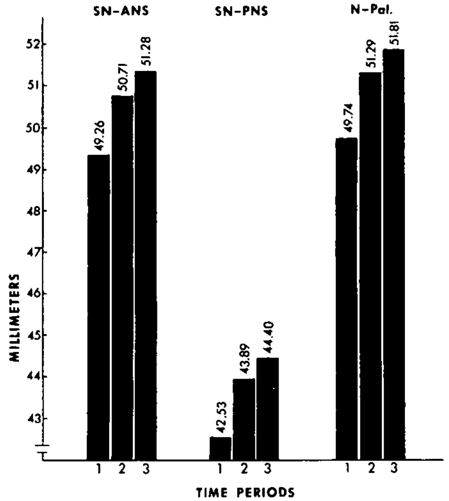



Fig. 14 Mean of angles SNA, SNB, SNP, and ANB by time period of measurement.




$t_{17}(D_1) = 6.51$ *** $t_{17}(D_1) = 8.63$ *** $t_{17}(D_1) = 9.11$ ***
$t_{17}(D_2) = 2.38$ * $t_{17}(D_2) = 4.69$ *** $t_{17}(D_2) = 2.30$ *
$t_{17}(D) = 7.36$ *** $t_{17}(D) = 10.93$ ** $t_{17}(D) = 8.76$ ***

$D_1$ = DIFF. TIME PERIOD 2 MINUS TIME PERIOD 1 * = P < .05
$D_2$ = " " " 3 " " " 2 ** = P < .01
D = " " " 3 " " " 1 *** = P < .001
N.S. = NOT SIGNIF.

TIME PERIOD 1 = MEAS. BEFORE TREATMENT

**Fig. 15 Mean of linear dimensions SN-ANS, SN-PNS, and N-Pal.**

the increase in vertical dimension or facial height. As seen in Figure 16 (center), the changes during $D_1$, $D_2$, and total change are all strongly significant.

Viewing Figure 16 (right), linear measurement from center of sella turcica to nasion increased significantly during $D_1$, then continued to increase but not as markedly from $D_2$ to D, with the final gain statistically significant.

Both Y-Axis and NS-Mand angular measurements showed real increases, then real decreases, with the final result no real change. These data are presented in Figure 17.

When studied in relation to their respective bases, maxillary and mandibular incisors exhibit significant amounts of eruption during all phases (Fig. 18 N-UI, Gn-LI). However, the amount of eruption of the mandibular incisors did not compensate for the inferior movement of the chin, as the distance from nasion to the mandibular incisors increased significantly one month after appliance removal and overall (Fig. 18 N-LI).

## Discussion

Previous workers[1,6] have reported increases in palatal width as a result of the rapid maxillary expansion procedure. The data in the present study support this finding and reveal a significant and permanent increase in width at the apex of the vault. Very little relapse occurs in this area during the experimental time period.

However, gains made in dento-alveolar width, although real at the conclusion of the experimental period, are subject to a significant relapse after the initial gain when not retained. Proportionately, this could be a response toward functional occlusion, since the gains in mandibular intra-arch width are not as extensive.

The functional effects of the procedure are improvement in tongue action during deglutition, mastication, and speech; reduction of manifest tongue activity; and eruption of mandibular and maxillary incisors in open-bite and incompetent bite cases. These would seem to validate the hypothesis of Palate-Tongue Relativity.

Nevertheless, the procedure is not without undesirable side effects. There is a universal increase in facial height which continues to increase in a significant manner for at least six months after appliance removal. This appears to be related to continued inferior movement of the palatal plane and to eruption of the maxillary first permanent molars, as seen in the cast study of palatal height.

Initially there is an inferior and posterior movement of the mandible. However, this posterior movement reverses so that six months after appli-

