Diagnosis and Treatment of Class II Division 2 Malocclusion

JOHN F. CLEALL AND ELLEN A. BEGOLE

Dr. Cleall is Professor and Head of the Department of Orthodontics at the University of Illinois College of Dentistry in Chicago. He holds B.D.S., M.D.S., and D.D.S. degrees from the Universiy of Otago, New Zealand.

Dr. BeGole is an Associate Professor in the Department of Orthodontics at the University of Illinois College of Dentistry in Chicago. She holds a B.S. degree from the University of Michigan, an M.S. degree from Columbia University, and a Ph.D. from the University of Pittsburgh.

Address:
Dr. John F. Cleall
Department of Orthodontics
University of Illinois
College of Dentistry
801 South Paulina Street
Chicago, IL 60612

This study was funded in part by the Edward Wach Fund of the University of Illinois College of Dentistry.

A morphologic and functional evaluation of Class II, division 2 malocclusion based on digitized data from cephalometric and cinefluorographic radiography and dental casts. The principal findings are an essentially normal skeletal pattern outside the immediate dental region, with the major deviations directly involving the dentition. The research studies are followed by a review of therapeutic options in the light of the findings.

The diagnostic and treatment problems associated with Class II, Division 2 malocclusion (II/2) have many interesting facets. The Class II anteroposterior malrelationship of the buccal segments is far from the only treatment problem to be resolved.

The usual deep overbite poses problems of vertical control, and the retroclination of the upper central incisors may require the use of an effective torquing mechanism (Fig. 1). Abnormal or unusual patterns of mandibular posture and closure can make the diagnosis and treatment of this malocclusion most intriguing.

Several possible treatment options are commonly employed in these cases. Some orthodontists simply procline the upper central incisors (Fig. 2), based on the rationale that II/2 is simply a variant of Class II, Division 1, and then proceed with routine Class

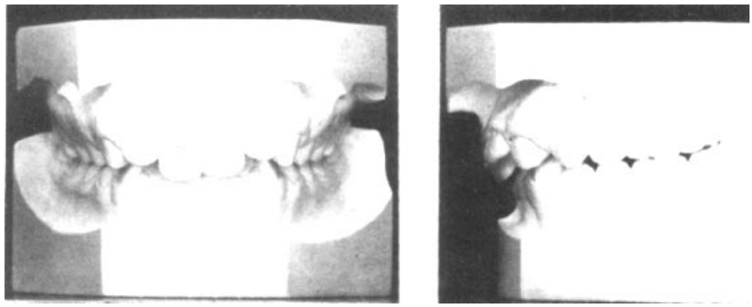


Fig. 1 Dental casts showing the characteristic incisor arrangement, deep overbite and Class II buccal segments

II, Division 1 treatment (Strang and Thompson,[11] Ricketts *et al.*[8]). Class II elastics, extraoral traction, bite planes, and functional appliances have all been used.

The success rate of these various appliances depends on growth vectors and the tooth movement limitations of each system. Advocates of the proclination of the upper incisors often do so in the expectation that this will permit the mandible to move forward into a better occlusal relationship (Timmons[12]).

Concern over the need to retract the apices of the upper central incisors, and the resultant strain on the upper buccal anchorage, is one reason why some clinicians have elected to extract upper first bicuspids (Fig. 3). The molar teeth are then allowed to remain in a Class II relationship, which usually presents few problems in interdigitation or function. Class II elastics are avoided to prevent the resultant advancement of the lower arch.

Should marked crowding be encountered in the lower arch, four first bicuspids may be removed. A variant on the latter theme involves the extraction of upper first and lower second bicuspids. The upper anterior segment is then retracted and torqued, while reciprocal forces from the Class II elastics are used to move the lower molars forward into a Class I relationship.

Failure to achieve treatment goals, and relapse experiences following apparently successful treatment of II/2, often involve incomplete correction of the deep overbite or a return toward the characteristic upper incisor arrangement. In an effort to help understand some of the complexities of II/2, the senior author has conducted a series of interrelated studies.

Materials and Methods

Diagnostic records and treatment data were collected for 115 patients who had received treatment for II/2 problems.* Clinical information, study casts, diagnostic photographs, cephalometric radiographs, and some cinefluorographic records were obtained. These records (except the cinefluorographic records) were made before treatment (A records), at the end of active treatment (B records), at the

* Private orthodontic practice (Cleall)
Orthodontic Graduate Clinic, University of Manitoba (source of all cinefluorographic records).
Orthodontic Clinic, Graduate College, University of Illinois.

