# ORTHODONTIC INFLUENCE

# ON THE SOFT TISSUE PROFILE

by

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"The only thing permanent in life is change."

The face of man is involved in many functions. Speech, digestion, emotion and respiration represent several, but one of its greatest roles is in the social acceptance and psychological well-being of an individual. Many patients come to us with only this one thought in mind, and if a pleasing, functional result is achieved, the orthodontist is praised, and if the end result is less satisfactory, the familiar phrase of "poor growth" is employed. Individual variation has then intervened and upset our planned modification of the environmental and hereditary influences.

A question of concern in orthodontics is the amount of soft tissue profile change that can be permanently produced through orthodontic treatment. A general concern is experienced when practitioners speak of a "dished in" or a flattened concave facial appearance of a patient following orthodontic treatment.

Two questions which seem of importance in helping to understand the effects of treatment on the dentofacial complex are, first, what amount of soft tissue change is achieved orthodontically, (beyond that attributed to the normal growth); and secondly, how much of this change occurs in the post-retention period into adulthood.

Interest in facial profile is apparent almost since the beginning of time, as seen in the sculptures, paintings and artifacts which have been recovered from ancient Egyptian, Greek and Roman civilizations up to the present time. Through these early works of art is seen a concept of cultural profile beauty and ideals. As an example, the idolized Egyptians exhibited a round, broad face with sloped forehead, evenly contoured nose and mild chin, while the Greeks looked toward a more prominent forehead with a straight sweep from the forehead to the tip of the nose and a well-defined chin. Cultural influence was also demonstrated recently when fifty American whites and fifty American blacks ranked facial photographs of ten black females. The American whites and blacks ranked those with Caucasion features as the most attractive, as opposed to fifty African blacks who ranked those with Negroid characteristics as most attractive.(1) The influence of mass media on fashioning our tastes cannot be overlooked.

It is little wonder, then, that orthodontics has been aware of facial changes, esthetics and their relation to orthodontic treatment, and has given its attention to modifying the form and function of the human face as well as the dentition. There are two concepts which may be responsible for the relatively few quantitative investigations that have been done on soft tissue facial profile. First, orthodontic treatment is primarily concerned with hard tissue manipulations, and secondly, it had been assumed that if the teeth are arranged to a given standard, the soft tissue will automatically drape in the most harmonious manner.(2) An opposing concept,

expounded from the time of Case, is that of altering the profile by reducing what is often called a "bimaxillary protrusion."

Many clinical observations and opinions can be found throughout orthodontic literature. Angle considered the mouth to be the most important part of the face, and that the best balance, the best harmony, and the best proportions of the mouth in its relation to other features requires that there shall be a full complement of teeth, and that each tooth shall be made to occupy its normal position.(3)

Case's awareness of profile change was exemplified by taking careful plaster profile records of pre and post-treated cases.(4) He states that the dentofacial area (fig.1) is naturally divided into four transverse zones of movement, according to the areas that can be moved separately by a movement of the crowns or the roots of the underlying teeth and alveolar process, and that if the labial teeth are moved bodily backward or forward, the overlying dentofacial zones will respond in proportion to the movement.

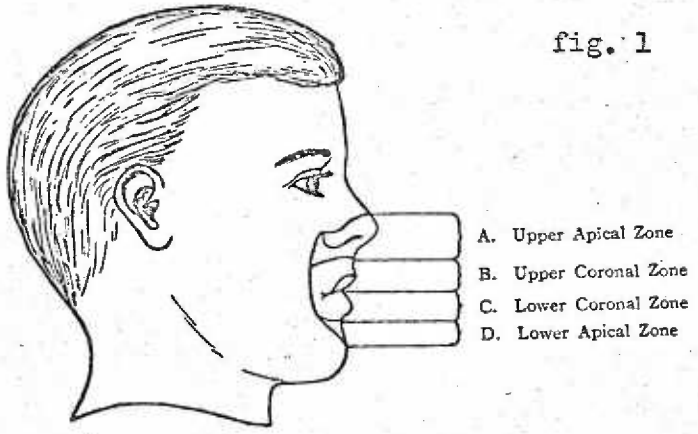



fig. 1

Wuerpel emphasized the importance of retaining the facial type presented by the patient by every possible means, and warned, "If you had but

one fixed idea of what an ideal face should look like, you might as well have been a baker and turn out great quantities of loaves, one exactly like the other."(5) Mershon, in 1935, stated "the subject of facial change is a problem of growth and development, and extractions cause deformity of the face because the mouth has a flat look, the nose looks larger because the mouth falls back, and the chin takes on added prominence."(6)

Hambleton qualitatively summarizes much of the current thinking on profile change: 1) The face in the area of the maxilla becomes less convex with age in relation to the rest of the skeletal profile; 2) The soft tissue over the maxillary bone becomes thicker; 3) The mandible grows forward more and later in males than it does in females; 4) The soft tissue follows the bone of the mandible forward; 5) The nose grows downward and forward during adolescence; and 6) The lips become larger with growth and thickening occurs in the vermillion portion.(7)

Subtelney used head films of thirty subjects three to eighteen years of age to study longitudinally the changes in the hard and soft tissue and quantitatively describes changes in the nose, chin, lips and teeth.(8) He concludes that all parts of the soft tissue profile do not directly follow the underlying bony profile, in that the nose and soft tissue point A showed progressively increased anterior prominence, while the integumental chin and lips reflected the modification in the underlying hard tissue. He also states that, although the skeletal convexity tended to decrease with age, as also stated by Bjork(9) and Lande (10), the convexity of the soft tissue, including nasal structures, tended to increase with age, as Elsasser found.(11) Negar states that a proportionate change or improvment in the integumental profile does not necessarily accompany extensive denti-

tion changes.(12) Bloom, projecting before and after treatment headfilms of sixty patients, concluded that soft tissue response is closely related to the orthodontically moved hard tissue structures, finding correlations ranging from r=.73 to r=.93 for linear change of upper and lower incisors with upper and lower lips and soft tissue concavities.(13) Rudee also correlated the movement of the upper and lower incisors with the movement of the upper and lower lips in eighty-five treated cases, finding correlation coefficients of r=.72 and r=.70 respectively.(14) He concluded that the full responsibility for undesirable facial alterations in a patient is oftened shouldered by the orthodontist, when in reality the changes are a product of physiologic development, and thus beyond his influence. Conversely, orthodontists take credit for gratifying results following orthodontic therapy when these same physiologic factors of growth and development have been the more important factors in molding facial contours.

Wylie used a "soft tissue angle of convexity" in evaluating twenty-nine cases treated by Tweed as to the angulation and movement changes of the lower incisors to change in soft tissue, finding correlations of r=.01 (net change in ∠ of lower incisors to border of mandible with net change in soft tissue ∠ of convexity) and r=.17 (net change, in mm, of lingual movement of lower incisor edge with net change in soft tissue ∠ of convexity).(15) Stoner, studying fifty-seven cases treated by Tweed, states that lower incisors, although indirectly, have a great deal of influence on facial esthetics, but he could show no correlations between lower incisors and soft tissue lips and chin greater than r= -.37. (16)

No quantitative study could be found relating to post-treatment soft tissue changes. However, Baum measured lateral headfilms of twenty-three males and twenty-one females with a mean time span of three years post

treatment, and plotted the mean change in the distance from the upper central incisor plane to the tip of the nose, pogonion and soft tissue chin point.(17) He noted different responses as to age and sex and concluded that when orthodontic treatment is completed before or during the period of developmental growth, a progressive change in the location of the denture in relation to the rest of the face can be expected. The denture will become less protrusive, especially in boys, where these changes have usually already been effected in girls of the same age. No statistical information as to the variation present within each group and the ages or the number of individuals from which the mean changes were derived was given.

