Mixed Dentition Treatment with Cervical Traction and Lower Lingual Arch

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A cephalometric comparison of treatment changes among cervical traction alone, cervical traction combined with banded upper incisors and a lower lingual arch, and untreated controls.

LITERATURE REVIEW OF MIXED DENTITION TREATMENT OF CLASS II MALOCCLUSION

There is little question that desirable treatment results can be achieved with a wide variety of appliances when they are used by skilled clinicians. Nevertheless, no clearly superior force system has come to the fore, and little commonality of opinion exists regarding treatment of Class II malocclusions at any stage of development.

The suggestion that treatment ought to begin in the mixed dentition is at least as old as Angle.[15] A considerable body of literature has been published extolling the advantages of early treatment.[1-17] Mathews[15] has suggested that his colleagues "preferentially" undertake the treatment of Class II malocclusions in the late deciduous or very early mixed dentition stage.

Maxillary Dentition

Many previous mixed dentition studies have evaluated the effects of extraoral traction in the treatment of

Class II malocclusions in the mixed dentition.

Following the reintroduction of extraoral traction by Kloehn,[18] the orthodontic literature blossomed with numerous and often conflicting reports on its effects on the dentition, maxilla, mandible and associated structures.[17-43]

Wieslander,[17] studying the effect of cervical traction on both early and late mixed dentition samples, found treatment results in the early mixed dentition to be more favorable.

King,[16] after reflecting on the success and failure of over 20 years of mixed dentition treatment, ends his paper expressing the hope that more study and research will expand the possibilities for definitive early treatment of Class II malocclusions.

It should be expected that the diversity of approaches used to treat such a diverse population as the seductively simple classification of Class II malocclusion would produce superficially conflicting reports.

Extraoral traction has been reported to produce varying effects on the occlusal plane,[4,20-28,37] a frequent tendency for downward tipping of the palatal plane,[20,22-24,27] an extrusive effect on the upper first molar,[25-28,34,37,40] an increase in vertical face height[28-31,34] and mandibular plane angle,[34-36,40] and reduced forward movement of pogonion.[21,24,27,28,34]

On the other hand, none of those effects occur universally with any of the many different force systems in use.[35-38]

Taking each of the diverse revelations of the different addenda to the literature as gospel would invariably lead to the condemnation or acceptance of some approach or other, even though such a posture might not be generally supported by the greater body of literature. In this light, the recently published works of Baumrind *et al*[40-42] provide a new perspective by which we can reevaluate some old beliefs.

Various investigators have consistently reported a retarding effect on the forward growth of the maxilla[13,22,24,27,43] or distal movement of upper teeth,[20,22,26,28] sometimes with a change in the position of the pterygomaxillary fissure[22,35] and the sphenoid bone.[24,35,36] Considering the combined findings of animal and clinical studies[42] on the effects of applying a distally directed force to the maxilla, one is led to the inevitable conclusion that the forward growth of the maxilla can be retarded and that an absolute distal displacement of the maxilla and maxillary dentition is possible.

Mandibular Arch

The lingual archwire has been used successfully in many ways over the years. A concise discussion has been published by Singer.[44] This versatile appliance has numerous applications, but the apparent simplicity of its design belies the complexity of its mastery. As expressed by Singer, "Certainly, it can be seen that the appellation 'passive lingual arch' is a misnomer."

Materials and Methods

It is easy to criticize previous investigations on the basis of their subjectivity, sample size, lack of a control sample, case report method, failure to control variables, statistics and so on.[34] Viewed from a broader perspective, each of these flawed attempts has added information which contributes to our better understanding in a speciality that is still heavily dependent on the art with which mechanical systems are applied.

TABLE 1
Samples

	Number			Age (Yr.) Film #1		Age (Yr.) Film #2		Elapsed
	Total	M	F	Mean	S.D.	Mean	S.D.	Time (Yr.)
Control	23	11	12	8.75	1.19	12.72	1.29	3.97
Treatment	21	12	9	8.54	2.1	12.51	2.3	3.97
KC Only	19	10	9	9.88	1.65	12.97	1.64	3.09

The observations of Moyers and Bookstein[45] notwithstanding, the data presented in this study was obtained by a retrospective analysis of lateral cephalometric radiographs of paired subjects who had been clinically diagnosed in the early mixed dentition as having a Class II malocclusion.