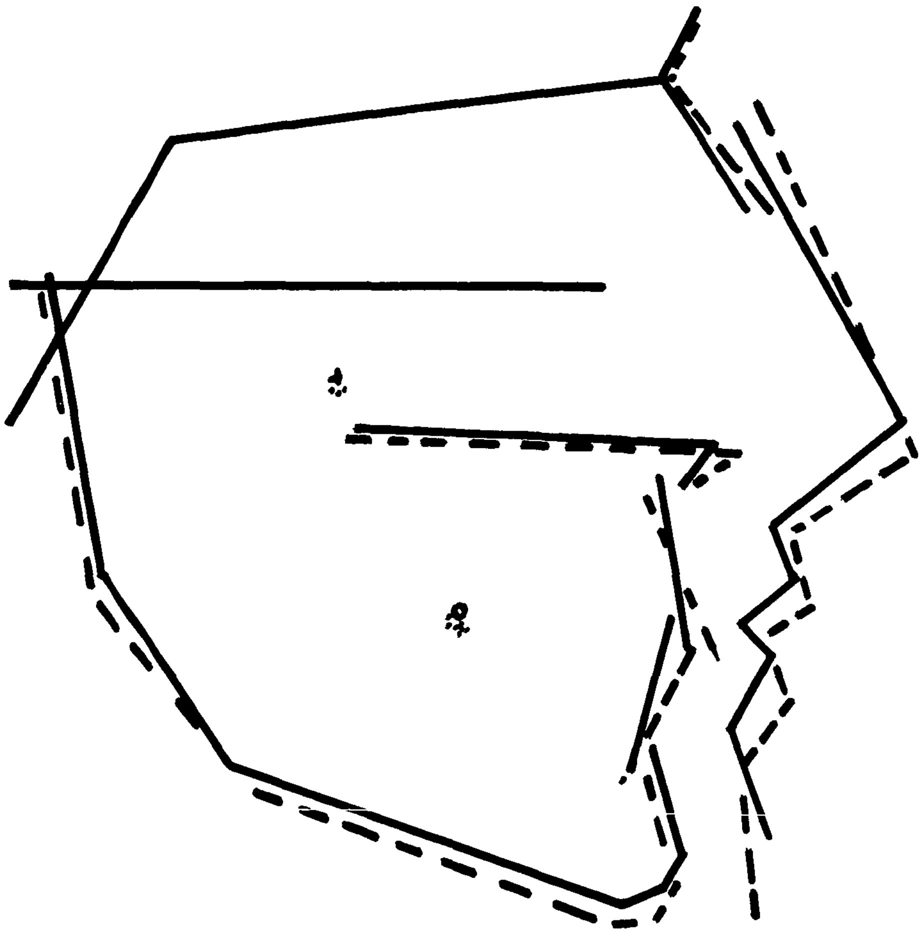
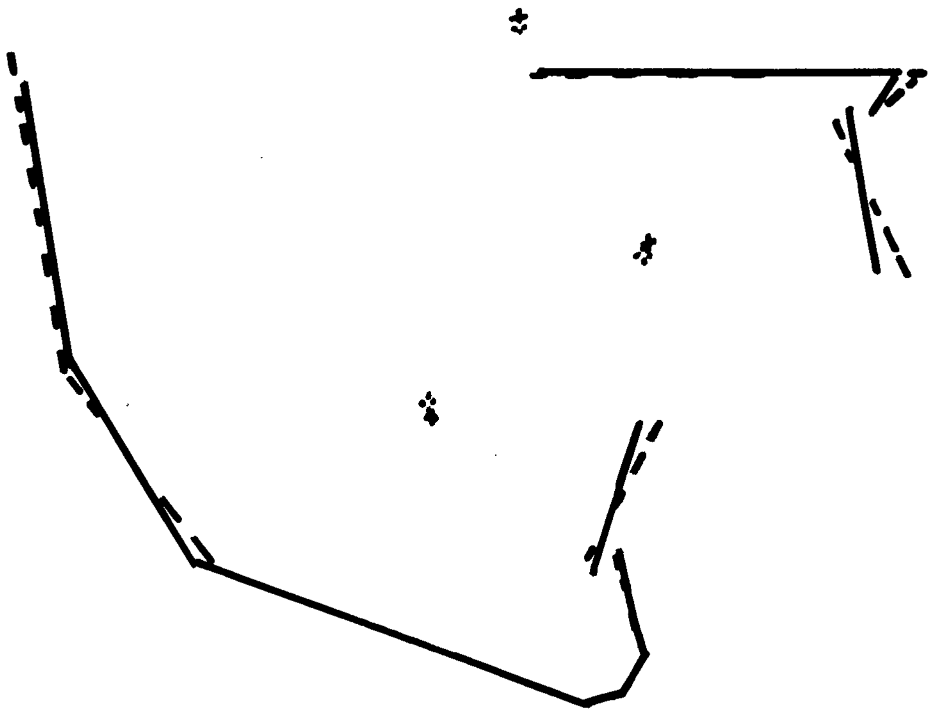
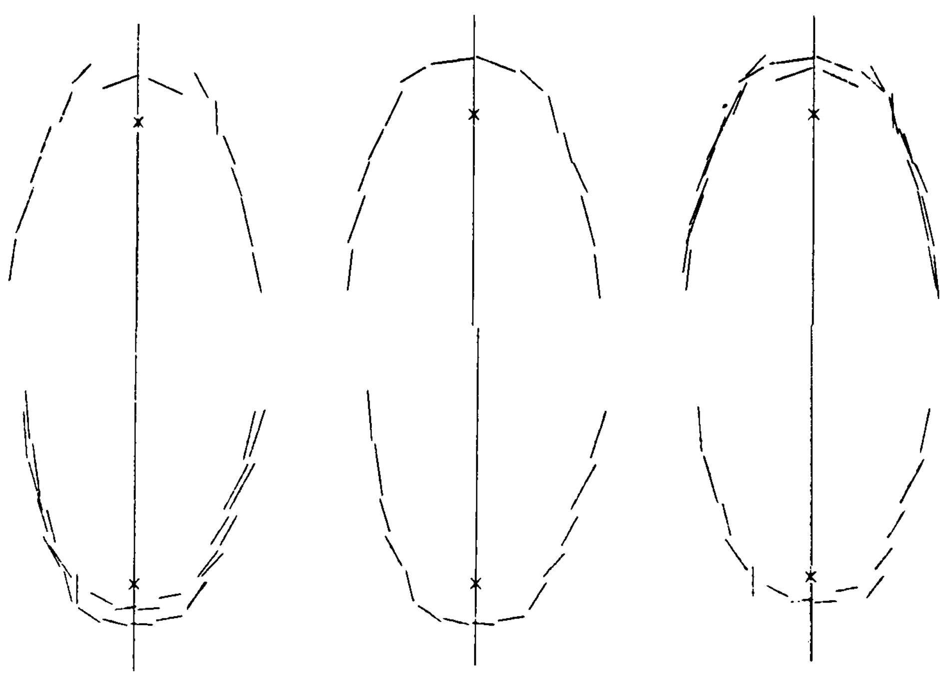


