The Cervical Facebow and Mandibular Rotation

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Since the popularization of the cervical facebow by Kloehn,[1] this treatment technique has become common in the correction of Class II malocclusions. Consequently, many investigators have examined the possible actions and reactions of the cervical facebow on growth and development of the craniofacial skeleton. Some clinicians have utilized this technique to great advantage in the orthodontic correction of Class II malocclusions.[2-4] Others have used the facebow primarily as an orthopedic device to affect the growth of the maxilla, thereby assisting in the correction of skeletal dysplasias.[5-9] However, the benefits of the cervical facebow have not been recognized and accepted by all clinicians. Some criticism has been advanced by investigators who feel that the reactive forces of the cervical facebow adversely affect the subsequent treatment of the malocclusion.[10-12] The effect of the reactive forces has been grouped and is collectively referred to as the "cervical facebow reaction."[13] There are seven parameters that constitute the "cervical facebow reaction." They are relapse to Class II molar, lack of facial improvement, lack of reduction of ANB angle, upper second molar positional problems, difficulty in torquing upper incisors, an unbalanced smile, and mandibular rotation.

It is the purpose of this study to cephalometrically evaluate the effect of cervical-pull facebow treatment on mandibular rotation. The term mandibular rotation connotes the change in directional growth and spatial positioning of the mandible. In this study, mandibular rotation in a group of Class II, Division 1 subjects treated with cervical pull facebow will be compared cephalometrically with a similar but untreated group of Class II, Division 1 subjects over the same time period. To adequately assess mandibular rotation, four separate methods of cephalometric superimposition were utilized for each subject's set of radiographs.

REVIEW OF THE LITERATURE

In the past many studies have examined the influence of cervical facebow on the mandible. The first direct comparative cephalometric study was done by Epstein in 1948.[14] He observed no change in the relationship between the lower border of the mandible and cranial base that could be attributed to the application of extraoral cervical traction. He also did not see any permanent molar extrusion or bite opening as a result of cervical headgear.

King[4] noted that in fifty cases treated with cervical headgear, all exhibited downward growth in excess of forward growth. Point A was shown to be displaced posteriorly and changes in the mandibular plane were nonsignificant. Newcomb[11] observed that the mandibular plane will subsequently close, if opened during treatment. Blueher[2] also noted that there was a bite-opening effect as a result of treatment with cervical headgear, and that this opening resulted in a downward and backward displacement of the mandible.

In two separate studies of treated versus untreated malocclusions, Poulton[15,16] observed a slightly greater increase in lower face height due to a downward and backward positioning of the mandible.

Ricketts[5] found a direct correlation between molar extrusion and a decrease in mandibular downward and forward growth. He showed mandibular plane opening and concluded that bite-opening mechanics, when applied on patients of limited growth potential, can result in irreversible open bite.

Kloehn[8] reported no significant elongation of molar teeth or bite opening due to mandibular rotation. Weislander[7] stated that cervical force extrudes maxillary molars, but also noted that there was some extrusion of the mandibular condyle out of the glenoid fossa allowing a parallel descent of the mandible.

Schudy[10] noted that cervical force extruded maxillary molars and felt, with Ricketts, that muscular pressure is not adequate to intrude mechanically-extruded molars. If extraoral treatment has caused mandibular rotation, only growth at the condyles can return the mandible to its original inclination. Poulton[12] agreed with Schudy[10] and Ricketts[5] in stating that steepening of the mandibular plane through treatment may be permanent unless subsequent growth of the mandibular condyle is compensatory.

In another study Schudy[17] found that vertical elongation of the molars due to facebow treatment had the same effect as decreased condylar growth. With an increased molar height the chin swings downward and backward exhibiting negative rotation, and the mandibular plane becomes steeper. Ringenberg,[18] in a study of single-arch cervical traction, noted that there was a significant increase in the mandibular plane angle.