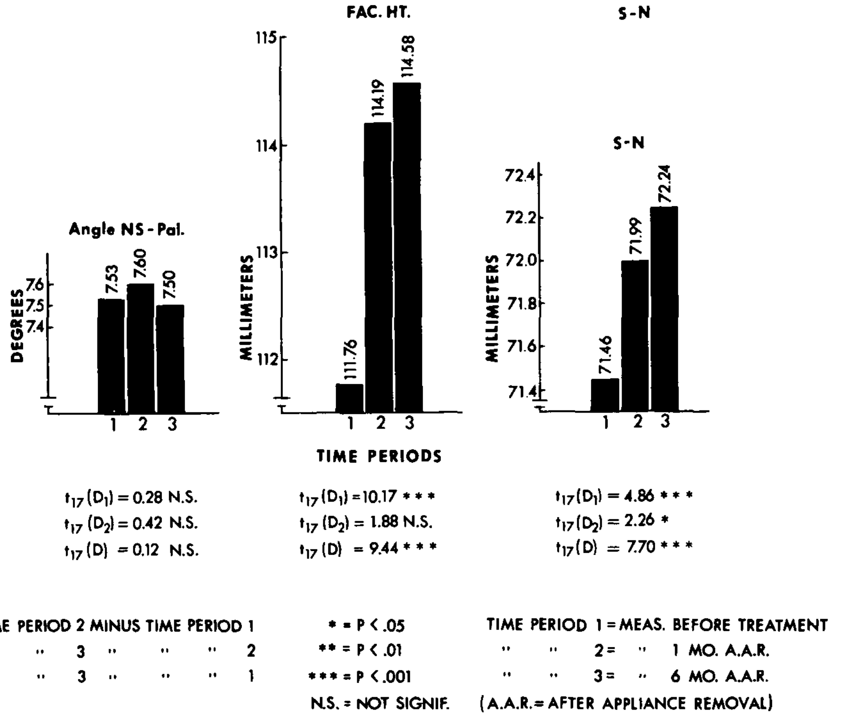



Fig. 16 Left - Mean angle NS-Pal. Center - Mean of linear dimension Fac. Ht. Right - Mean of linear dimension S-N.

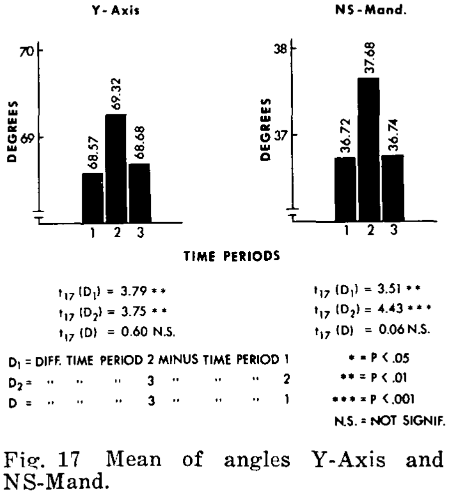



Fig. 17 Mean of angles Y-Axis and NS-Mand.

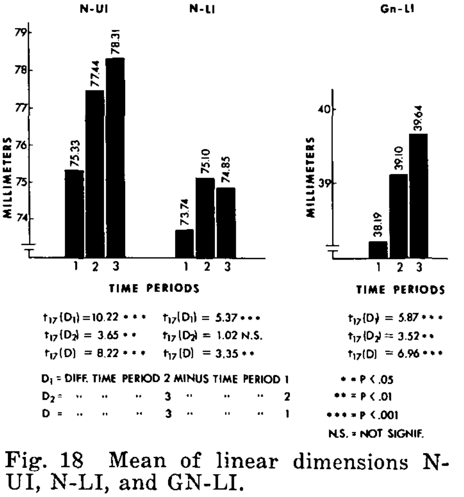



Fig. 18 Mean of linear dimensions N-UI, N-LI, and GN-LI.

ance removal there is no significant change from the original.

Since the character of the tongue is not available in radiographic and cast records, recognition of unfavorable PTR is done by clinical examination. All patients in the present investigation gave the impression of an inability to contain the tongue within the oral cavity with ease. In relation to the tongue, the palatal area appeared abnormally constricted, and normalization of tongue environment became a fundamental goal of treatment.

For each of these patients rapid maxillary expansion represented the first step in the complete correction of the malocclusion. In most instances extraction or nonextraction therapy was decided at the outset but in some, this decision was postponed until the effects of expansion were evident. It was found that, despite the statistically significant increase in arch width, most of the arch lengthening took place by the incisors becoming more procumbent.

Case J. D. is representative of a group of three patients whose crowded, irregular incisors spaced and rotated into normal alignment. Figure 19 shows the change in axial inclination and position of the maxillary incisors. Incisal procumbency, succeeding retruded, crowded incisors, is viewed as an alteration of equilibrium between the labial and lingual musculature, and this consideration is included in final treatment planning.

Toward the end of the statistical work-up an important question arose. "How much increase in palatal vault width is necessary to produce a favorable dental response?" Correlations between palatal vault width at point *A* and at point *B* and N-UI and Gn-LI were computed and all proved to be nonsignificant.