Fig. 2 Selected treatment records of a patient who underwent nonextraction treatment. Edgewise mechanics.

Cephalometric polygons above and top right show the changes with treatment. Tooth movement is depicted in the maxillary and mandibular superimpositions.

Dental cast computer plots (right) show before treatment, after treatment, and superimposition (from left to right). Maxillary plots are above and mandibular plots below. Segments are formed by the computer, plotting the lines joining the mesial and distal contact points on each tooth.





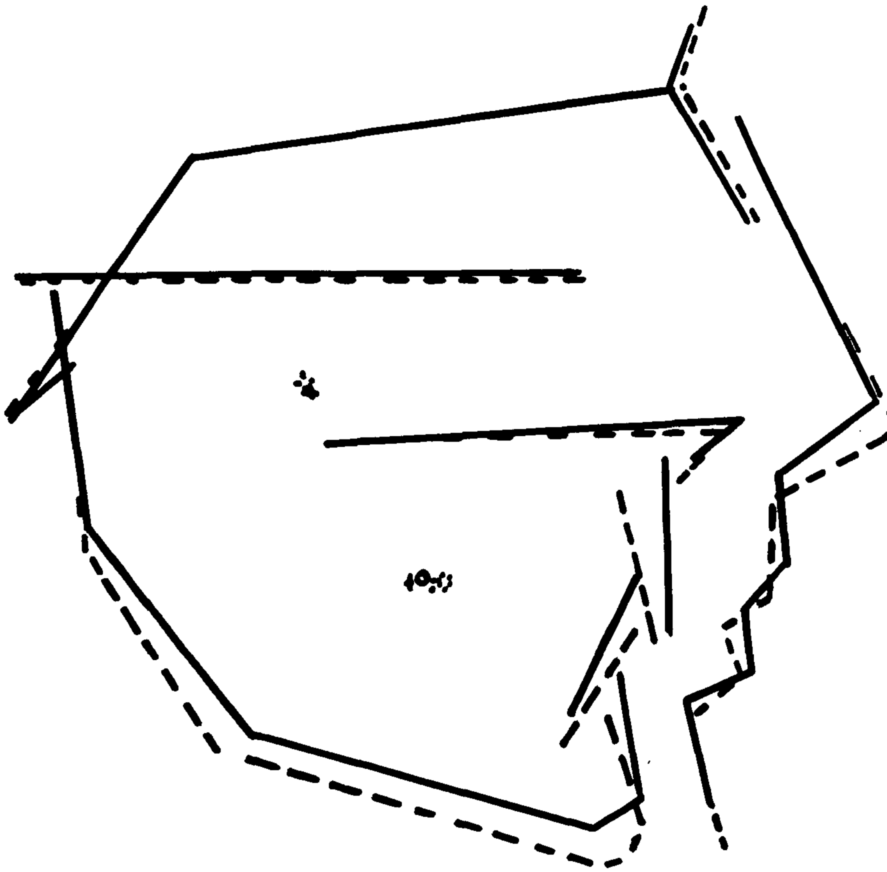


Fig. 3 Selected records of a patient who underwent treatment following the extraction of upper first bicuspids.

end of retention (C records), and at least two years following the removal of all retainers (D records).

Dental casts were photographed using a standardized technique, anatomical details were digitized and the resulting coordinate data were analyzed using the routine cast analysis system in use at the University of Illinois (BeGole *et al.*[2]). Occlusal arch form plots were also produced (Fig. 2).

Lateral cephalometric radiographs were digitized and analyzed using the system described by Chebib *et al.*,[3] which is currently routinely used for all graduate clinic patients at the University of Illinois. Polygon plots derived from the coordinate data were used for graphic display and superimposition (Fig. 2).

Cinefluorographic recordings were made for some cases prior to treatment and during the retention period (Beaton and Cleall[1]). Single-frame analysis of the resulting 16 mm films was based on digitized landmarks.