The treatment sample (Table 1) consisted of 21 individuals, 12 male and 9 female, each of whom received treatment for correction of the anteroposterior dysplasia, establishment of normal overbite and overjet relationships, maintenance of mandibular leeway space and alignment of the lower anterior teeth. It was not expected that a second phase of treatment would be required in the permanent dentition.

The control sample consisted of 11 males and 12 females who also presented with similar Class II malocclusions in the early mixed dentition.

An additional treatment sample of 10 males and 9 females, referred to as "KC Only," received treatment with only a Kloehn cervical traction appliance for the correction of the anteroposterior dysplasia.

The experimental sample was selected solely on the basis of pre-treatment records and criteria. Sample selection was approached in a manner as close as possible to statistical randomness, without conscious bias. No consideration was given to the treatment result.

The University of California Combined Head Film Analysis[46] was applied to all radiographs. This method, developed by Dr. Sheldon Baumrind, is a computer-aided procedure which refines the precision with which films can be compared.

The 21 dental and skeletal landmarks shown in Fig. 1 were located on each film. Paired films were compared with registrations on the palatal plane, anterior cranial base and mandibular border.

Each film was traced by four different individuals, producing four independent estimates for each landmark and anatomic superimposition. Each estimate of each point was digitized on a two-dimensional coordinate system and averaged to yield a best estimate for the coordinates of each point. Additional computer operations superimposed those average patterns on each of the three anatomic reference bases.

Treatment

All subjects in the experimental sample were treated with a partial Edgewise appliance augmented by cervical traction and a lower lingual arch. The maxillary incisors and all four first molars were banded.

