Cephalometric Analysis Of Treatment With Cervical Anchorage*

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The primary purpose of this study was to determine the facial skeletal changes which occur during treatment with the full edgewise appliance plus cervical traction. The cases recorded were classified as Class II, Division 1 and Class I with Class II tendencies, all without extractions. The neckband appliance was the prime motivating factor for reduction of the Class II relationship or tendency.

Much of the credit for the widespread revival of extraoral anchorage is due Kloehn. His work, as first reported at the meeting of the Mid-western Component of the Edward Angle Society of Orthodontia, 1947, made members of the profession aware of the value of cervical traction in a private practice. Kloehn stressed the guidance of growth and the conservation of mandibular anchorage made possible with the cervical gear. The cases discussed in this paper were treated with these fundamental aspects in mind.

Thirty-four individuals are represented: seventeen boys and seventeen girls. Six of the boys and six of the girls had two periods of treatment, a preliminary period with the neckband appliance only, and a second period with a full edgewise appliance added. The mean starting age for the preliminary period was ten years while the mean treatment time was eleven months. The second period of treatment for the children in this group averaged fifteen months; the total mean time for the two periods combined was twenty-seven months.

For the eleven boys and eleven girls who were treated in one period, the mean starting age was thirteen years, and the mean treatment time eighteen months.

Tracings of before and after treatment lateral head x-rays were made. All angular values were read with a standard protractor and lineal measurements were determined with millimeter rule. The Frankfort plane of each original tracing was transferred to the second by superimposition of the SN plane registered at S.

The following angular measurements were made: SNA, SNB, SNPo, NAPo, NSGn, the angle of the palatal plane to a perpendicular projected from S-N, and the mandibular plane angle according to Downs.

The linear measurements were: SA and SB.

Perpendiculars were projected to the Frankfort plane from points S, A, and B and the distances from S to A and B measured in millimeters. The point S was selected as a base from which to measure because it has been established as one of the most stable points of reference in the head.

Class I cases demonstrating a Class II tendency were included with the Class II, Division 1 cases in this study because therapy was identical. Furthermore, Lande[8] showed the same general tendencies in growth behavior regardless of type. Silverstein[10] concluded that in his sample there was no significant difference in growth trends be-

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tween untreated Class II cases and untreated normals.

Anterior Maxillary Alveolar Process

Previous Findings

Brodie[1] in his study of growth changes from the eighth to the seventeenth years showed that the conformation of the anterior surfaces of the alveolar process of maxilla and mandible change little or "drop back".

Lande[8] evinced relative stability of the anterior maxillary area in untreated cases. He went further to confirm Brodie's observation that the alveolar growth did not keep pace with the growth of its skeletal base in a horizontal direction. Both substantiated the findings in this regard of earlier workers.

Ricketts[9] in an unpublished study of untreated Class II, Division 1 cases discovered very slight if any change in point A.

Carlson[2] in an unpublished thesis studying ten boys and ten girls with excellent occlusions showed a slight increase in SNA from ages eight to seventeen, the increase being greater in males than females. Clements[3], also in an unpublished thesis, measuring twenty-one males and fifteen females with good to excellent occlusions saw a significant increase in SNA in males between eight to twelve years and in girls between ten and twelve.

Silverstein[10] found that SNA tended to decrease in males with treatment but not in females. Graber[4] spoke of treatment cases in which maxillary alveolar growth was apparently held back by extraoral appliances.

Stoner[11], and co-workers using a linear measurement demonstrated a reduction of point A in cases treated by Tweed. King[5] showed a similar reduction with cervical traction. Klein[6] after measuring SNA writes of an average retraction of 1.3° in cases treated with cervical anchorage. Eight of his twenty-four cases yielded no change.

Present Findings

In the boys in this study the greatest change in SNA was reduction of 4.5°, the least .5°, and the mean 1.86°. In the girls the largest decrease was 7°, the least .5°, and the mean 2.39°. It must be noted that the average reduction in the girls without the unusual high of 7° would have been 1.96°, which is still higher than the mean for the boys. There was a reduction in fifteen of the seventeen boys and fourteen of the seventeen girls.

Only one individual, a boy, in the thirty-four total cases showed an increase in SNA (2.5°). The before and after readings remained the same for one boy and three girls. In summation there was an SNA reduction in twenty-nine of thirty-four cases; the angle remained the same in four cases, and increased in one.