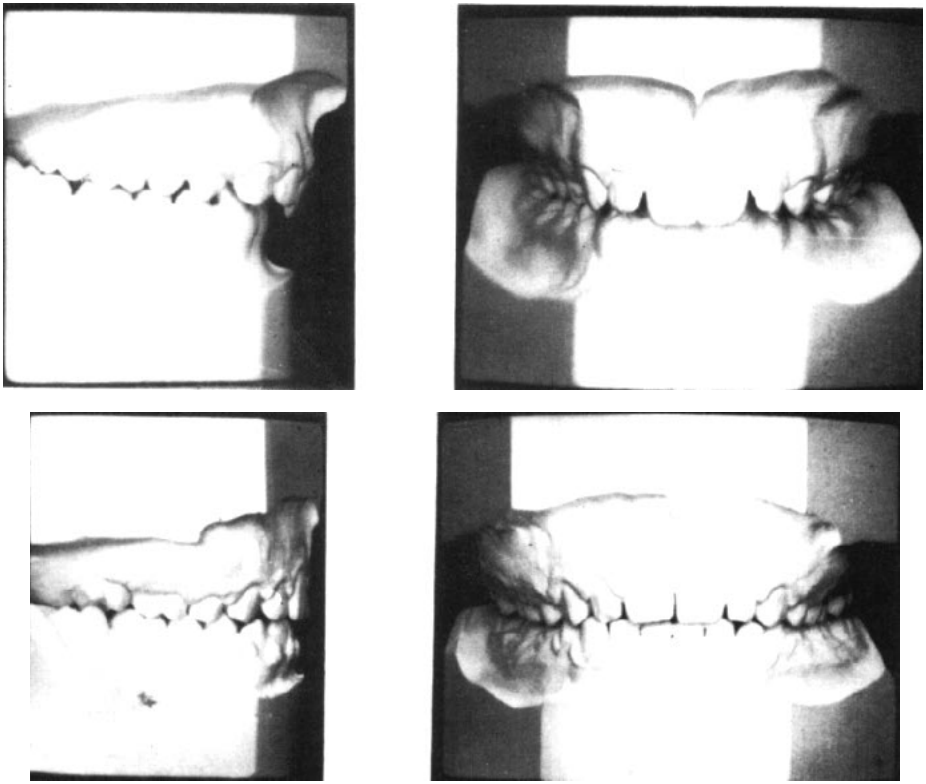


Fig. 3 *Continued*

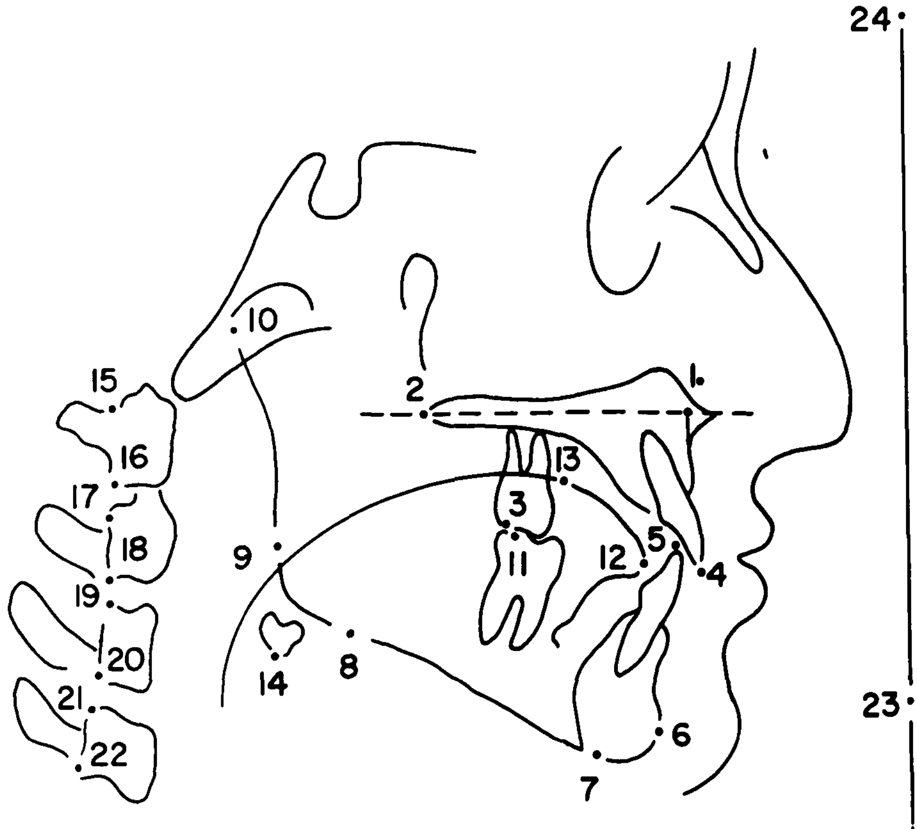
Linear and angular changes of many of the landmarks depicted in figure 4 were measured in relation to the palatal plane registered on the projection of point "A." Changes in these variables and in the axis of rotation of the mandible were computed from rest to initial incisor contact, and from initial contact to full occlusion.

Statistical comparisons and correlations were derived from the study casts, cephalometric radiographs and cinefluorographic films. These statistical studies are based on the 22 sets of records with adequate cinefluorographic data and other records at matched ages.

Results

Facial and Dental Pattern

The mean facial pattern, as determined from the before-treatment lateral cephalometric radiographs, is presented in brief form in figures 5 and 6 and table I. Apart from perhaps a slightly greater angle of facial convexity, the skeletal measurements show a marked similarity to the normal standards used in our clinic. This supports the contention of the authors, that on the average, subjects with II/2 malocclusion have essentially normal skeletal patterns outside the immediate dental area, and therefore should



1. Projection of Point 'A' on palatal plane
2. Posterior Nasal Spine
3. Upper First Molar
4. Upper Incisor
5. Lower Incisor
6. Pogonion
7. Menton
8. Lower Border
9. Ramus
10. Condyle
11. Lower Molar
12. Tip of Tongue
13. Dorsum
14. Hyoid Bone
15. c.1. Upper
16. c.1. lower
17. c.2. Upper
18. c.2. Lower
19. c.3. Upper
20. c.3. Lower
21. c.4. Upper
22. c.4. Lower
23, 24. True Vertical

Fig. 4 Cineflurographic landmarks used to assess oropharyngeal structural movement patterns. Cervical, facial and dental structures are coded, as is a gravity-determined true vertical, to assess head movement.

not be considered to be like those with Class II, Division 1 malocclusions.