The research of Merrifield and Cross[7] has shown that the amount of extrusion of maxillary molars is related to the cant of the occlusal plane which closely follows the mandibular plane angle.

The preceding studies have demonstrated that there are many varied and conflicting opinions concerning the effect of cervical pull on mandibular rotation. The reason for the variety of ideas seems to be that numerous variables are present during such treatment. Magnitude, direction and duration of force, as well as the patient's growth, development and biologic response, all contribute to influence the effects of the cervical facebow treatment. Many of these variables may be assessed in measurable parameters but many cannot even be quantified. Furthermore, the variables that can be accurately measured are not easily placed under the clinicians' control but under the direct influence of the patient.

In evaluating the mandibular response to cervical facebow treatment, the majority of the preceding studies compared pretreatment and posttreatment cephalometric radiographs. A superimposed series of tracings gives a pictorial representation of changes due to growth and treatment which is often more valuable than a statistical one. However, the inherent problem of superimposition is locating a reference point void of changes of position as well as shape during all stages of growth.

Broadbent[19] was probably the first to realize the difficulty in evaluating radiographs through superimposition. He selected points and planes upon which tracings could be superimposed by measuring various areas in the cranial base and selecting the area which yielded the smallest coefficient of variability. He found the area to be the body of the sphenoid bone and used this fact as a basis for superimposition on his registration point (R).

Brodie[20,21] utilized a line from sella turcica to nasion as a registration for a method of superimposition. This line served as a division between the cranial vault and the face and was thought to provide a stable base against which growth could occur. This method has gained wide acceptance by clinicians and seems to be the leading method by which treatment effects and growth changes are currently evaluated.

Bergersen[22] developed a method of cephalometric superimposition, the intersection point, which statistically seems to be more accurately adapted to longitudinal cephalometric research than either the sella-nasion method or the registration point method. His evidence indicated that, during growth, facial landmarks diffuse more accurately from a common center of movement and migrate apart from each other more proportionately in the intersection point method than the other two procedures.

Ricketts,[23] utilizing the idea of a central phenomenon of growth, investigated the area near the top of the pterygopalatine fossa as a possible area for superimposition. He felt this area was important as it is the location of the nerve and blood supply to the nasal capsule, palatal roof and maxilla. By utilizing a polar coordinate grid, he developed the correlation coefficient or C.C. point. It is located at a perpendicular to basion-nasion from pterygoid point.

This study considered all four methods of superimposition in examining the effect of cervical-pull facebow treatment on mandibular rotation.

Methods and Materials

The treatment group consisted of a sample of forty subjects, twenty male and twenty female. At the initial clinical examination all subjects were classified as having Angle Class II, Division 1 malocclusions. Each subject was treated with the edgewise appliance and treatment was continued until the malocclusion was corrected and the subject exhibited a Class I occlusion. In all cases a Kloehn-type cervical facebow applied to the maxillary permanent first molars was used for the correction of the malocclusion. In no cases were any permanent teeth removed in the course of treatment nor was there any prolonged use of Class II elastics for molar correction. Pretreatment and posttreatment cephalometric radiographs were obtained for all treated subjects with the age ranges recorded.

The control group consisted of a sample of forty subjects, twenty male and twenty female. Each subject had been followed longitudinally with serial cephalometric radiographs and had undergone no orthodontic treatment. All the control group subjects had been classified for the study as having Angle Class II, Division 1 malocclusions. Tracings had been made each year for all control subjects; therefore, it was possible to *exactly* match the age, sex and time span between initial and final radiographs of each control subject with each treatment subject. The age distribution of the total sample appears in Figure 1.

In all tracings bilateral anatomical landmarks were bisected and the midpoint was taken for the cephalometric measuring point. This technique reduces the landmarks to their midsagittal value and minimizes error due to variation in the positioning of the subject.