Linear Measurements of Point A

The SA distance along Frankfort plane decreased in eight of the seventeen boys, twelve of the seventeen girls. The greatest decrease in the boys was 3 mm., the least .5 mm., the mean 1.5 mm. The largest decrease in girls was 4 mm., the smallest .5 mm., the mean 1.66 mm.

The distance from S to A increased in nine boys and in only three girls. The high increase in the boys was 4.5 mm., the low .5 mm., the mean 2.38 mm. The high in the girls was 4 mm., the low 1.5 mm., and the mean 2.66 mm. Two of the girls remained the same.

Discussion

There appears to be no correlation between a decrease of the angle SNA and a decrease in the S to A linear measurement.

Our findings bear out those of the other workers quoted who have found that treatment does influence the angle SNA and the point A. In this instance, we have shown that the forward growth of the maxillary anterior alveolar process was restricted in full edgewise appliance cases using the neckband appliance as the restraining force.

It would appear also from our measurements that this alveolar process may be more readily held back with cervical traction in girls than in boys. Or, it may be said that the forward growth tendency in boys is greater than in girls; that the resistive force of the neckband appliance has more to withstand or overcome in the male.

This is a different concept from that expressed by Silverstein who found a treatment decrease in SNA in males but none in females. It is the opposite idea, also, from that of King who found the greatest change in point A in males. Silverstein's report included seventy-four Class II cases (forty more than this sample) in which it is presumed the chief reducing agents were Class II elastics. King reported fifty Class II, Division 1 cases (sixteen more than this paper), both extraction and nonextraction with a greater age range, and some of his cases did not have full edgewise appliances in addition to the neckband appliance.

On the basis of the findings in the smaller sample reported here and with the conclusions of Carlson and Clements in mind (that SNA increases more in good occlusion males than females) I submit the opinion that:

1. Cervical traction may retract or hold back forward change of the maxillary anterior alveolar process more in nonextraction girls than in nonextraction boys because females do not have as much forward growth force.

2. Some of the greater forward growth force potential in boys may express itself in spite of the restraint of cervical traction.

3. If concepts 1 and 2 should be true, then boys, ideally, ought to wear the neckband appliance twenty-four hours a day, whereas the girls, having less growth to hold back, should need to wear the appliance only twelve to fourteen hours daily. This might be true if the end result of treatment was concerned only with reduction of point A. However, the comparatively greater forward growth at other facial points compensates for this relative difficulty in restraining point A in the male.

Mandibular Anterior Alveolar Process

Previous Findings

Lande found no significant change in point B from seven to twelve years, but a mean forward movement of 2.2 mm. from twelve to eighteen years. SNB was not affected by treatment Silverstein observed, while Stoner and his co-workers found a mean forward movement of .08 mm. in the fifty-seven consecutively treated Tweed cases.

Carlson found an increase in SNB from eight to seventeen years. This increase was greater than the SNA increase and more in males than females. Clements reported an increase in SNB in both males and females.

Present Findings

The angle SNB increased in nine boys, decreased in four and remained the same in four. It increased in eight girls, decreased in seven and remained the same in two.

In boys the high increase was 2°, the low 1°, and the mean 1.27°; girls had a high increase of 2.5°, a low of .5°, and a mean of 1.5°. The greatest male decrease was 1°, the lowest .5°, the mean .87°, while the greatest female decrease was 1.5°, the lowest .5°, and the mean .85°.

Linear Distance of SB

The SB distance increased in thirteen boys, decreased in three and remained the same in one. It increased in ten girls, decreased in five, remained the same in two.

The high increase in the boys was 7 mm., the low .5 mm. and the mean 3.38 mm. with a high increase in the girls of 6 mm., a low 1 mm. and a mean 2.65 mm.

Boys' greatest decrease was 2.5 mm., the low .5 mm. and the mean 1.33 mm. The greatest decrease in the girls was 4.5 mm., the low .5 mm., the mean 1.4 mm.

Discussion

The measurements of SNB change with this treatment would indicate that this angle is just as likely to either decrease or stay the same in both sexes, as it is to increase. Seventeen of the total cases decreased or stayed identical while seventeen increased. The big difference was the fact that the mean increase was greater than the mean decrease.