Dentally, the cephalometric measurements showed greatest differences in the angulation of the occlusal plane and the upper incisors. If the abnormality is centered on the dentition it might be expected that problems in treatment would often relate to adequate handling of factors related to the dental irregularity.

Other types of cephalometric analysis have revealed a short anterior face height in those subjects with II/2 (Wylie[13] and Coben[4]). More importantly, a continued relative forward rotation of the mandible during growth was sometimes seen. Growth is not covered in this paper, but changes during treatment do, of course, reflect a combination of treatment and growth changes.

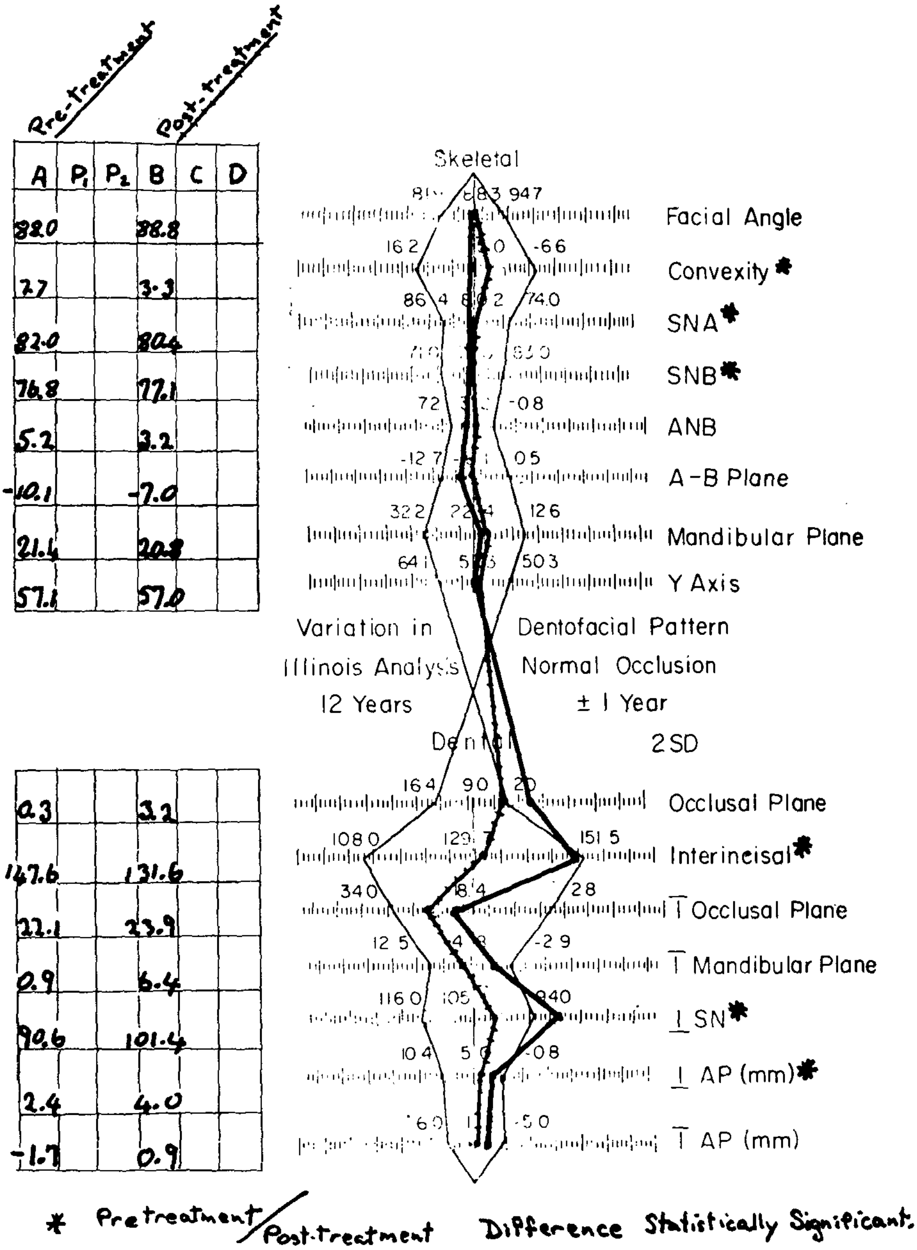


Fig. 5 Clinical lateral cephalometric radiographic analysis. The standard Illinois "wiggle" showing pre-treatment means and post-treatment means for the Class II, Division 2 group superimposed on the norm "yardstick."