Treatment in the maxillary arch

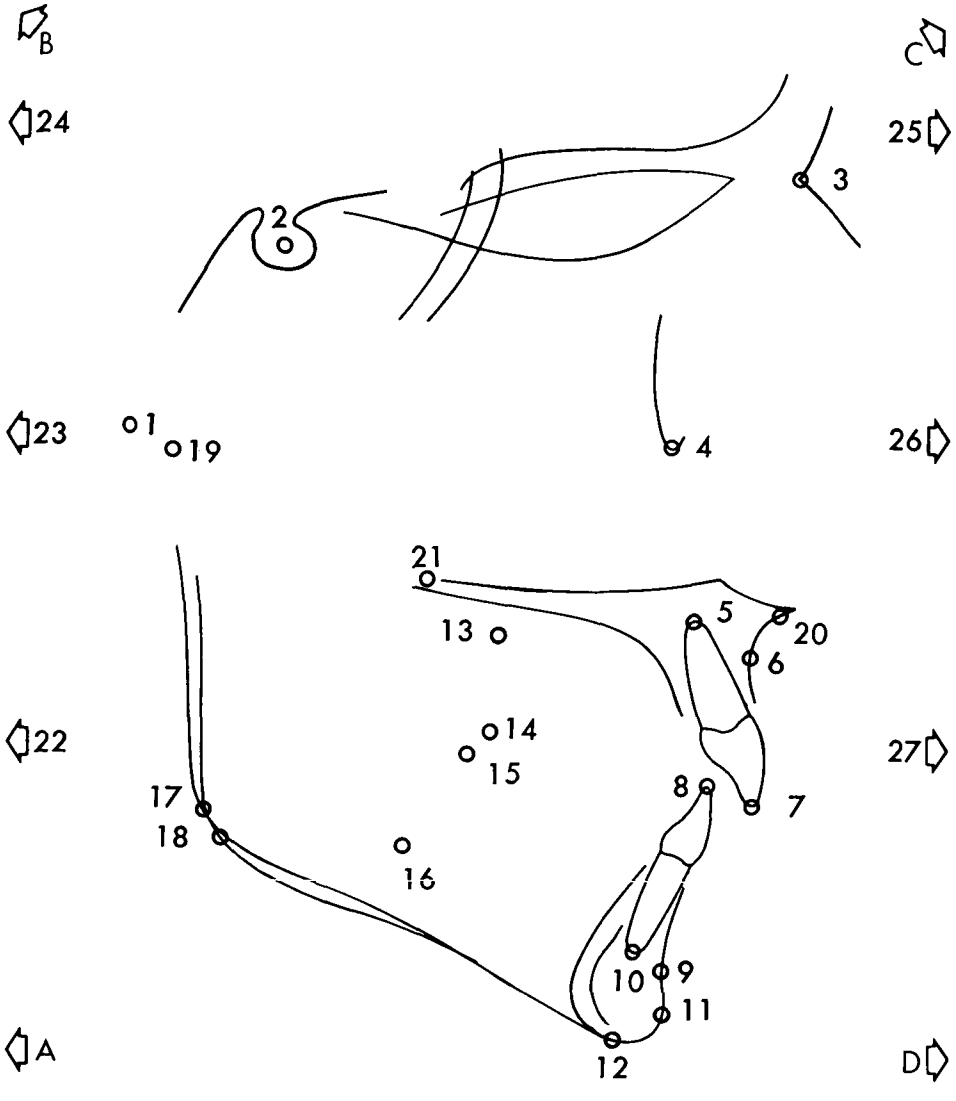

Fig. 1 Landmarks used in U.C.S.F. Combined Headfilm Analysis.

1. Porion
2. Sella
3. Nasion
4. Orbitale
5. Upper Incisor Apex
6. Point A
7. Upper Incisor Edge
8. Lower Incisor Edge
9. Point B
10. Lower Incisor Apex
11. Pogonion
12. Menton
13. Upper Molar Apex
14. Upper Molar Cusp
15. Lower Molar Cusp
16. Lower Molar Apex
17. Upper Gonion Image
18. Lower Gonion Image
19. Condyle
20. Anterior Nasal Spine
21. Posterior Nasal Spine

These data were acquired using hardware and software technologies developed at the Craniofacial Research Instrumentation Laboratory of the Department of Growth and Development at the University of California, San Francisco, under NIH-NIDR Grants DE03598 and DE03703.

was initiated with a multistranded twisted .0215″ (0.55mm) archwire, followed by .020″ (0.51mm) round and .019″ × .025″ (0.48 × 0.64mm) rectangular archwires with vertical offsets distal to the lateral incisors. Compression coil springs were used between the first molars and lateral incisors to maintain or gain space for the eruption of the permanent cuspids and bicuspids.

In some cases deciduous teeth were extracted to gain more favorable eruption of the permanent cuspids.

Cervical traction was applied to the first molars with a .045″ (1.14mm) Kloehn type facebow. The long outer bows were raised to prevent distal crown tipping of the molars and possible incisor extrusion.

In the mandibular arch a symmetrical preformed .030″ (0.77mm) lingual arch with a vertical loop mesial to the horizontal molar sheath was used. The lingual arch was adjusted to contact the lower incisors only, near the level of their contact points. The arch form was modified as required for cuspid eruption.

The objectives of this phase of treatment were a normal molar relationship, normal overbite and overjet, well-aligned and positioned incisors and adequate space for the eruption of permanent cuspids and bicuspids.

When those goals were achieved, the maxillary incisor bands were removed and a removable palatal appliance with an anterior elastic was worn full-time. During this supervision/retention phase the cervical appliance was worn as required to maintain molar relationships.

The second records were made to evaluate the need for further treatment after the second molars had begun to erupt. Of the 21 individuals in the treatment sample, 16 were judged to not require additional banded treatment.

The results are shown in Figs. 2-11 and Tables 2-21.

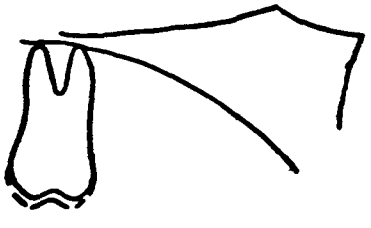

Fig. 2 Upper first molar (U6) eruption during treatment averaged 0.25 mm/yr more than the controls.

TABLE 2
Treatment vs. Controls
Vertical Changes in Position of U6 (mm)

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	7.3	1.3	8.4	3.2	1.1	1.50
to S-N	7.15	1.4	8.5	2.8	1.35	2.05
to Palatal Plane	2.15	1.0	3.1	1.7	0.95	2.26*

* Significant at 0.05 level of confidence.

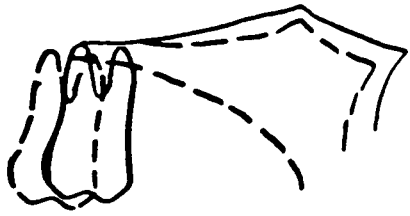

Fig. 3 Experimental treatment had a significant mean orthopedic effect, inhibiting the forward displacement of the upper first molar with growth with no significant change in dento-alveolar relationships.