With regard to the SB linear distance there is a decided statistical advantage on the side of the increase. Twenty-three of the total showed an increase, while eleven decreased or stayed the same. The increase was greater in the boys than in the girls. The mean decrease was similar in the two sexes.

A comparison of the results of the angular and lineal measurements related to point B indicates that much of the forward growth of the mandibular anterior alveolar process may be masked in the angular measurements by the forward growth of point N. The SB measurements show that B moves forward predominantly in both sexes but more in boys than girls. This would tend to confirm the findings of Lande, Stoner et. al., Carlson, and Clements.

It would appear likely that point B was affected very little, if any, by treatment as Silverstein noted. However, where there was a decrease in the SB distance or where it remained the same, the bite opening effects of treatment may have had some influence. This would tend to corroborate King when he said that such bite opening apparently occurred in individuals who grew little or none at all, and that this opening resulted in a downward and backward displacement of the mandible.

SNPo

Previous Findings

Lande found that there was an increase in mandibular prognathism generally occurring beyond seven years of age.

Brodie in measuring SNGn showed a predominantly forward movement of the chin point of three to six degrees. Four of his nineteen cases remained the same.

An increase in SNPo in untreated males and females was noted by Silverstein. In the analysis of treated cases he concluded that the forward movement of pogonion was inhibited in both sexes to the extent that the expected growth potential was not attained.

Stoner and his group in their linear measurements of point Po found that it moved forward more than six times farther than point B; King concluded that forward growth of pogonion was disappointing in all his treatment groups except nonextraction males.

Present Findings

The angle SNPo increased in ten boys, decreased in three and remained the same in four. It increased in nine girls, decreased in five, and stayed the same in three. Nineteen of the entire group had an increase, eight had a decrease, and seven remained the same.

The boys showed a high increase of 3°, a low of 1°, and a mean of 1.65°. The girls evidenced a high increase

of 3.5°, a low of .5°, and a mean of 1.55°.

The three boys who showed a decrease were identical with 1° each, while the greatest decrease in the girls was 1°, the least .5° and the mean .8°.

Discussion

It is regrettable that the plan for this paper did not include a lineal measurement of SPo. The interesting findings brought out by comparison of the angular and linear measurements of points A and B dictate inclusion of SPo in a contemplated revision of this work.

The interesting factor, however, in the measurements of SNPo is the similarity of behavior in the two sexes. Not only were the numbers of boys and girls in each category nearly the same, but also, the high, low, and mean measurements were practically identical.

Furthermore, the changes occurring in SNPo were much like those of SNB, as to numbers of individuals in each category and all measurements. There seemed to be a slightly greater quantity of increase in point Po than B, but in the instance of decrease the quantity was equable.

The fact that in the decrease cases the angles SNB and SNPo were reduced similarly could lend further strength to King's expression of the bite-opening effects of treatment in poor growth cases. This may also be further evidence to confirm Silverstein's conclusion that forward growth of pogonion can be inhibited by treatment.

NAPo

Previous Findings

One of Lande's chief conclusions was that the convexity of the face nearly always decreased. It will be recalled that this was in a study of thirty-four cases, ten of which had Class II denture relationships.

Carlson noted that the facial profile became less convex with growth and that this straightening was greater in males than females. He found that this decreased convexity was associated more with an increase in face height than a change in the sagittal relation of the jaws.

In this regard King mentioned that his treatment cases exhibited downward growth in excess of forward growth.

Klein, in his twenty-four cases treated with cervical traction, noted a range of decrease in the angle of convexity of 0° to -7° with a mean reduction of 2.8°. He mentioned the significance of this change since the majority of his cases evidenced an opening of the Y axis; and further, the chin appeared less prominent in some cases as a result of bite opening or growth.

Present Findings

Of the entire thirty-four cases, thirty-three showed a decrease in convexity; and one remaining case — a boy — remained the same. Therefore, sixteen boys had a decrease as did all seventeen girls.

The greatest decrease in the boys was 9.5°, the low 1°, and the mean 4.93°. The largest decrease in the girls was 16°, the least .5°, and the mean 5.08°. Eliminating the unusual high of 16° in the girls, the high would have been 9°, and the mean 4.37°.