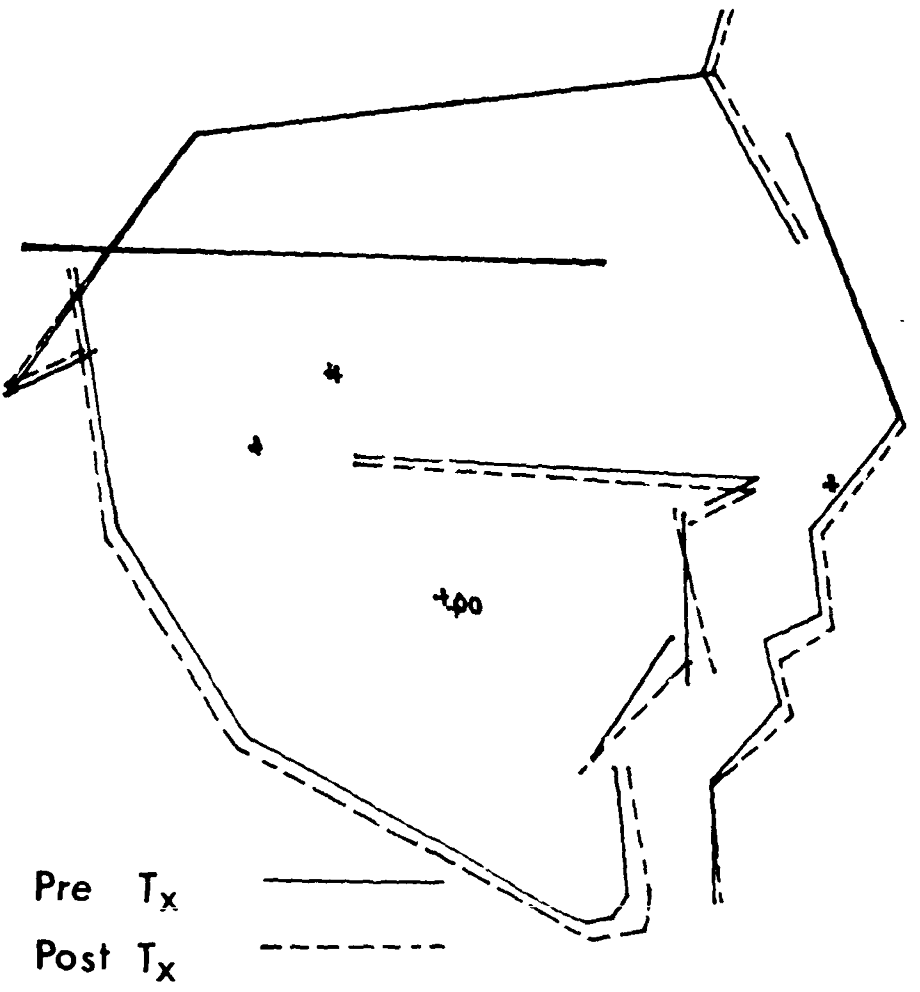


Fig. 6 Mean cephalometric polygon plots superimposed on the sellanasion line. Changes resulting from treatment and/or growth are illustrated.

Statistical examination of the cephalometric data before and after treatment showed several significant changes (Table 1). As a result of treatment and/or growth, the angle of facial convexity and the sella-nasion-point A (S-N-A) angle were found to be reduced. A slight increase in the S-N-B angle was the only other skeletal variable found to have changed.

Other analyses have shown an increase in the apparent prominence of the chin in many individuals. This change may relate to a relative forward rotation of the mandible with growth during treatment, which occurred despite the fact that cervical traction was used in many of these cases.

The average overall dental cephalometric measurements were likewise changed only a little (Table 1). The interincisal angle was reduced (often not as much as the authors might have wished), largely due to the proclination and procumbency of the upper incisors.

The computerized diagnostic system at the University of Illinois is also programed to analyze changes within the dentition, using a "best fit" technique based on the outline and internal architecture of the palate and certain mandibular surfaces and landmarks. These data are shown in Table 2.

A major change in mean tooth position during treatment was proclination of the upper central incisors. The upper molars (UM) were extruded, perhaps by leveling procedures and cervical traction. On the average, the upper molars were moved anteriorly, probably due partly to anchorage loss while torquing upper central incisors and partly to the expected movement in the extraction cases. No significant incisor intrusion was noted.

Changes within the mandibular dentition again showed no significant incisor intrusion, but the lower incisors were proclined. As in the maxillary dentition, the first molars moved occlusally and mesially. While molar extrusion can increase vertical face height and offset the relative upward and forward mandibular growth rotation, it is the author's experience that bite opening achieved in this manner is often transient.

Dental Study Cast Analysis

Dental analysis showed that the abnormalities most characteristic of II/2 were those variables most influenced by the treatment (Table 3). Although some cases were treated by the extraction of upper first bicuspids, the mean change was toward a Class I molar relationship. The overbite was reduced by almost 4 mm, with changes in the curve of Spee and compensating curve accounting for less than half of the reduction. Much of the overbite correction was apparently due to molar extrusion propping the dentition open, rather than to incisor intrusion. The lower incisor intrusion reported by many clinicians was not found.

The remaining variables were not changed at a statistically significant level. Tooth size and changes in arch length could not be evaluated due to the mix of extraction and nonextraction cases in the sample. The dental data derived from cephalometric and cast analyses were generally in agreement. A technique for integrating these two forms of analysis has been developed (Sondhi *et al.*[9]), but has not yet been implemented clinically.

Orofacial Movement Patterns

The movements of the mandible, tongue, hyoid, and head were assessed from the border movements in the cinefluorographic film sequences. A coordinate measuring system based on the palatal plane and registered at the projection of point "A" was used to record vertical, horizontal and angular changes in the position of these structures. Table 4 shows the closing movements of these structures from the rest position to initial tooth contact before treatment.