TABLE 3
Treatment vs. Controls
Horizontal Changes in Position of U6

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	3.9	1.5	0.7	3.8	4.6	4.71**
to S-N	4.20	1.85	0.0	3.7	4.2	4.77**
to Palatal Plane	2.05	1.5	2.4	2.3	0.35	0.57

** Significant at 0.01 level of confidence.

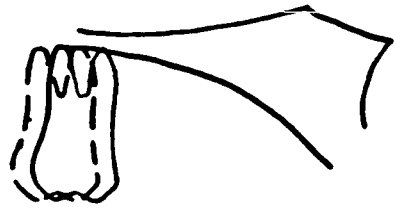

Fig. 4 The mean effects of Kloehn headgear alone on the first molar were primarily distal movement within the alveolar process.

TABLE 4
Treatment vs. Cervical
Horizontal Changes in Position of U6

	Treatment		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	0.7	4.6	0.0	2.6	0.7	0.63
to S-N	0.0	4.2	0.3	2.2	0.3	0.66
to Palatal Plane	2.4	2.3	0.7	1.5	1.70	2.93**

** Significant at 0.01 level of confidence.

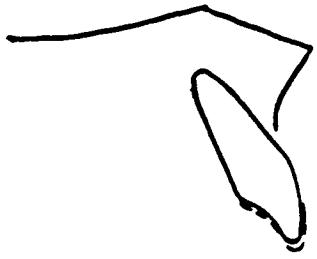

Fig. 5 Experimental treatment had no significant effect on restricting the mean downward growth of the upper central incisors.

TABLE 5
Treatment vs. Control
Vertical Changes in Position of U1

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	6.45	1.75	7.2	3.0	0.75	0.69
to S-N	6.35	1.80	7.2	2.7	0.85	1.81
to Palatal Plane	1.55	1.05	1.7	1.4	0.15	1.67

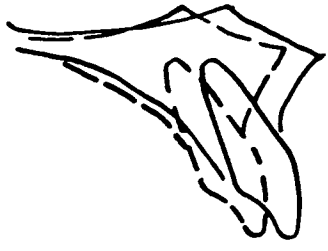

Fig. 6 Experimental treatment had a significant mean orthopedic effect in inhibiting the forward growth of the maxillary anterior alveolar process and central incisors.

TABLE 6
Treatment vs. Control
Horizontal Changes in Position of U1

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
	Mesial		*Distal*			
to Anterior Cranial Base	2.4	2.7	—3.2	4.7	3.6	4.87**
to S-N	2.75	2.7	—2.9	4.4	5.65	5.14**
to Palatal Plane	0.45	2.2	—0.7	2.4	2.85	2.82*

* Significant at 0.05 level of confidence.
** Significant at 0.01 level of confidence.

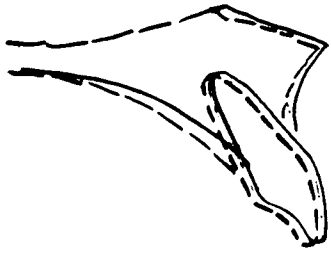

Fig. 7 Differences in the mean horizontal effects of experimental treatment and Kloehn cervical traction on the horizontal position of the upper central incisors were not statistically significant.

TABLE 7
Treatment vs. Cervical
Horizontal Changes in Position of U1

	Treatment		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
	Distal		*Distal*			
to Anterior Cranial Base	—3.2	4.7	—2.0	2.9	1.2	1.17
to S-N	—2.9	4.4	—1.6	2.6	1.3	1.57
to Palatal Plane	—.07	2.4	—1.4	2.2	0.7	0.875

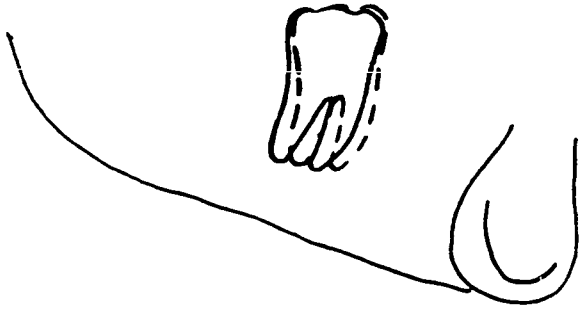

Fig. 8 Experimental treatment, including lower lingual arch, did not inhibit lower molar eruption.