A statistical study asking the fundamental questions, 1) what amount of soft tissue change could be achieved orthodontically beyond what was expected by normal development, and 2) what was the long-term prognosis of such a change, seems in order.

## MATERIALS AND METHOD

The control or non-treated group included in the present study consisted of ten male and sixteen female caucasion children enrolled in the longitudinal child study program at the University of Oregon. They were selected because of continuous cephlometric, photographic and model records from at least ten years through eighteen years of age. The orthodontically treated group consisted of eight male and eight female caucasion children and was selected because post-treatment records showed retraction of the lower incisors of at least 3mm using mandibular superimposition at the symphysis. In addition, this sample had to be available for records at least three years post-retention.

Several additional restrictions placed on both samples required that the lateral headplates show 1) relatively good soft and hard tissue definition, 2) molar teeth in occlusion, 3) lips in contact or in what was thought to be a relaxed relation as determined by examination of pre or post-radiographs or agreement with photographs taken at the same time.

The beginning age of the control group was selected by matching the dentitions (mixed or permanent) with the beginning models of the treated group. The latest records available above eighteen years of age were used to compare with the post-retention age of the treated group.

The osseous landmarks and reference lines used in this study are as follows:

Sella: the center of the bony crypt occupied by the hypophysis cerebri.

N asion: the most anterior point of the frontomasal suture.

Pogonion: the most anterior point located on the curvature of the symphysis of the mandible located by swinging a rule centered on nasion.

Nose: the most everted point of the nose tangent to a line drawn parallel to the N-P line.

Soft tissue A: the most inverted point of the integumental convexity at the root of the nose tangent to a line drawn parallel to N-P line.

Upper lip: the most everted point of the upper lip tangent to a line drawn parallel to N-P line.

Lower lip: the most everted point of the lower lip tangent to a line drawn parallel to N-P line.

Soft tissue B: the most inverted point of the labiomental groove tangent to a line drawn parallel to N-P line.

Chin: the most everted point of the chin tangent to a line drawn parallel to N-P line.

A N S: the most everted point of anterior nasal spine tangent to a line drawn parallel to N-P line.

Point A: the most inverted point of the maxilla tangent to a line drawn parallel to N-P line.

Upper incisor: the most everted point of the upper incisor tangent to a line drawn parallel to N-P line.

Lower incisor: the most everted point of the lower incisor tangent to a line drawn parallel to N-P line.

Point B: the most inverted point of the mandible tangent to a line drawn parallel to N-P line.

The age breakdown of the sample was as follows:

SAMPLE AGE

| | | Begin. of Trmt. | End of Trmt. | Post Ret. |
|---|---|---|---|---|
| Treated: | $\bar{X}$ | 11 yrs. 5 mos. | 16 yrs. 6 mos. | 23 yrs. 4 mos. |
| | R | 10-2 to 15-10 | 13-5 to 19-4 | 18-2 to 28-0 |
| Non-treated: | $\bar{X}$ | 11 yrs. 2 mos. | 15 yrs. 1 mos. | 19 yrs. 2 mos. |
| | R | 10-0 to 13-0 | 12-6 to 17-0 | 18-0 to 22-1 |

The films were traced as shown in figure 2, on acetate tracing film. Before marking any reference points, each was observed over the three film series to minimize point location error. Measurements were then recorded from the N-P line using a modified boley guage read to the nearest .1 mm.

To isolate some of the variables in locating landmarks, ten patients with three films each were selected at random and second tracings were made in the manner described above. The standard error of measure (S E meas.) was then calculated for the following measurements and angles:

TABLE I

S E meas.* of 10 Subjects (30 headplates) in mm

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Soft Tissue | SNP | Nose | A | UL | LL | B | Chin |
| | .27 | .22 | .15 | .14 | .12 | .16 | .21 |
| Hard Tissue | ANS | A | UI | LI | B | | |
| | .41 | .21 | .11 | .26 | .18 | | |

* S E meas. $= \sqrt{\frac{\sum d^2}{2N}}$ which gives us the average difference from the average of any measurements.

To obtain estimates of errors arriving from positioning of subject and change in tonacity of facial musculature, tracings were made of subjects at 11 and 11.6 years of age and standard error of measurements between the films calculated.

TABLE II

S E meas. Between Films of 10 Subjects at 11 and 11.6 yrs.(mm)

| Soft tissue | SNP | Nose | A | UL | LL | B | Chin |
|---|---|---|---|---|---|---|---|
| | .24 | .38 | .52 | .71 | .37 | .28 | .37 |

| Hard tissue | ANS | A | UI | LI | B |
|---|---|---|---|---|---|
| | .34 | .36 | .17 | .26 | .14 |

The amount of change was then calculated between the before and end of treatment radiographs, and the end of treatment and post-retention radiographs and S E meas. of change calculated for each of the landmarks. If the agreement between the changes of two different tracings was less than the S E meas. of change, the mean change of the measurements was then used. If the change between the two tracings differed by more than the S E meas. of change, two more measurements of the landmarks were made, and the mean change of the four measurements was used in the final calculations.

TABLE III

S E meas. of Change for 10 subjects (40 films)

| Soft tissue | TN | A | UL | LL | B | Chin |
|---|---|---|---|---|---|---|
| | .44 | .51 | .40 | .52 | .43 | .42 |

| Hard Tissue | SNP | ANS | A | UI | LI | B |
|---|---|---|---|---|---|---|
| | .54 | .62 | .42 | .26 | .25 | .32 |

The enlargement factor due to the changing of cephlometric headholders in the treated sample was found to be less than 2% (3.9 mm over a 200 mm distance) and, therefore, was not corrected for, due to the small (0-10 mm) distances over which most of the measurements were made.

## FINDINGS

The findings of this study are found in Tables IV and V. Statistically, the only significant difference of soft tissue measurements was that of upper and lower lips. No significant differences at the beginning of treatment could be demonstrated for the nose, soft tissue point A, soft tissue point B, chin or angle SNP. A significant difference in means could not be shown for either the end of treatment or post-treatment time. Soft tissue point A, upper lip, lower lip and soft tissue point B all showed a significant difference in change in the before treatment to post-treatment period. Soft tissue point A, upper and lower lip showed a significant difference in change for the periods before to end of treatment, end of treatment to post-treatment, and before to post-treatment.

A significant difference in change between the treated and non-treated groups is also noted for ANS, point A, upper incisor and lower incisor, and point B in the before treatment to end of treatment period. The only significant difference in the end of treatment to post-treatment period was point A and upper incisor. The upper and lower incisor means differ at both the before and after treatment times. There are no significant differences in hard or soft tissue means at the post-treatment stage.

## DISCUSSION

In studying the hard and soft tissue changes of a non-treated and an orthodontically treated sample during a period of early adolescence to early adulthood, a wide range of individual variation was noted. (Fig. 3 & 3a).