To quantify mandibular rotation on serial cephalometric radiographs, a coordinate system was developed.[25] Sella turcica was used as the base

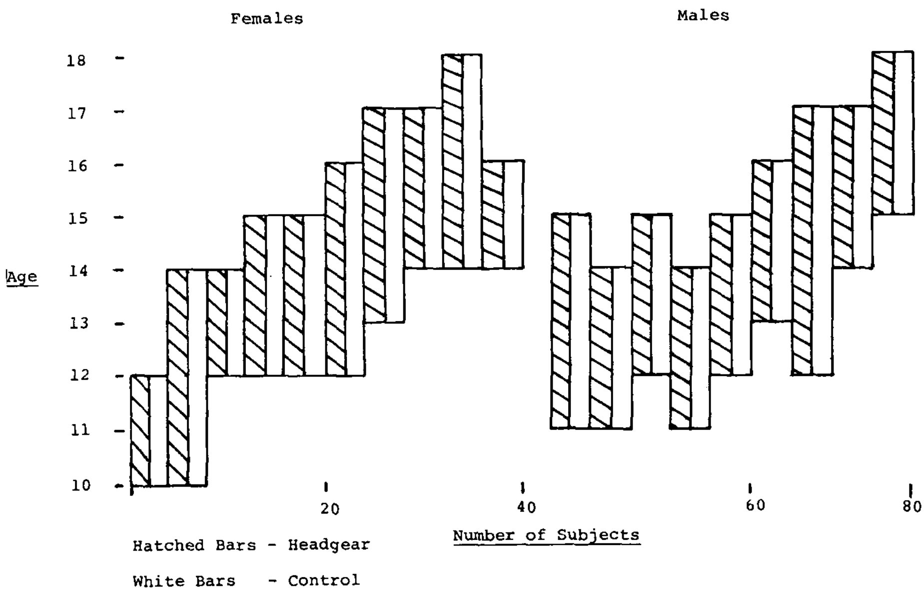

Fig. 1 Age distribution.

point and a line at gnathion was drawn completing the coordinate system. The angular and linear growth changes were measured on this coordinate system with gnathion at "Time One" as the starting point. This system is illustrated in Figure 2.

Growth progress was plotted on the coordinate system by superimposing the serial tracings on the sella-nasion line at sella, on the intersection point, on the registration point and on the C.C. point. The amount and direction of growth was measured from gnathion on the pretreatment radiograph to gnathion on the posttreatment radiograph. For each method of superimposition two variables were recorded: the intensity of growth in millimeters, and the angular direction of growth in degrees.

The initial statistical analysis was to directly compare the four methods of superimposition. The control group and the treatment group were examined and compared statistically

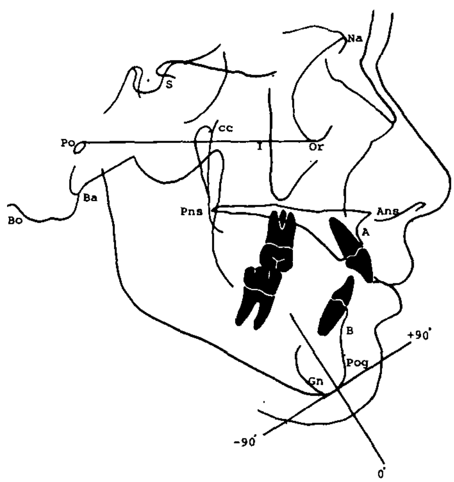

Fig. 2 Landmarks and coordinate axis.

for intensity and direction of mandibular growth.

The final statistical analysis was a cross-sectional test to determine the effect of the cervical-pull facebow on mandibular rotation. In this analysis the untreated group was compared with the treated group as superimposed by the above four methods.

Results and Discussion

One hundred sixty radiographs from eighty patients were examined and statistically compared. The untreated sample was selected to perfectly match the treated sample. This was done to eliminate any unnecessary sampling error so that the only major difference between the two samples was the orthodontic treatment.