The movement of the lower incisor from rest to initial contact averaged 4.6 mm upward and 1.3 mm lingually. Data for other variables showed similar upward and backward movement of mandibular structures from rest to occlusal contact in II/2 patients. The most common closing path in normal subjects is upward and forward

(Stone[10]), so the distal shift noted in II/2 is a major departure from the normal pattern. The head itself was noted to undergo a slight downward flexure with a straightening of the cervical spine.

The change in position of the moving structures from initial tooth contact to full occlusion were so small and variable that no consistent pattern could be detected (Table 5).

A statistical t test comparison of the movement patterns before and after orthodontic reatment revealed few significant changes in the mean values. While many individual patients showed a change in the closure pattern, the variability and small magnitude of the changes precluded any evaluation based on means.

However, some of the changes in movement patterns do have significant clinical implications. The mandible traveled a shorter vertical distance from rest to initial contact after treatment, suggesing a larger freeway space in some subjects before treatment (Strang *et al.*).[11]

An important finding was the alteration of the distal shift of the mandibular structuresin closing, that was found before orthodontic therapy, to a more vertical movement pattern afterward. This change was presumably the result of correction of the deep overbite and proclination of the incisors, adding credence to the concept of "unlocking the mandible" in II/2 treatment (Ricketts *et al.*[8]).

Stone,[10] studying some of the same pretreatment cinefluorographic records used in this study, reported two types of mandibular closure patterns in II/2. A younger group showed a distal path of closure, while the pattern in an older group was more vertical and slightly forward. A significant finding in Stone's second group was retroclination of the lower incisors, often accompanied by crowding, which accommodated this more normal path of closure.

Mandibular Rotation

An axis of rotation was constructed for each subject's mandible for the movements from rest to initial contact and from initial contact to occlusion. Large individual variations were noted, with a repeatability of ±5 mm in X and Y values. The mean trends are shown in diagrammatic form in figure 7.

Before orthodontic treatment, the mandibular symphysis moved in an upward and slightly backward direction in relation to the palatal plane, with the axis of rotation below the body of the mandible. The shift from initial contact to full closure before the axis of rotation was noted withthe center of rotation was noted within the morphological outline of the mandible. On no occasion either before or after treatment was the axis of rotation found to be positioned at the condyle, which also holds true for so-called "normal" samples studied by the author. Some degree of translation always occurred; a "hinge axis" was never recorded.

The movement pattern from rest to contact following orthodontic treatment showed the axis of rotation positioned high and well behind the ramus. The movement of the mandible became more vertical. Following initial contact, the movement was slightly upward and sometimes slightly forward.

The positions of these computed axes of rotation of the mandible. support the other cinefluorographic findings where the changes in the mandibular structures were assessed in reference to the palatal plane.

(Text continued on page 53)