As the dentition was retracted in the treated group, the soft tissue points A and B, upper lip, and lower lip appear to recede (1.2 to 2.7 mm) as opposed to the non-treated group where almost no changes (-.2 to +.2) are observed. To determine if any relationship existed between treatment and soft tissue changes, correlations between the upper and lower incisors and soft tissue points nose, A, upper lip, lower lip, B and chin were run. (Table V). The correlations were surprisingly less for the lips than had been previously reported(13), with no correlation being higher than r=.34. To check this disparity (r=.26 vs. r=.87 for upper incisor with upper lip) the coordinates of a scattergram representing r=.87 were refigured and the correlation coefficient recalculated. The result was a r=.44 which appears to better describe the data presented. One explanation for the relatively low correlation of the upper lip with upper incisor is apparent in Table III in the variability in the tonacity of the upper lip from one film to the next. The negative correlation of r= -.22 for the nose and r= -.19 for the chin indicate that, although the dentition is being retracted, in relation to N-Pog, these structures tended to become more prominent, therefore giving the facial profile a flatter appearance from that originally presented.

Although no significant difference between the two groups for angle SNP exists, the slightly higher mean change of the treated group, (2.43° vs. 1.98°) probably reflects the older post-treatment age of the treated group and is close to the mean difference of 2.77° which Bjork found in his study of Swedish males at ages 12 and 22.

The significant difference in the mean change of ANS, A and B between the two groups is not surprising because of their close bony relationship with the upper incisor (retracted an average of 6.4 mm) and lower incisor (retracted an average of 4.8 mm). The higher correlation when these points are related to the dentition, as opposed to the soft tissue, reflects their close bony relationship, e.g., the change in point A with the change of the upper incisor (r=.51).

It is interesting to further note the effect of treatment on the upper and lower incisors and lips. Before treatment, the dentition and lips of the treated group were significantly more prominent than the non-treated group (2-4 mm), but by the end of treatment no difference was noted in the lips, and the incisors were retracted to a point of being significantly different, but in the opposite direction (approx. 1 mm). This is better seen in fig. 4, 4-A, 5 and 5-A. When the graphs are extended to the post-treatment period, a convergence is indicated for the incisors of both groups, whereas the lips tend to diverge post-treatment. A possible explanation might be that the soft tissue is still readapting to the new denture position long after orthodontic treatment is completed. The opposite situation appears for hard tissue points ANS, A, and upper and lower incisors which tended to advance after treatment (tenths of mm), whereas the non-treated sample continued to recede slightly.

That no significant differences of means was found at the post-treatment time of measurement appears to indicate a return to a similar developmental pattern between the groups after orthodontic treatment.

## SUMMARY AND CONCLUSIONS

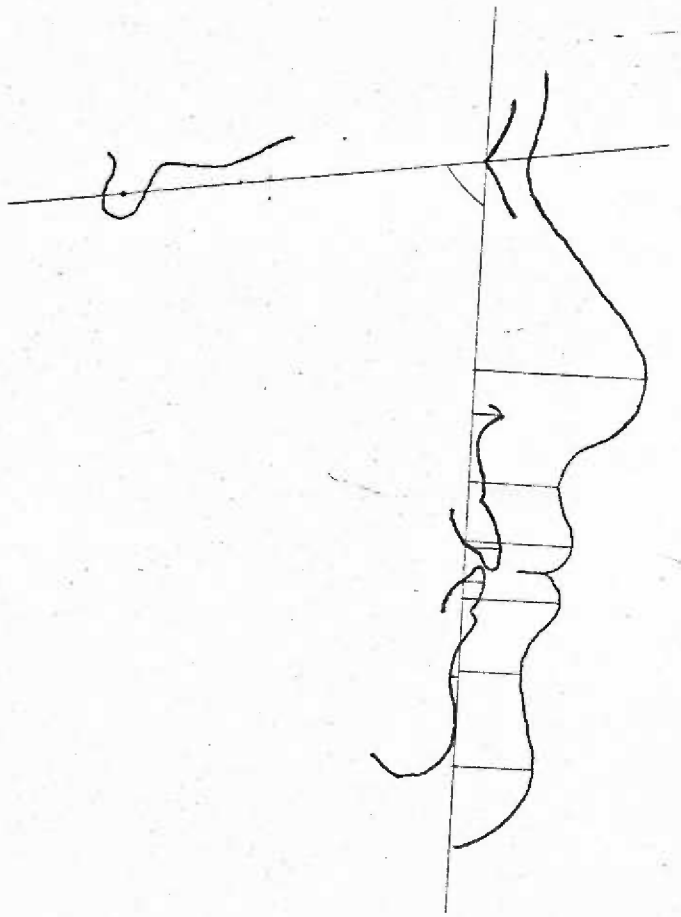
The influence of orthodontic treatment on hard and soft tissue profile was investigated by studying a non-treated and an orthodontically treated group.

Signigicant differences in soft tissue change were demonstrated between the two groups for soft tissue point A, upper lip, lower lip and soft tissue point B during treatment. The change appeared to be relatively stable, as no significant difference between the sample means could be demonstrated at the post-treatment time of measurement.

Correlations of change in soft tissue with dentition changes in the treated group were too low to be of any clinical significance.

Significant differences in mean change between the samples were reflected at ANS, point A, upper incisor, lower incisor, and point B. The post-treatment changes in the hard tissue were minimal (tenths of mm), and no significant difference between the groups could be demonstrated at the time of post-treatment measurement.

A return to a similar developmental pattern appeared to take place during the period following active orthodontic treatment.



Method Used for Describing Facial Profile

Fig. 2

## TABLE IV

### DIMENSIONAL CHANGES DURING PERIOD OF OBSERVATION

| | Non-treated (N = 26) | | | | Treated (N = 16) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | $S^2$ | R | Mean | SD | $S^2$ | R | t |
| **SNP°** | | | | | | | | | |
| Before trmt. | 77.7 | 2.72 | 7.43 | 71.5+81.7 | 76.8 | 2.15 | 4.64 | 73.5+80.5 | 1.15 |
| End trmt. | 79.3 | 3.42 | 11.72 | 72.0+83.3 | 78.4 | 2.67 | 7.14 | 75.1+82.5 | 1.41 |
| Post trmt. | 79.6 | 2.90 | 8.43 | 72.0+84.0 | 79.2 | 2.77 | 7.70 | 74.5+83.5 | .67 |
| Before-end tr. | 1.6 | 0.82 | 0.68 | -0.2+ 3.3 | 1.6 | 1.82 | 3.33 | -2.0+ 6.0 | 0.05 |
| End-post trmt. | 0.3 | 0.81 | 0.67 | -1.0+ 2.1 | 0.8 | 0.93 | 0.87 | -0.5+ 2.5 | 1.66 |
| Begin-post tr. | 1.9 | 1.09 | 1.19 | -0.5+ 3.7 | 2.4 | 1.81 | 3.28 | -1.0+ 6.0 | .99 |
| **ANS** | | | | | | | | | |
| Before trmt. | 7.2 | 2.42 | 5.85 | 3.0+11.8 | 7.9 | 2.48 | 6.19 | 3.9+13.0 | .98 |
| End trmt. | 6.9 | 3.07 | 9.46 | 2.3+13.5 | 6.0 | 2.91 | 8.44 | 0.5+12.5 | .85 |
| Post trmt. | 6.6 | 2.99 | 8.97 | 0.9+11.7 | 6.0 | 3.22 | 10.39 | 0.5+12.5 | .52 |
| Before-end tr. | -.3 | 1.33 | 1.77 | -3.1+ 2.2 | -1.9 | 1.49 | 2.22 | -5.4+ 0.4 | 3.81** |
| End-post trmt. | -.3 | 0.86 | 0.75 | -1.8+ 1.3 | 0.0 | 1.03 | 1.06 | -1.7+ 3.2 | 2.61** |
| Begin-post tr. | -.6 | 1.33 | 1.78 | -3.1+ 2.7 | -1.9 | 1.62 | 2.61 | -5.1+ 0.0 | 2.69** |
| **A** | | | | | | | | | |
| Before trmt. | 2.7 | 2.13 | 4.55 | -1.1+ 7.0 | 4.4 | 2.21 | 4.91 | 2.0+ 9.0 | 2.44** |
| End trmt. | 2.3 | 2.59 | 6.72 | -0.3+ 6.2 | 1.1 | 2.67 | 7.18 | -3.1+ 6.7 | 1.34 |
| Post trmt. | 1.7 | 2.46 | 6.09 | -3.1+ 5.8 | 1.2 | 2.83 | 8.02 | -2.6+ 7.2 | .71 |
| Before-end tr. | -.4 | 0.86 | 0.75 | -2.9+ 0.9 | -3.3 | 2.04 | 4.18 | -7.0+ 0.2 | 6.63** |
| End-post trmt. | -.6 | 0.74 | 0.54 | -2.9+ 0.5 | 0.1 | 0.78 | 0.61 | -1.7+ 1.7 | 2.82** |
| Begin-post tr. | -1.0 | 0.94 | 0.88 | -3.1+ 0.8 | -3.2 | 1.73 | 3.00 | -6.5+ 0.9 | 5.25** |