The comparison was between two variables: direction and intensity of mandibular growth, utilizing four methods of superimposition. Both variables were read directly from the superimposed tracings. The direction of mandibular rotation could be in negative degrees as well as positive, dependent on which side of the sella-gnathion line it fell.

The results of the initial analysis comparing the four methods of superimposition between treated and untreated groups indicate that there is a statistically significant difference at the 0.5 percent level of confidence among the four methods. This indicated that all four methods of superimposition in untreated and treated Class II, Division 1 malocclusions, utilizing both parameters of mandibular rotation, are uniquely different. Consequently, direct comparisons of superimpositional methods could not be made.

Therefore, the final statistical analysis was a cross-sectional comparison between the untreated groups and the treated groups utilizing all four methods of superimposition. The results are listed in Tables I, II, III and IV.

TABLE I

COMPARISON OF CONTROL VERSUS HEADGEAR UTILIZING SELLA-NASION.

	Direction	
	Control	*Headgear*
$\bar{X}$	22.55	–15.05
S.D.	28.22	15.75
S.E.	6.31	3.52

Significant at the 0.01 level.

	Intensity	
	Control	*Headgear*
$\bar{X}$	8.05	14.10
S.D.	4.22	3.35
S.E.	0.94	0.74

Significant at the 0.01 level.

TABLE II

COMPARISON OF CONTROL VERSUS HEADGEAR UTILIZING REGISTRATION POINT

	Direction	
	Control	*Headgear*
$\bar{X}$	17.65	–10.55
S.D.	25.95	15.05
S.E.	5.20	4.60

Significant at the 0.01 level.

	Intensity	
	Control	*Headgear*
$\bar{X}$	9.17	15.22
S.D.	5.34	4.47
S.E.	0.97	0.81

Significant at the 0.01 level.

TABLE III

COMPARISON OF CONTROL VERSUS HEADGEAR UTILIZING INTERSECTION POINT

	Direction	
	Control	*Headgear*
$\bar{X}$	0.32	8.01
S.D.	38.86	29.90
S.E.	8.69	6.68

Not significant.

	Intensity	
	Control	*Headgear*
$\bar{X}$	11.62	11.90
S.D.	4.10	3.29
S.E.	0.91	0.73

Not significant.

In evaluating the *direction* of growth utilizing the sella-nasion method and the registration point method in the control versus the headgear groups, there was found to be a significant difference at the one percent level of confidence. This indicates that in treated cases the treatment had some significant effect

TABLE IV

COMPARISON OF CONTROL VERSUS HEADGEAR UTILIZING C.C. POINT

	Direction	
	Control	*Headgear*
$\bar{X}$	−1.30	4.67
S.D.	31.00	29.07
S.E.	7.77	5.85

Not significant.

	Intensity	
	Control	*Headgear*
$\bar{X}$	12.77	12.75
S.D.	5.25	4.44
S.E.	0.88	0.79

Not significant.

on mandibular directional rotation viewed from these reference lines. Analyzing the *intensity* of growth with respect to these methods, there was also found to be a significant difference at the one percent level of confidence. This demonstrates that the treated cases exhibited a change in growth patterns when compared with the untreated malocclusions as judged from these reference lines. The range of direction for the headgear sample, in both sella-nasion and registration point, indicated that the cervical facebow produced a significantly more downward and backward mandibular rotation. With regard to growth intensity, the headgear group also exhibited a greater amount of mandibular displacement (Fig. 3).