The convexity reductions of the six boys and six girls who had two periods of treatment (1st—neckband appliances, 2nd—neckband appliances plus full edgewise appliances) were then separated from the group. It was found that the high reduction for the six boys was 9.5° the low 2.5°, the mean 5.66°; for the six girls the greatest reduction was 7°, the low 1.5°, and the mean 4.66°.

The ten boys showing reduction and having just one period of treatment showed a high decrease of 8°, a low of 1°, and a mean of 4.5°.

The ten girls (still excluding the un-

usual high) treated in one period had a high decrease of 9°, a low of 1.5°, and a mean of 4.35°.

Discussion

The above mentioned ten boys and ten girls had a starting age range of eleven years six months to fifteen years four months with a mean starting age of thirteen years. The treatment time ranged from fourteen to twenty-two months with a mean of eighteen months.

Klein's sample of twenty-four youngsters was started from seven years seven months to ten years two months with a mean starting age of eight years six months. The treatment time ranged from six to thirty-three months with a mean of seventeen months. These cases were treated with neckband appliances together with flat acrylic bite planes in some cases.

The mean reduction in our twenty full appliance plus neckband cases was 4.42° (if the one zero change case had been included the mean would have become 4.19°). Klein's neckband appliance cases, at an earlier age but with almost the same average treatment time, had a mean convexity decrease of 2.8°.

There would seem to be a significant difference in the convexity change at the two ages. In all probability the addition of the full edgewise appliance did not account for this difference, but rather growth variance in the two age groups was chiefly responsible.

Following the findings of Carlson and King it may well be that a greater increase in face height in the older group was a major contributing factor.

In consideration of the entire group of thirty-four children, less the boy who had no change and the girl who had the unusually high change, the similarity in measurements is noteworthy. The high, low, the mean readings in the two sexes were very close with those of the girls being slightly less in each respect.

Silverstein found that there probably were individual differences in growth trends between the two sexes. He believed, however, that these differences were probably masked by the great variation within each sex.

Most of the workers previously referred to did find that the quantitative change in a great number of measurements in the two sexes showed the same trend, with the boys generally greater than the girls.

NSGn

Previous Findings

From his sample Lande's measurements showed that NSGn evidenced very little change from seven to seventeen years.

Brodie concluded that this angle was quite stable from eight to seventeen. He found no change in it in eleven of nineteen cases. The angle increased around 2° in seven cases and decreased in only one.

Klein measured the Y axis from the Bolton plane and found that in his cervical traction cases it opened an average of 1° with a range from a reduction of 1° to an increase of 3°.

Present Findings

In a total of twenty-two of the thirty-four cases the angle NSGn opened. In the eleven boys showing an increase the high change was 4°, the low .5°, and the mean 1.86°.

In the eleven girls the high was 2.5°, the low .5°, the mean 1.5°.

One boy had a decrease of 1°. Two girls decreased 1° and 2° respectively. Five boys and four girls remained the same.

To recapitulate: in twenty-two cases NSGn increased; in three cases it decreased, and in nine cases it stayed the same.

Discussion

In the face of this evidence, there can be little doubt that treatment with cervical anchorage does tend to cause a bite opening. It is probable also that the addition of a full edgewise appliance and treatment between eleven and fifteen years produced a greater degree of opening.

There is no apparent relationship between length of treatment and degree of NSGn increase. Some of the cases treated the longest showed less than average opening. One boy and one girl in this group stayed the same, and one girl decreased. Those who grow well seem to open the least, again tending to verify the findings of King.

Mandibular Plane

Previous Findings

Lande found a decrease in the inclination of the mandibular lower border associated with the increase in mandibular prognathism. Over half of Brodie's cases demonstrated no notable change in the mandibular border. Where there was a change, it was a decrease.

Silverstein found a decrease in the mandibular plane angle with age. He found also that treatment inhibited this decrease and reversed the normal growth tendency in the female, causing the angle to increase.

King's cases showed an increase in both sexes but this was not as great as that shown by Tovstein in cases treated with Class II elastics.

Present Findings

In six of the boys the mandibular plane angle increased from 1° to 5° with a mean of 2.33°; in eight boys the angle decreased from 1° to 4° with a mean of 2.12°; and in the remaining three the angle was unchanged.

Ten of the girls showed an increase of .5° to 3° with a mean of 1.35°; Five girls showed a decrease of 1° each, and in two girls there was no change.