Increases in vault width ranged from 1.0 to 5.3 millimeters at point *A* and

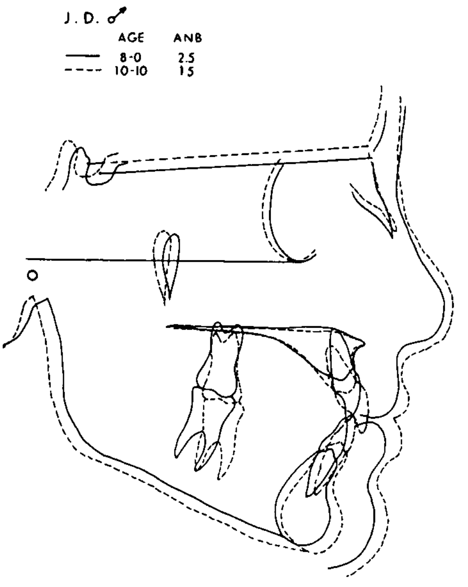



Fig. 19 Case J. D. Cephalometric tracings with maxillary outlines superimposed and registered on ANS. Note the downward and forward movement of the maxillary incisors. This procumbent effect produced an increase in arch length which enabled the incisors to rotate and align (See Fig. 5) and is viewed as an alteration of equilibrium between labial and lingual musculature.

0.2 to 3.8 millimeters at point *B*. All cases exhibited maxillary incisal eruption ranging from 1.0 to 6.25 millimeters. With the exception of one case, mandibular incisors also erupted in all instances, the range being 0.25 to 2.75 millimeters.

No indication was obtained from the data for determining the magnitude of increase in palatal vault width which would produce a desirable dental response. However, when maxillary expansion proceeded to the point where the buccal inclines of the lingual cusps of the maxillary first permanent molars were just lingual to the apex of the buccal cusps of the mandibular first permanent molars, the following was seen: (a) Mandibular buccal segments widened. (b) The tongue was able to function with a new degree of freedom.

(c) A new equilibrium between it and the buccal musculature was established.

As the maxillary buccal segments relapsed lingually during the "no-retention" phase, the mandible was impelled anteriorly. Decidedly, this is detrimental in Class III cases but advantageous in some Class II cases.

Patients who benefitted most from the procedure were those with Class II malocclusions and low FMA angles. Initial clockwise rotation of the mandible was compensated for by adequate growth which in most cases produced a net improvement in mandibular position. Furthermore, increased facial height did not detract from these faces. However, caution must be exercised in cases with high FMA angles. Not only does mandibular response make Class II correction more difficult, it also causes facial lengthening which may be irreversible and, in some instances, disfiguring. The author's attention is now being directed toward overcoming these adverse side effects by mechanotherapy. The principles and methods for this mechanotherapy are described and depicted by Haas[7].

Three cases from the experimental group have been selected for their clinical interest, and cephalometric records during the three time periods are shown.

*Case R. M.* (Fig. 20)

This was the only Class III case in the series. With SNB 80 degrees before treatment, the malocclusion could be classified as pseudo-Class III, but an anterior crossbite did exist, the subnasal area appeared deficient, and the mandible was prominent.

One month after appliance removal a very favorable response for the Class III condition was seen. The palate had descended, B point had gone down and back, ANB had changed from minus 0.5 degrees to plus 0.5 degrees, the

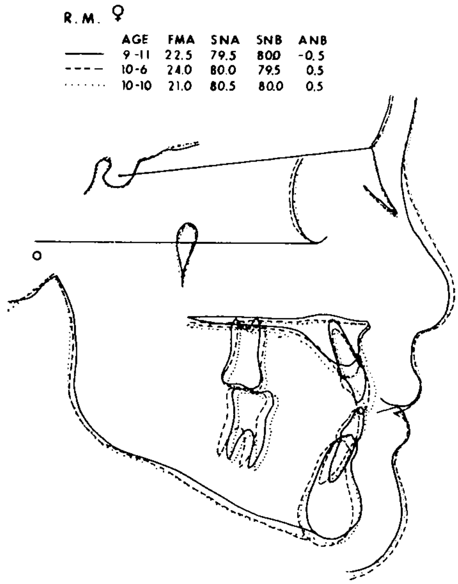



**Fig. 20 Case R. M. Cephalometric tracings at three time periods of the one Class III case in this series. Time period 1: One month after appliance removal chin point had gone down and back, FMA had increased, incisors had erupted and moved forward. Time period 2: Four months after appliance removal, chin point had moved upward and forward, FMA had decreased below original angle, incisors had become more procumbent.**

open bite had closed, and the anterior crossbite had corrected. FMA had increased. Nevertheless, four months after appliance removal the strong Type C growth trend[8] was evident. The palatal plane had continued its descent, but FMA had closed to 21 degrees from an original 22.5 degrees. ANB remained the same and the overjet remained normal.