TABLE 8
Treatment vs. Control
Vertical (Upward) Changes in Position of L6

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	6.7	1.9	8.8	3.1	2.1	2.73*
to Mandibular Plane	2.65	1.35	4.1	1.8	1.45	3.02**

* Significant at 0.05 level of confidence.
** Significant at 0.01 level of confidence.

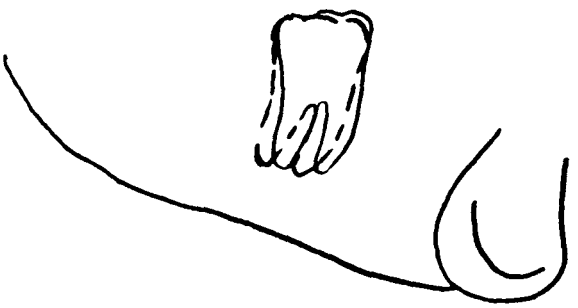

Fig. 10 Lower lingual arch did not prevent forward growth of the lower first molar, but did result in a more upright angulation than in the controls.

TABLE 9
Treatment vs. Cervical
Vertical (Upward) Changes in Position of L6

	Treatment		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	8.8	3.1	6.9	3.0	1.9	1.86
to Mandibular Plane	4.1	1.8	2.6	1.9	1.5	2.68*

* Significant at 0.05 level of confidence.

Fig. 9 More mean lower molar eruption occurred with experimental treatment including lower lingual arch than with Kloehn cervical therapy alone.

TABLE 10
Treatment vs. Control
Horizontal Changes in Position L6

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
to Anterior Cranial Base	3.9	1.5	—0.2	3.8	4.71	4.71**
Crown to Mandibular Plane	1.5	1.55	1.7	1.7	0.2	0.41
Apex to Mandibular Plane	0.4	1.55	3.0	3.3	2.6	3.38**
Tip (degrees)	1.85	4.45	—4.6	8.6	6.45	3.15

** Significant at 0.01 level of confidence.

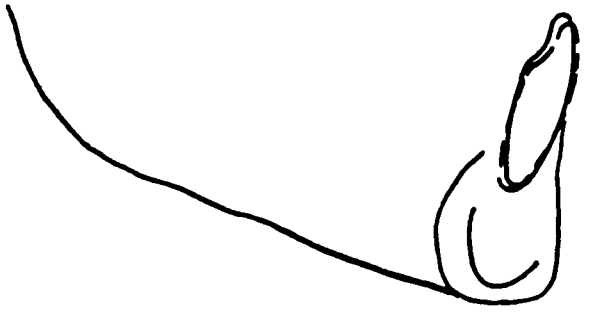

Fig. 11 The lower li
gual arch did not signi
cantly affect the erupti
or angulation of the low
incisors.

TABLE 11
Treatment vs. Control
Changes in Position of L1

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Labial, to Anterior Cranial Base ..	2.65	2.55	1.6	3.9	1.05	1.06
Downward, from Anterior Cranial Base	5.45	2.35	10.0	3.3	4.55	3.41**
Edge upward from Mandibular Plane	2.65	1.65	2.0	1.9	0.65	1.23
Edge Labial, to Mandibular Plane ..	1.0	1.45	1.8	1.8	0.8	1.63
Tip (degrees)	3.2	4.65	5.7	5.2	2.5	1.69

** Significant at 0.01 level of confidence.

TABLE 12
Treatment vs. Control
Changes in Vertical Position of Maxilla

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point A to Anterior Cranial Base ..	4.8	1.65	5.9	2.3	1.1	1.83

TABLE 13
Cervical vs. Control
Changes in Vertical Position of Maxilla

	Control		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point A to Anterior Cranial Base ..	4.8	1.65	5.8	3.2	1.1	1.3

TABLE 14
Treatment vs. Cervical
Changes in Vertical Position of Maxilla

	Treatment		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point A to Anterior Cranial Base ..	5.9	2.3	5.8	3.2	0.1	0.12