Table 1V cont.

| | Mean | SD | $S^2$ | R | Mean | SD | $S^2$ | R | t |
|---|---|---|---|---|---|---|---|---|---|
| **UPPER INCISOR** | | | | | | | | | |
| Before trmt. | 8.4 | 2.37 | 5.64 | 3.1+12.1 | 12.3 | 2.52 | 6.36 | 7.2+15.3 | 5.08** |
| End trmt. | 7.6 | 2.98 | 8.92 | 0.5+12.5 | 5.4 | 2.03 | 4.13 | 1.8+ 9.3 | 2.58** |
| Post trmt. | 7.1 | 2.92 | 8.55 | 0.8+12.0 | 5.9 | 2.72 | 7.41 | 1.8+10.8 | 1.44 |
| Before-end tr. | -0.8 | 1.24 | 1.55 | -4.3+ 0.9 | -6.9 | 2.58 | 6.66 | -11.1+ 1.0 | 10.70** |
| End-post trmt. | -0.4 | 0.93 | 0.96 | -2.8+ 2.0 | 0.5 | 1.13 | 1.28 | -2.4+ 0.2 | 2.82** |
| Begin-post tr. | -1.3 | 1.42 | 2.03 | -4.7+ 0.7 | -6.4 | 3.16 | 10.01 | -13.5+ 0.5 | 5.25** |
| **LOWER INCISOR** | | | | | | | | | |
| Before trmt. | 3.6 | 1.81 | 3.28 | 0.7+ 7.5 | 7.0 | 2.13 | 4.57 | 2.8+10.5 | 5.17** |
| End trmt. | 3.4 | 2.27 | 5.17 | -0.9+ 8.0 | 2.0 | 2.20 | 4.87 | -1.9+ 6.5 | 1.94** |
| Post trmt. | 3.3 | 2.48 | 6.19 | -0.6+ 8.9 | 2.2 | 2.61 | 6.82 | -2.5+ 6.3 | 1.25 |
| Before-end tr. | -0.2 | 1.10 | 1.21 | -3.2+ 1.2 | -5.0 | 1.43 | 2.03 | -7.3+ 3.1 | 12.73** |
| End-post trmt. | -0.1 | 0.53 | 0.28 | -1.4+ 0.9 | 0.2 | 1.05 | 1.01 | -2.2+ 1.5 | 1.45 |
| Begin-post tr. | -0.3 | 1.36 | 1.85 | -3.3+ 1.7 | -4.8 | 1.63 | 2.67 | -7.1+ 3.1 | 9.33** |
| **POINT B** | | | | | | | | | |
| Before trmt. | -1.4 | 0.75 | 0.57 | -2.8+ 0.0 | -0.5 | 0.68 | 0.47 | -1.9+ 0.8 | 3.69** |
| End trmt. | -2.2 | 0.98 | 0.96 | -4.2+ 0.5 | -2.5 | 1.70 | 2.89 | -5.0+ 1.4 | 0.84 |
| Post trmt. | -2.3 | 0.95 | 0.91 | -3.9+ 0.5 | -2.7 | 1.70 | 2.91 | -5.9+ 1.0 | 1.05 |
| Before-end tr. | -0.8 | 0.57 | 0.33 | -1.9+ 0.3 | -1.9 | 1.30 | 1.69 | -3.3+ 0.3 | 4.00** |
| End-post trmt. | -0.1 | 0.30 | 0.09 | -0.7+ 0.5 | -0.2 | 0.42 | 0.18 | -1.0+ 0.6 | 0.79 |
| Begin-post tr. | -0.9 | 0.76 | 0.58 | -2.2+ 0.1 | -2.2 | 1.29 | 1.68 | -4.0+ 0.2 | 4.24** |

$t_{.95}(30) = 1.70$

TABLE V

DIMENSIONAL CHANGES DURING PERIOD OF OBSERVATION

| | Non-treated (N = 26) | | | | Treated (N = 16) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | $S^2$ | R | Mean | SD | $S^2$ | R | t |
| **Nose*** | | | | | | | | | |
| Before trmt. | 30.2 | 2.38 | 11.47 | 21.4+35.5 | 31.2 | 3.32 | 11.04 | 27.0+38.8 | .41 |
| End trmt. | 33.6 | 3.56 | 12.65 | 27.3+38.3 | 34.3 | 2.60 | 6.79 | 31.0+38.8 | .69 |
| Post trmt. | 34.5 | 3.10 | 9.60 | 27.6+40.5 | 34.9 | 2.64 | 6.98 | 31.0+40.0 | .43 |
| Before-end tr. | 3.4 | 1.61 | 2.58 | .5+ 8.0 | 3.1 | 2.79 | 7.80 | 0+ 6.6 | .44 |
| End-post trmt. | 0.9 | 1.40 | 1.95 | - .3+ 4.7 | .6 | 1.67 | 2.80 | -1.4+ 5.5 | .45 |
| Begin-post tr. | 4.3 | 1.81 | 3.30 | .5+ 8.6 | 3.7 | 2.54 | 6.44 | 0+ 8.5 | .75 |
| **Soft Tis. A** | | | | | | | | | |
| Before trmt. | 16.9 | 2.87 | 8.26 | 12.3+22.7 | 18.3 | 2.40 | 5.78 | 15.4+23.4 | 1.64 |
| End trmt. | 16.7 | 3.00 | 9.04 | 11.4+23.7 | 17.0 | 1.78 | 3.20 | 14.8+21.1 | .40 |
| Post trmt. | 17.0 | 3.18 | 10.13 | 11.7+22.6 | 15.7 | 2.06 | 4.25 | 14.0+21.7 | 1.36 |
| Before-end tr. | 0.2 | 1.75 | 3.05 | -5.0+ 2.2 | -1.3 | 1.45 | 2.10 | -5.0+ 0.1 | 3.06** |
| End-post trmt. | 0.3 | 1.49 | 2.24 | -3.7+ 2.8 | -1.2 | 1.24 | 1.53 | -2.9+ 0.9 | 3.40** |
| Begin-post tr. | 0.1 | 2.11 | 4.49 | -2.9+ 0.9 | -2.5 | 1.30 | 1.70 | -4.9+ 0.7 | 4.47** |
| **Upper Lip** | | | | | | | | | |
| Before trmt. | 20.1 | 3.34 | 11.18 | 12.6+25.2 | 23.2 | 2.87 | 8.26 | 18.6+28.2 | 2.90** |
| End trmt. | 19.9 | 3.39 | 11.50 | 13.4+26.4 | 20.5 | 2.44 | 5.95 | 17.2+25.6 | .37 |
| Post trmt. | 20.5 | 3.85 | 14.88 | 13.4+28.0 | 19.2 | 2.17 | 4.74 | 13.8+21.2 | 1.22 |
| Before-end tr. | -.2 | 2.34 | 5.46 | -5.0+ 4.3 | -2.7 | 1.91 | 3.64 | -6.1+ 0.0 | 3.71** |
| End-post trmt. | 0.6 | 1.83 | 3.36 | -5.0+ 3.1 | -1.2 | 1.70 | 2.89 | -6.3+ 0.7 | 3.31** |
| Begin-post tr. | 0.4 | 2.78 | 7.76 | -6.1+ 5.2 | -3.9 | 2.17 | 4.71 | -8.4+ 1.5 | 5.33** |