Subsequent to the completion of the present study, two similar cases were treated by rapid maxillary expansion. In both instances an initial increase in ANB was followed by reversal and strong Type C growth. It is now standard procedure in the author's practice to institute chin cap therapy immediately after stabilization of the expansion appliance.

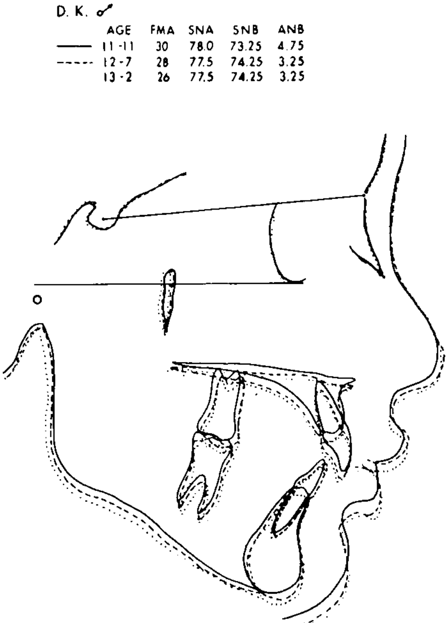



Fig. 21 Case D. K. Cephalometric tracings at three time periods of the case with the most favorable growth response in the Class II group. Type C growth is evident. FMA and ANB have decreased during Time periods 1 and 2.

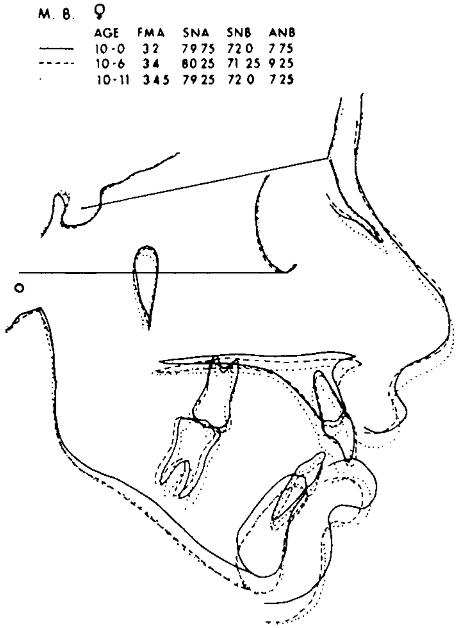



Fig. 22 Case M.B. Cephalometric tracings at three time periods of the case with the least favorable growth response in the Class II group. She had the largest increase in palatal vault width (See Fig. 4) and in facial height. Time period 1: Note the downward tipping of the palate posteriorly and the clockwise rotation of the mandible. Time period 2: Palatal plane has recovered somewhat by the downward movement of ANS. Most of the decrease in ANB has been from the posterior movement of point A. FMA has continued to increase.

*Case D. K.* (Fig. 21)

This case showed the most favorable response of the Class II group. One month after appliance removal the palatal plane had descended, but the mandible responded with Type C growth. FMA closed, and B point came forward. ANB decreased 1.5 degrees.

Eight months after appliance removal the Type C growth trend had continued. FMA and ANB had continued to decrease.

*Case M. B.* (Fig. 22)

This patient had the greatest increase in facial height in the series, 4.25 millimeters. During Time period 1 the palatal plane descended and tipped downward posteriorly, wedging the mandible down and back. FMA and ANB increased sharply.

Six months after appliance removal, FMA had continued to increase. ANB had closed to 7.25 from an original 7.75 degrees, due chiefly to the reduction of SNA. The overbite had continued to increase and the overjet to decrease. At this time the face appeared "too long".

## Summary

By means of rapid maxillary expansion the shape and size of the palate were altered in thirty-eight subjects. Although no retention was employed, the significant increase achieved in vault width remained. From the widened position the maxillary dentoalveolus relapsed to a significant degree, but there was still a statistically significant net gain in width.

A new equilibrium was achieved between maxillary and mandibular teeth. This was due in part to widening of the mandibular arch in the first molar and bicuspid areas.

Tongue activity, which was originally hyperactive, subsided sufficiently to permit eruption of maxillary and mandibular incisors. This seemed to validate Palate-Tongue Relativity as a functional hypothesis.

There was pronounced inferior growth of the palate and eruption of the maxillary first permanent molars. This forced the mandible downward and produced a universal increase in anterior facial height. These changes continued in most cases through the period of study and represented an undesirable side effect in those cases with high Frankfort-mandibular angles.

After the initial setback the mandible responded by growing forward to a point slightly anterior to its original position. However, this change was not statistically significant.

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