These findings are in agreement

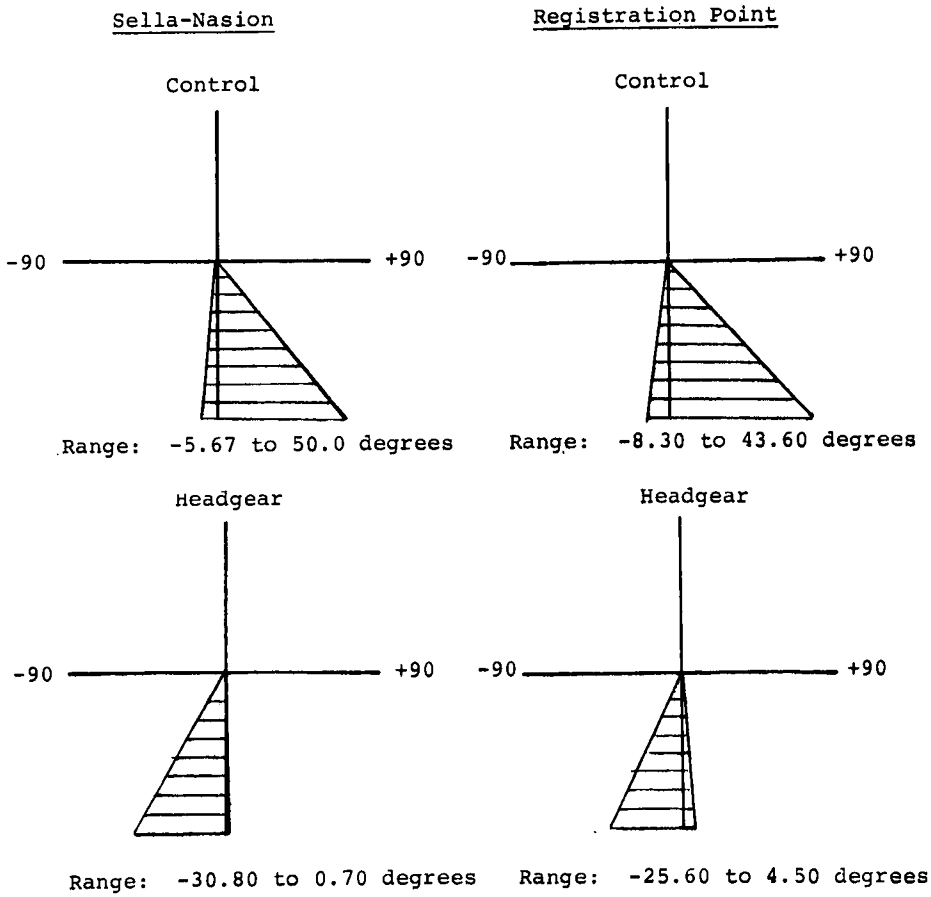

Fig. 3 Range of direction for sella-nasion and registration point (R).