* N = 13 in treated sample due to nose cut on 3 films

Table V cont.

| | Mean | SD | $S^2$ | R | Mean | SD | $S^2$ | R | t |
|---|---|---|---|---|---|---|---|---|---|
| **Lower Lip** | | | | | | | | | |
| Before trmt. | 17.2 | 3.20 | 10.28 | 10.4+22.5 | 19.4 | 3.18 | 10.13 | 14.4+24.1 | 2.19** |
| End trmt. | 17.2 | 2.91 | 8.46 | 11.9+22.5 | 17.3 | 2.40 | 5.78 | 13.2+21.6 | .18 |
| Post trmt. | 17.7 | 3.23 | 10.42 | 11.9+24.7 | 16.3 | 1.81 | 3.28 | 12.9+19.0 | 1.57 |
| Before-end tr. | .0 | 1.77 | 3.16 | -5.2+ 3.1 | -2.1 | 2.69 | 7.23 | -6.1+ 3.5 | 3.16** |
| End-post trmt. | .5 | 1.43 | 2.07 | -2.2+ 4.0 | -1.0 | 1.28 | 1.63 | -2.8+ 0.9 | 3.64** |
| Begin-post tr. | .5 | 2.27 | 5.16 | -3.0+ 4.6 | -3.1 | 2.60 | 6.77 | -7.0+ 1.4 | 4.96** |
| **Soft Tis. B** | | | | | | | | | |
| Before trmt. | 9.6 | 2.36 | 5.57 | 6.0+12.7 | 10.2 | 1.25 | 1.57 | 8.3+12.2 | 1.15 |
| End trmt. | 9.8 | 2.36 | 5.58 | 7.5+13.1 | 9.6 | 1.47 | 2.16 | 7.0+12.5 | .29 |
| Post trmt. | 9.7 | 2.35 | 5.54 | 6.6+13.0 | 9.6 | 1.60 | 2.56 | 7.5+12.0 | .08 |
| Before-end tr. | .2 | 1.17 | 1.39 | -1.9+ 3.1 | -1.2 | 2.37 | 5.63 | -3.5+ 2.5 | 2.84** |
| End-post trmt. | -.1 | 0.75 | 0.57 | -1.8+ 1.8 | 0.0 | 0.73 | 0.54 | -1.0+ 1.7 | .50 |
| Begin-post tr. | .1 | 1.26 | 1.59 | -2.0+ 2.6 | -0.6 | 1.68 | 2.83 | -3.8+ 2.5 | 1.65 |
| **Chin** | | | | | | | | | |
| Before trmt. | 11.4 | 2.04 | 4.16 | 7.8+15.1 | 11.5 | 1.56 | 2.45 | 8.5+14.5 | .06 |
| End trmt. | 12.0 | 1.74 | 3.03 | 9.0+15.2 | 12.4 | 1.52 | 2.32 | 9.9+14.6 | .46 |
| Post trmt. | 12.3 | 1.60 | 2.57 | 9.0+16.0 | 12.5 | 1.77 | 3.14 | 9.2+15.7 | .41 |
| Before-end tr. | .6 | 1.06 | 1.14 | -1.1+ 3.2 | 0.9 | 1.49 | 2.21 | -2.0+ 3.6 | .47 |
| End-post trmt. | .3 | 0.58 | 0.33 | -1.0+ 1.2 | 0.1 | 1.06 | 1.12 | -1.5+ 2.9 | 1.09 |
| Begin-post tr. | 1.0 | 1.21 | 1.43 | -2.1+ 3.6 | 1.0 | 1.28 | 1.64 | -1.0+ 3.3 | 0.10 |

$t_{.95}(30) = 1.70$

TABLE VI

Correlation of change of upper incisor with the change of:

| | | Begin.to End of Trmt. | Begin to Post Trmt. |
|---|---|---|---|
| Treated Group | A N S | r = .40 | r = .24 |
| | Point A | r = .51 | r = .43 |
| | Nose * | r = -.22 | r = -.58 |
| | Soft Tissue A | r = .23 | r = .30 |
| | Upper Lip | r = .26 | r = .18 |
| | Lower Lip | r = .23 | r = .33 |

*N = 13 due to nose cut on 3 films

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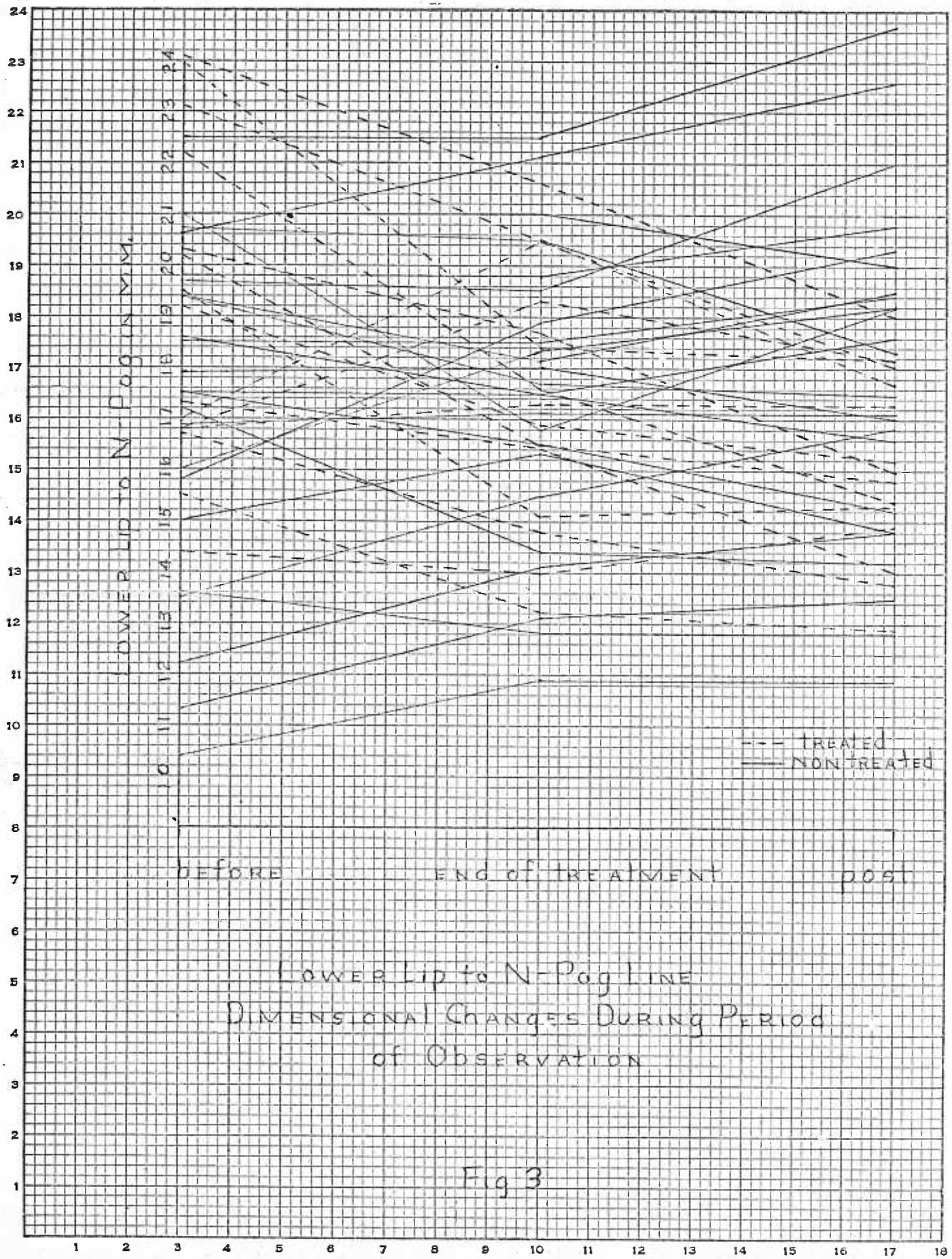
TABLE VII