TABLE 15
Treatment vs. Control
Changes in Horizontal Position of Maxilla

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point A to Anterior Cranial Base ..	2.5	1.45	0.8	3.0	3.3	4.65**
Point A to Palatal Plane	0.0	0.65	0.2	1.2	0.2	0.71

** Significant at 0.01 level of confidence.

TABLE 16
Control vs. Cervical
Changes in Horizontal Position of Maxilla

	Control		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point A to Anterior Cranial Base ..	2.5	1.45	0.0	2.1	2.5	4.63**
Point A to Palatal Plane	0.0	0.65	0.0	0.5	0.0	—

** Significant at 0.01 level of confidence.

TABLE 17
Treatment vs. Cervical
Changes in Horizontal Position of Maxilla

	Treatment		*KC*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point A to Anterior Cranial Base ..—0.8		3.0	0.0	2.1	0.8	1.03
Point A to Palatal Plane	0.2	1.2	0.0	0.5	0.2	0.71

TABLE 18
Treatment vs. Control
Changes in Horizontal Position of Mandible

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point B to Anterior Cranial Base .. Labial	1.9	2.55	0.0	3.9	1.9	1.91
Point B to S-N at Sella ..... Labial	2.15	3.5	0.3	3.3	1.85	1.81
Point B to S-N at Nasion .....—1.2 Lingual		2.85	3.4	3.0	2.2	2.5*
Point B to Mandibular Plane .....—0.2 Lingual		0.35	0.3	0.6	0.1	0.67

Significant at 0.05 level of confidence.

TABLE 19

Treatment vs. Control
Changes in Vertical Position of Mandible

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Point B to Anterior Cranial Base .. Down	6.15	2.35	9.9	3.0	3.75	4.63**
Point B to S-N ..... Down	6.1	2.7	10.0	3.1	3.9	5.13**
Point B to Mandibular Plane ..... Up	1.35	1.0	1.7	1.7	0.35	0.83

** Significant at 0.01 level of confidence.

TABLE 20

Treatment vs. Control
Changes in Measured Variables

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Occlusal Plane Angle	1.0	4.1	—0.9	3.0	1.9	1.76
Overbite	0.9	2.15	—1.1	2.6	2.0	2.78*
Overjet	0.1	2.10	—5.6	2.4	5.7	8.38**
Mandibular Plane Angle	1.15	1.4	0.5	1.8	1.65	3.43**
Y-Axis	0.35	1.3	1.9	1.8	1.55	3.30**
Go-Gn/S-N .....—1.15		1.90	0.3	1.3	1.45	2.96**
Pogonion to Anterior Cranial Base Labial	2.6	2.9	0.1	4.1	2.5	2.36*
Pogonion to Anterior Cranial Base Down	7.85	2.1	11.5	3.5	3.65	4.2**

* Significant at 0.05 level of confidence.
** Significant at 0.01 level of confidence.

TABLE 21

Treatment vs. Control
Changes in Face Height

	Control		*Treatment*			
	Mean	*S.D.*	*Mean*	*S.D.*	*dX*	*t*
Upper FH	4.55	1.75	6.1	1.8	1.55	2.92
Lower FH	3.8	1.80	5.5	2.8	1.7	3.24
% Upper FH	0.6	1.2	0.7	0.9	0.1	0.31
% Lower FH .....—0.6		1.2	—0.7	0.9	0.1	0.31
Total FH	8.35	2.4	11.7	4.2	3.35	3.25

Summary and Conclusions

The quantitative changes which occurred as the result of this specific regimen of treatment in a sample of Class II malocclusions in the early mixed dentition were compared with like changes in a closely matched sample of untreated Class II malocclusions. Selected parameters were also compared with a comparable group of Class II malocclusions treated with only a Kloehn cervical appliance.

1. Treatment as described does tend to slightly increase the vertical eruption of the upper molar.
2. No maxillary orthopedic effects were noted in the horizontal plane.
3. There was significant inhibition of the forward displacement of the upper molar.
4. Cervical traction without anterior bands resulted in actual distal movement of the upper molar, not just an inhibition of its forward growth.
5. The treatment significantly inhibited the forward growth of the upper incisors and point A.
6. Cervical traction alone had less effect on overjet and the S-N-A angle.
7. A lingual arch is effective in maintaining lower leeway space while still allowing horizontal and vertical growth changes in the positions of molars and incisors.
8. Rotation of the mandible was downward and backward.
9. Overall face height was increased.

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