Therefore, sixteen of the thirty-four cases evidenced an increase in the mandibular plane angle while thirteen had a decrease, and five remained the same.

Discussion

It would appear that about one-half the cases treated with full edgewise appliances plus the neckband appliances tend to show an increase in the mandibular plane angle.

The mean increase in the mandibular plane inclination was greater in the boys than in the girls. Likewise, when the mandibular plane decreased, it did so greater in the boys than in the girls. But the angle in the majority of boys either decreased or remained the same whereas, in the majority of girls it increased. Can the basis for this difference be laid again at the feet of our patron saint, growth?

Can the finding of Lande, that the decrease of the mandibular lower border was associated with the increase in mandibular prognathism, be turned around to apply here? Can it be said that because the girls tend to less mandibular prognathism, that their mandibular planes have less tendency to decrease? And that, therefore, this plane in girls is more easily influenced to increase by treatment?

Palatal Plane

Previous Findings

Brodie noted a definite tendency for the hard palate or nasal floor to remain stable over the entire growth range. In those cases where there was a change, the anterior end dropped more than the posterior. In terms of this paper, the described change was an increase in the palatal plane angle.

In his treatment cases Klein found that the palatal plane predominantly

dropped downward anteriorly; in only four cases did the plane remain the same; in no case was there a decrease of the angle or a greater dropping posteriorly rather than anteriorly.

Present Findings

Twenty-five of the thirty-four cases demonstrated an increase in the palatal plane angle; six showed a decrease; three remained the same.

Twelve boys had an increase of 1° to 5° with a mean of 1.95°. Three of the boys showed a decrease of 1° to 1.5° with a mean of 1.16°. Two boys remained unchanged.

The angle increased in thirteen girls ranging from .5° to 3°. The mean increase was 1.76°. It decreased in three girls 1° each. One girl remained the same.

Discussion

Before discussing the findings, it would be well to point out that delineation of the posterior nasal spine in the headplate of a pre-adolescent youngster can be difficult. This point can be obscured by the shadow of the erupting second molars. It would appear that error is definitely possible, but it may be that this error is duplicated from tracing to tracing thus minimizing its significance.

It seemed, though, that a trend was apparent in treatment cases. The palatal plane angle increased in the majority of Klein's cases and so also did it here. Perhaps, as Klein speculated, cervical traction can alter the basic maxillary structure.

The small decrease in the angle in six cases is not understandable on the basis of previous findings and may be due to error in tracing.

Summary

In Class II, Division 1 and Class II tendency cases treated with full edgewise appliances plus neckband appliances as auxiliaries the following observations were made:

1. The angles SNA and NAPo were generally reduced.

2. The SA distance was reduced in the majority of cases. This reduction occurred more often in the female than in the male. In the boys A moved forward as often as backward. The millimeter change in forward movement was greater than that which occurred in backward movement.

3. SNB behaved similarly in both sexes. It tended to stay the same or decrease, as often as it increased. The decreases when registered were smaller than the increases and may have been influenced by bite opening.

4. The SNPo measurements were strikingly like those of SNB. The only real difference was that the degree of increase of SNPo was slightly greater than that of SNB.

5. The SB distance increased in the majority of both boys and girls. The increase in the boys was greater than that in the girls, numerically and quantitatively.

6. The differences between angular and linear measurements of points A and B respectively indicate a masking of true events in the recordings of angles. It should be remembered that SNA, SNB, and NAPo are influenced by growth activity at points other than A and B.

7. NSGn increased in the majority of cases, indicating the bite-opening propensities of the appliances.

8. The mandibular plane either decreased or stayed the same in most of the boys whereas it tended to increase in the majority of girls. This may be another indication of greater growth forces in the male than in the female.

9. The palatal plane increased in the majority of both boys and girls. If the possibility of error in tracing could be discounted, this increase would be indicative of a tendency for the neckband

appliance to change the palatal plane in a natural direction.

The recognized variables in a study of this type primarily concern the patient. Not only are there differences between the sexes, but also, there are wide individual variations: of growth activity related to age, of tissue responses to orthodontic pressures, and of individual patient cooperation in following instructions. The fact that the majority of patients respond in one way in one area of measurement does not prognosticate like reaction in any other individual.

This paper is presented with full recognition of the above facts, as a record of changes in some patients to one form of clinical management.

Medical Art Square

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