Correlation of change of lower incisor with the change of:

| | Begin to End of Trmt. | Begin to Post Trmt. |
|---|---|---|
| Upper Lip | r = .34 | r = .41 |
| Lower Lip | r = .34 | r = .22 |
| Soft Tissue B | r = -.02 | r = .01 |
| Chin | r = -.19 | r = -.27 |
| Point B | r = .33 | r = .53 |
| Upper incisor with lower incisor | | r = .75 |




Lower Lip to N-Pog Line
Dimensional Changes During Period
of Observation

Fig 3

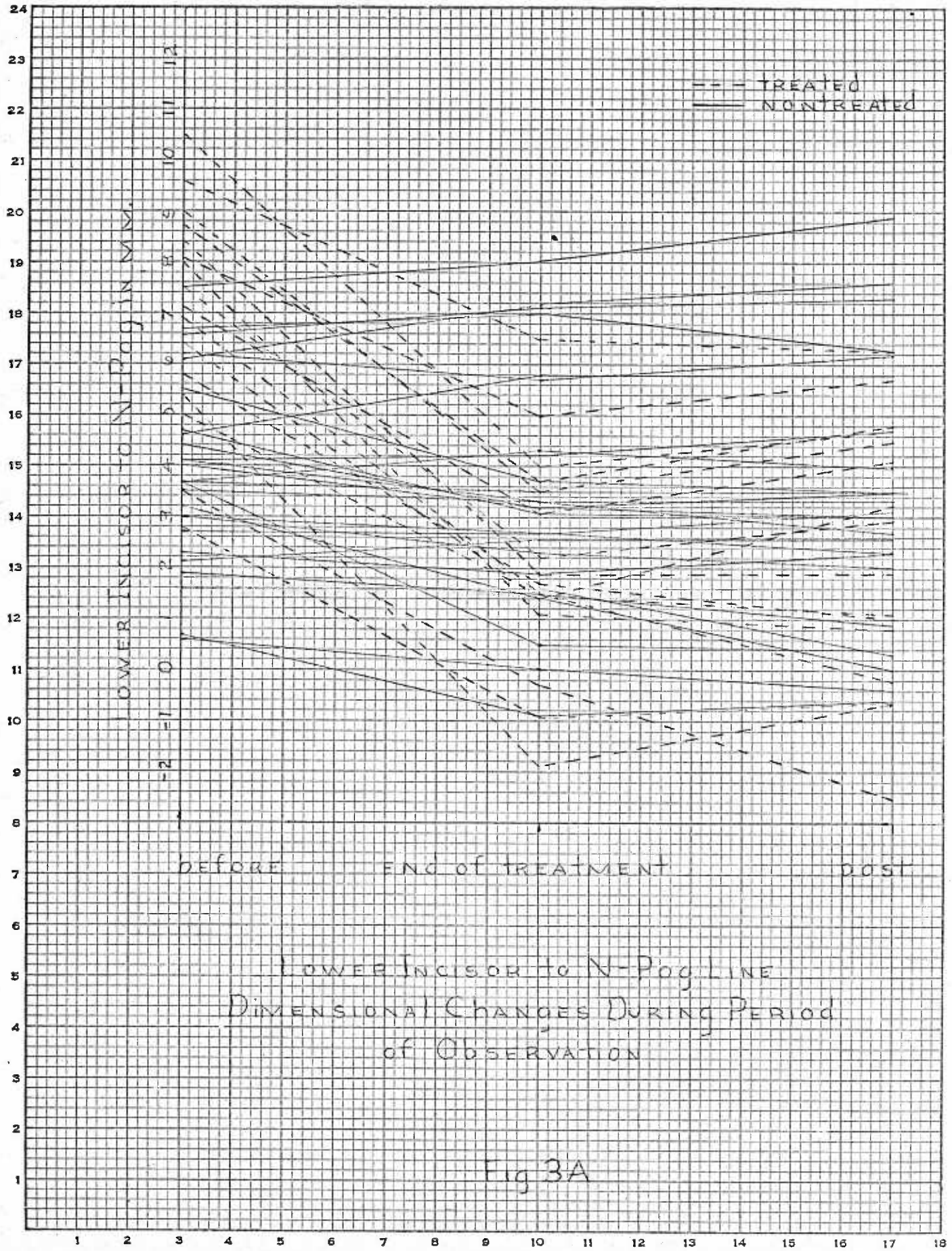
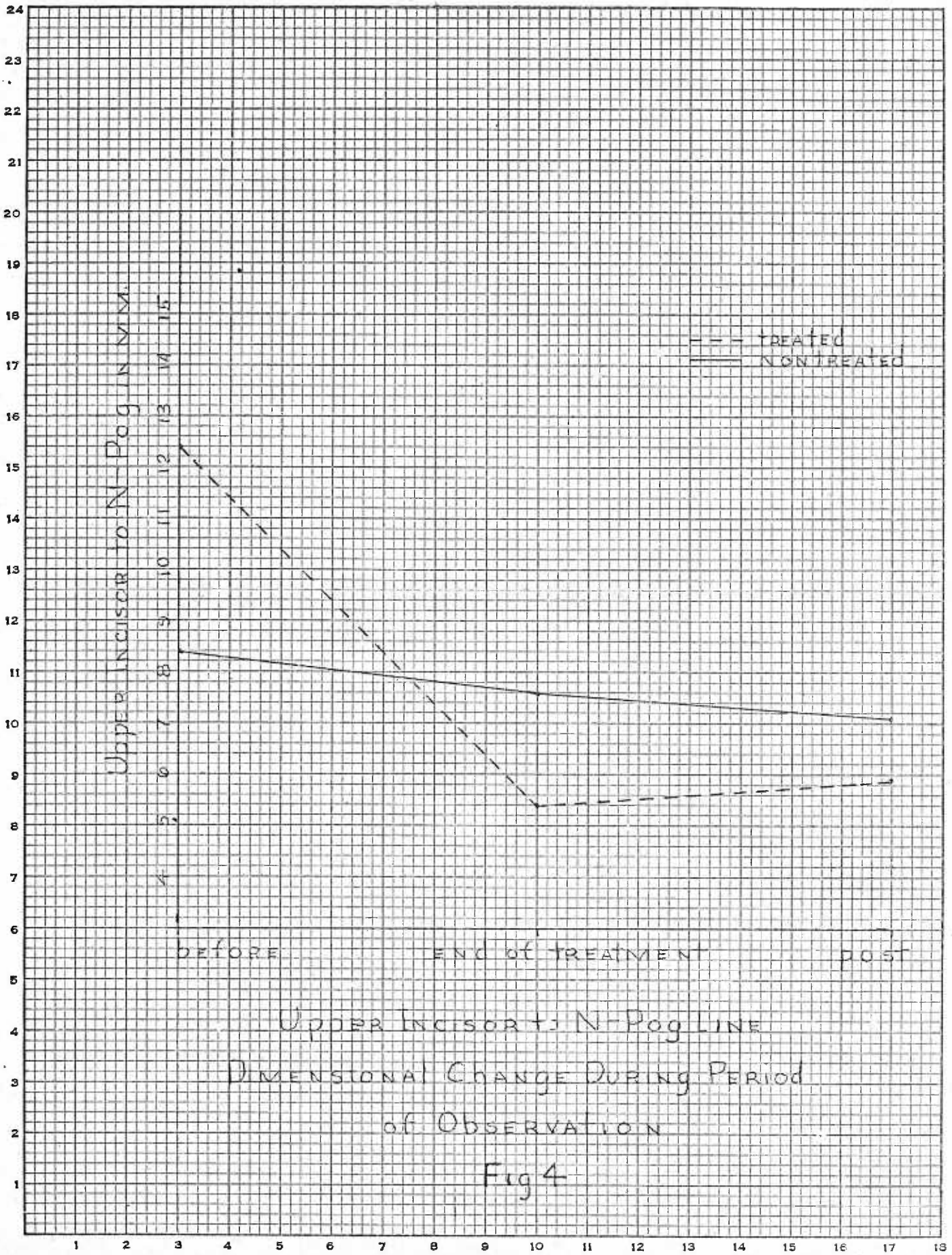
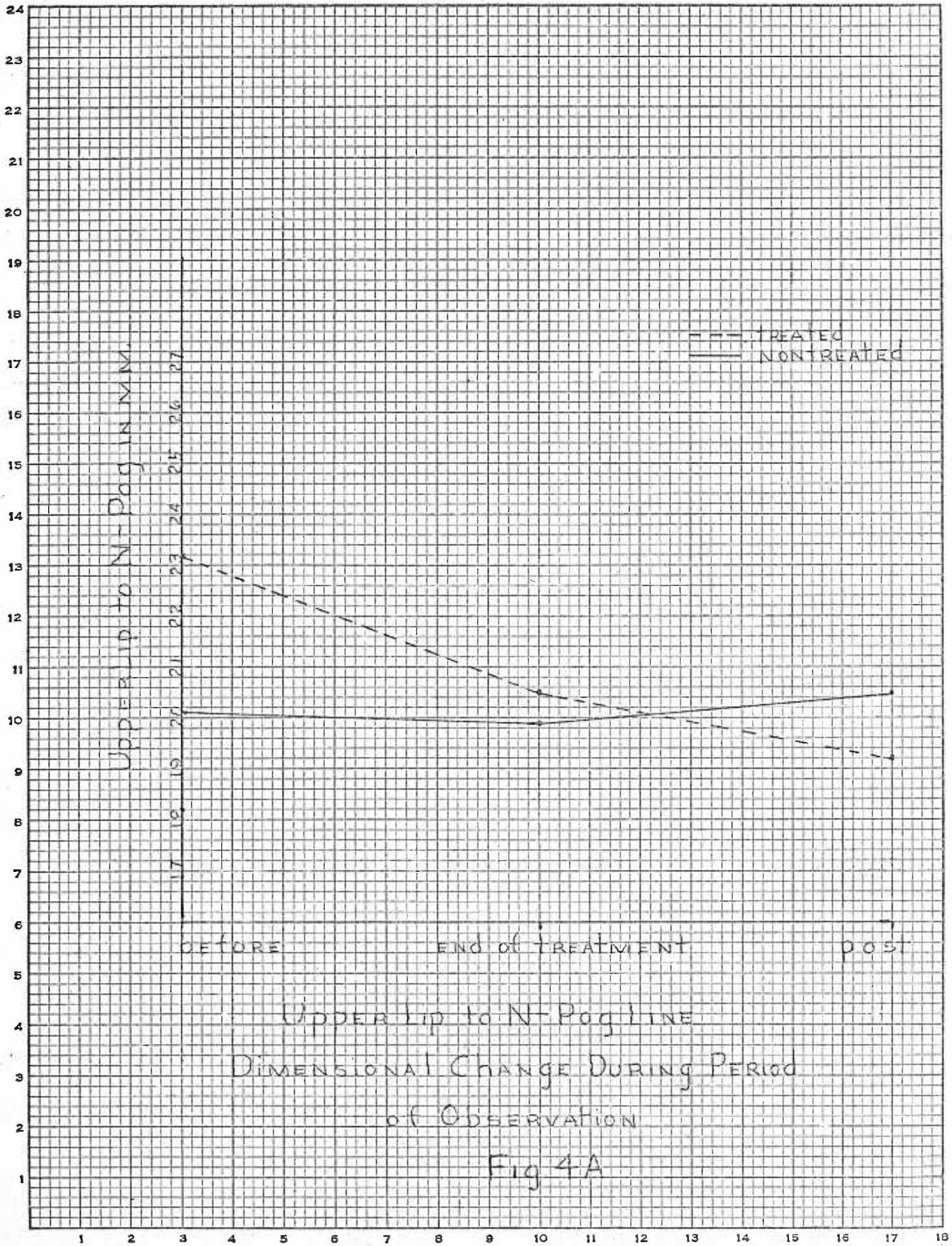

TREATED
NONTREATED
LOWER INCISOR TO N-POG IN MM.
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12
BEFORE
END of TREATMENT
POST
LOWER INCISOR to N-POG LINE
DIMENSIONAL CHANGES DURING PERIOD
of OBSERVATION