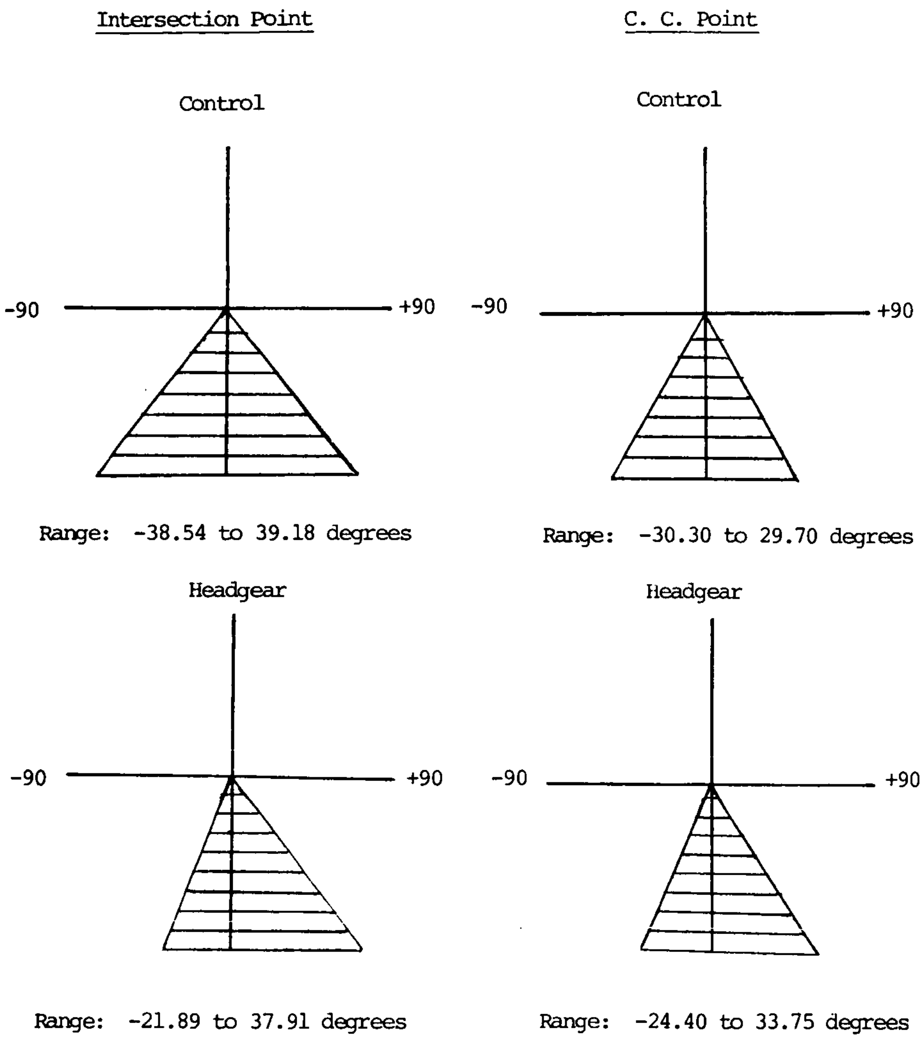

Fig. 4 Range of direction for intersection point and C.C. point.

with many of the studies reported in the literature that noted a downward and backward positioning of the mandible in cases treated with cervical-pull facebow.

In evaluating the direction of growth utilizing C.C. point and intersection point, there was *no* significant difference between headgear and control groups. This indicates that use of the cervical facebow had *no* significant effect on mandibular rotation as viewed from these reference points. There was also no significant difference in intensity of mandibular displacement. This seems to demonstrate that there was no change in mandibular rotation that could be directly attributable to the cervical facebow. These findings are in agreement with studies in the literature that state that cervical-pull facebow treatment could be utilized without disturbing the position and balance of the mandible (Fig. 4).

It becomes readily apparent that,

for the same cases, backward mandibular rotation does and does not occur with the cervical facebow; the contributory effects of the headgear to mandibular rotation must be looked at with a diminishing role. The apparent backward mandibular rotation seems to be correlated with the methods of superimposition, *not* the methods of treatment.

The sella-nasion and registration point methods must be examined more closely to determine if they inherently produced a more downward and backward displacement of the mandible. Possibly, direction of growth of the cranial base is being restricted by using sella-nasion and registration point as a stationary reference. This arbitrary restraint of growth of the cranial base would produce a clockwise rotation of superimposed serial tracings and would necessarily produce a more inferior migration of mandibular landmarks which could be interpreted as a backward rotation.

With the intersection point and C.C. point methods, the serial orientation of the radiographs provided growth patterns that could be termed outwardly concentric. As a result, there was no significant inferior migration of mandibular landmarks. Hence, backward mandibular rotation was not apparent in the treated or the untreated groups.

Summary and Conclusions

The purpose of this longitudinal investigation was to determine whether the cervical facebow treatment affected mandibular rotation. Pretreatment and posttreatment tracings were compared using four different methods of superimposition in the headgear group and the control group. Mandibular rotation was measured in parameters of direction and intensity. Statistical evaluations of the data were made to determine significant differences between headgear and control groups.

The following conclusions can be made:

(1) There is a significant difference among the four methods of cephalometric superimposition.

(2) The sella-nasion and registration point methods showed a significant difference in mandibular growth direction and intensity between the headgear and the control cases while the intersection and C.C. methods did not.

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