Fig 3A



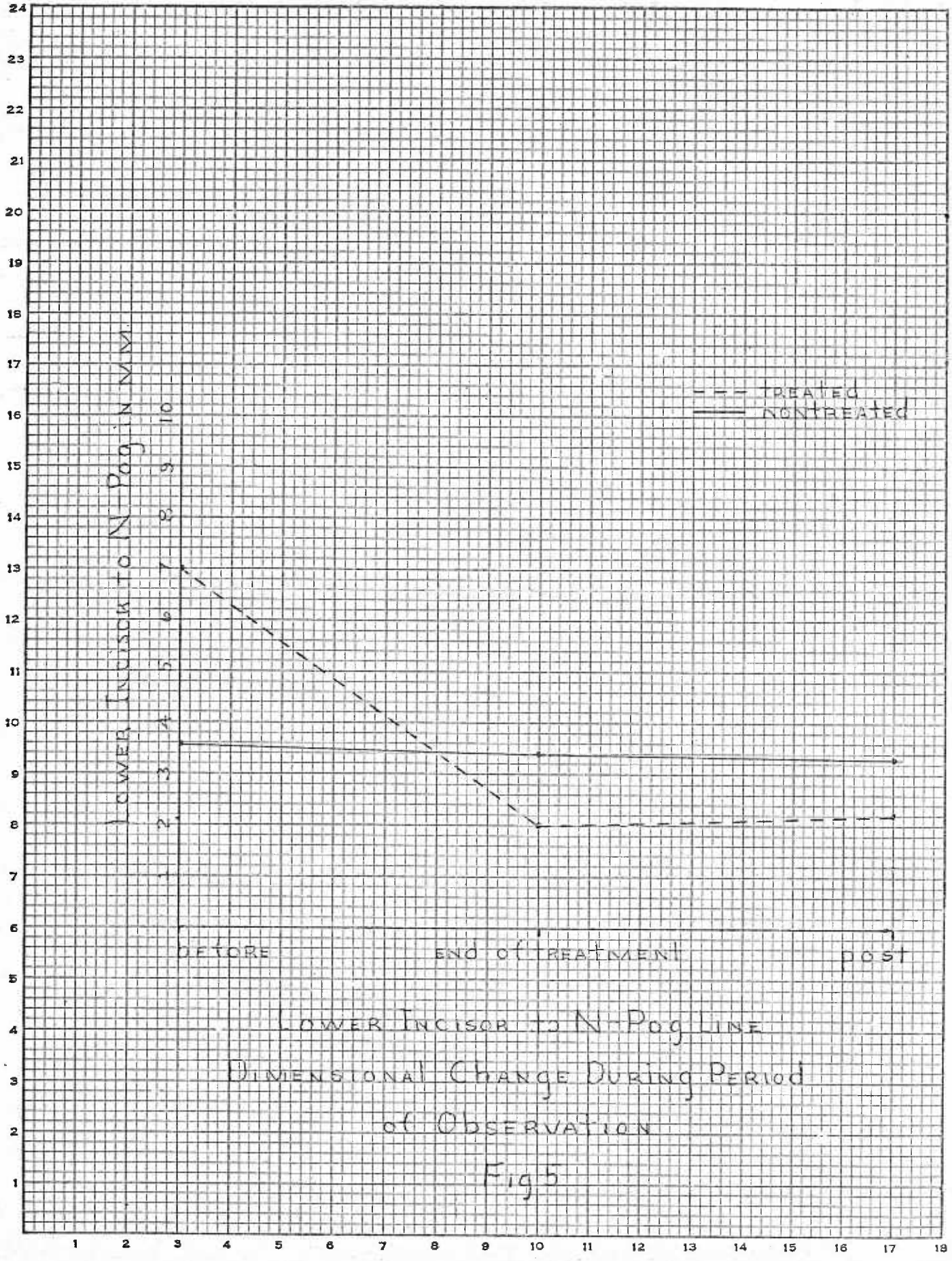

Upper Incisor to N-Pog Line
Dimensional Change During Period
of Observation

Fig 4



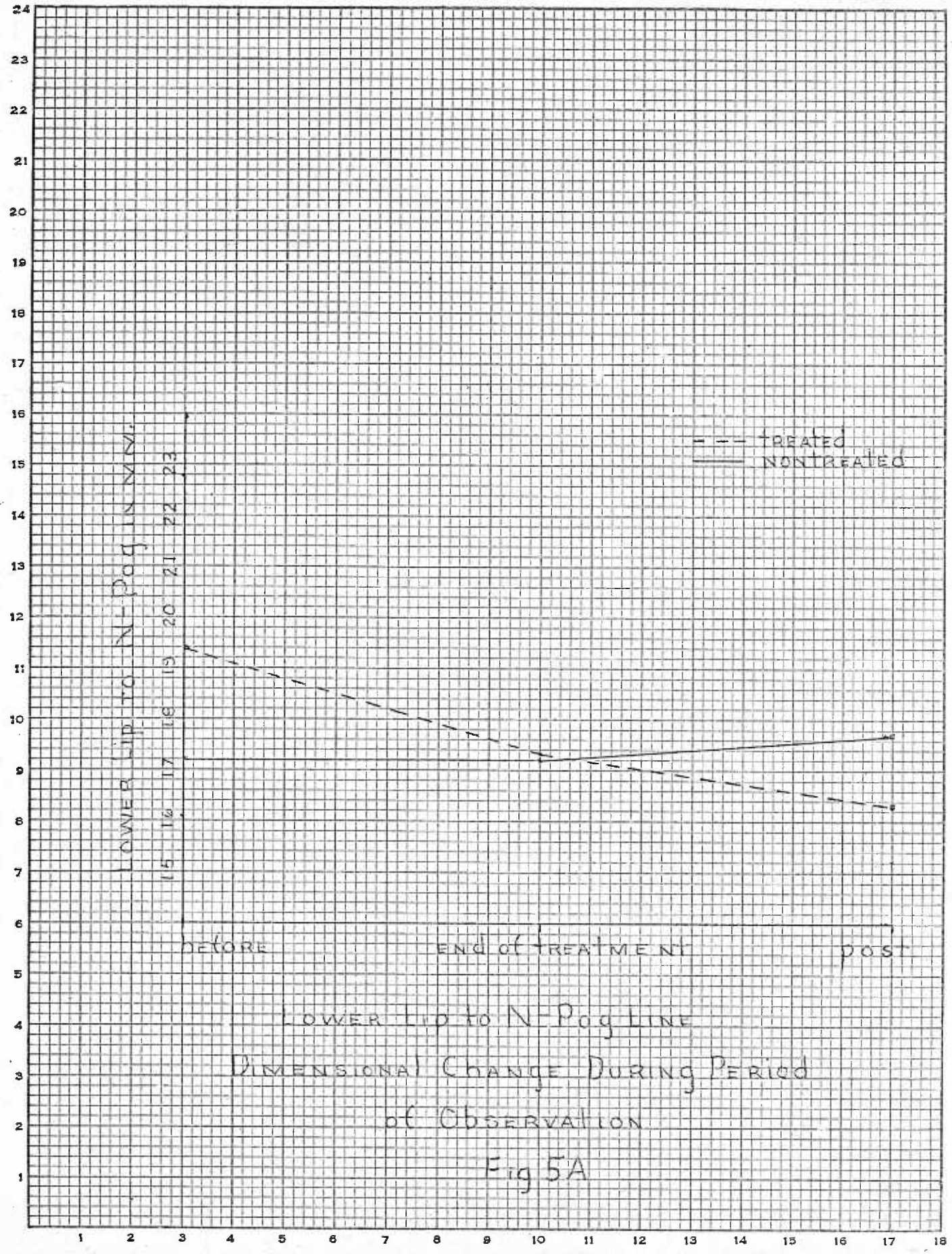

Upper Lip to N-Pog Line
Dimensional Change During Period
of Observation

Fig 4A




LOWER INCISOR TO N-POG LINE
DIMENSIONAL CHANGE DURING PERIOD
OF OBSERVATION

Fig 5




LOWER LIP to N-POG LINE

DIMENSIONAL CHANGE DURING PERIOD

of OBSERVATION

Fig 5A

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