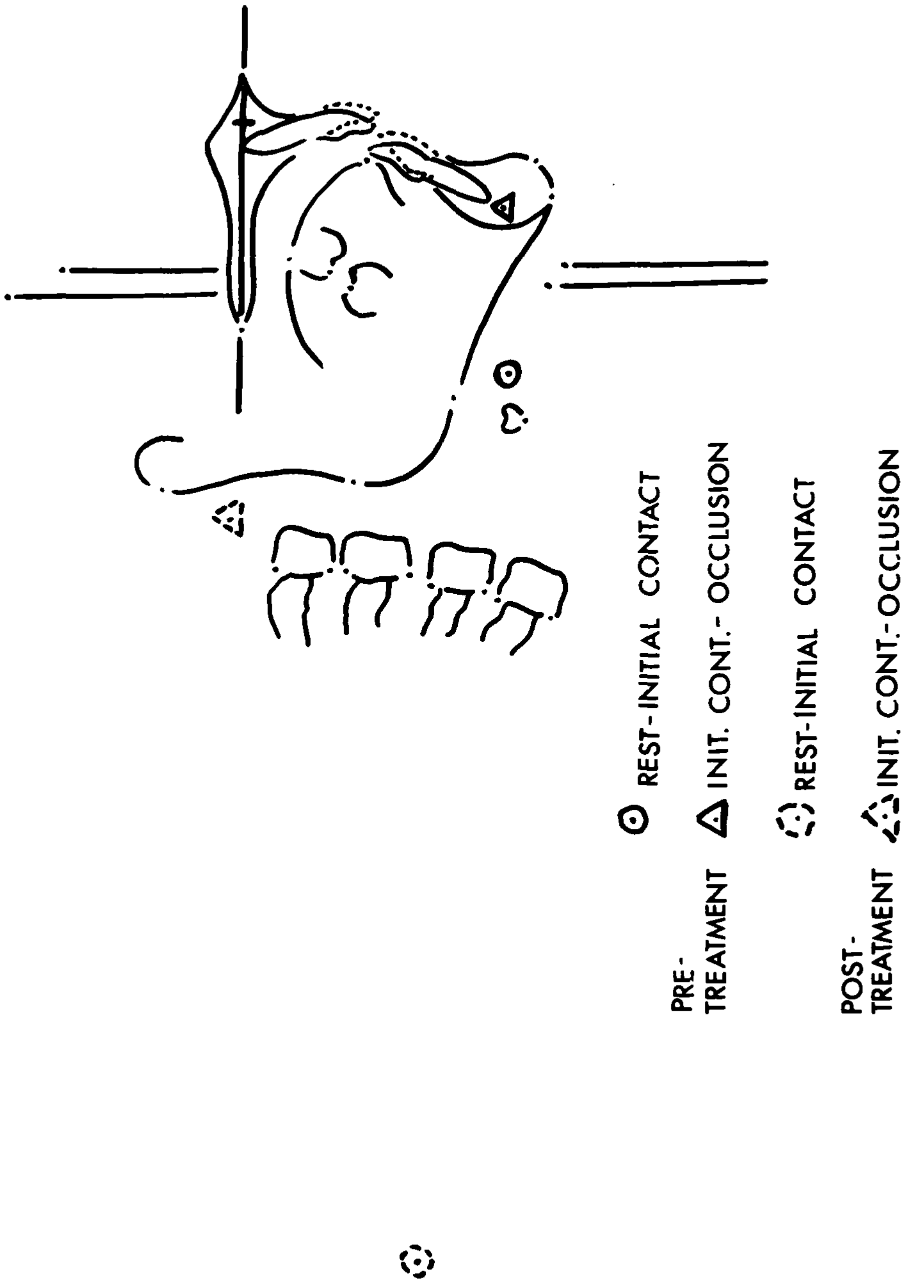


Fig. 7 Mean axes of rotation of the mandible are shown in diagramatic form from rest to initial contact, and from initial tooth contact to occlusion. Pre-treatment and post-treatment means are portrayed. The maxilla has been included to give orientation.

TABLE 1

CLASS II DIVISION 2 - CEPHALOMETRIC ANALYSIS

VARIABLE	PRE-TREATMENT MEAN	PRE-TREATMENT S.D.	POST-TREATMENT MEAN	POST-TREATMENT S.D.	DIFFERENCE		SIGNIFICANCE
FACIAL ANGLE	87.98	4.12	88.80	3.45	0.78	1.84	
CONVEXITY	7.73	4.93	3.26	3.47	-4.47	3.64	*
SNA	82.03	4.65	80.35	4.32	-1.68	1.68	*
SNB	76.83	4.80	77.12	4.48	0.30	1.36	*
ANB	5.21	1.90	3.23	1.44	-2.0	1.49	
A - B PLANE	-10.10	3.67	- 7.01	2.71	3.10	2.41	* *
MANDIBULAR PLANE	21.38	4.37	20.80	4.77	-0.58	2.19	*
Y AXIS	57.06	3.87	57.04	3.50	-0.02	1.66	
OCCLUSAL PLANE	0.31	3.72	3.24	4.32	2.93	4.93	
INTERINCISAL	147.55	15.35	131.60	10.76	-15.94	16.80	*
L.I. - OCCLUSAL PLANE	22.05	8.03	23.93	6.76	1.90	8.24	* *
L.I. - MANDIBULAR PLANE	0.96	9.73	6.37	6.84	5.41	8.49	
U.I. - SN	90.58	12.41	101.37	6.43	10.78	11.34	*
U.I. - AP (MM)	2.37	2.80	4.01	2.22	1.64	2.99	*
L.I. - AP (MM)	-1.71	2.11	0.92	2.28	2.63	2.15	*

* STATISTICALLY SIGNIFICANT. $P < 0.01$
* * STATISTICALLY SIGNIFICANT. $P < 0.05$

TABLE 2

CLASS II DIVISION 2 - CEPHALOMETRIC DENTAL CHANGES

VARIABLE	PRE-TREATMENT/POST-TREATMENT CHANGE MEAN	S.D.	SIGNIFICANCE
U.I. (VERTICAL)	0.18	1.98	
U.I. (HORIZONTAL)	3.56	3.38	*
U.I. - PAL. PL.	11.39	10.68	**
U.I. - OP	8.48	9.52	**
O.P. - PAL. PL.	2.92	5.06	**
U.M. (VERTICAL)	1.70	2.11	*
U.M. (HORIZONTAL)	2.65	3.57	*
ARCH LENGTH	0.54	3.08	
L.I. (VERTICAL)	-0.09	2.68	
L.I. (HORIZONTAL)	2.46	2.69	**
L.I. - MP	5.81	8.72	*
L.I. - OP	1.88	8.24	
O.P. - MP	-3.93	4.28	**
L.M. (VERTICAL)	1.82	1.86	*
L.M. (HORIZONTAL)	2.64	3.48	*
ARCH LENGTH	-0.04	3.02	

* STATISTICALLY SIGNIFICANT. $P < 0.01$
* * STATISTICALLY SIGNIFICANT. $P < 0.05$

TABLE 3

COMPARISON OF PRE-TREATMENT AND POST-TREATMENT STUDY MODEL DATA

	PRE-TREATMENT		POST-TREATMENT			
MEASURE	MEAN	S.D.	MEAN	S.D.	DIFFERENCE	SIGNIFICANCE
ARCH RELATIONSHIP						
LEFT	2.87	1.90	0.35	0.62	2.52	**
RIGHT	2.60	1.90	1.20	1.15	1.40	**
OVERJET	2.98	1.40	2.14	1.18	0.85	
OVERBITE	5.75	1.36	1.95	1.74	3.80	*
CURVE OF SPEE	0.55	0.57	-0.31	0.35	0.86	*
COMPENSATING CURVE	0.49	0.84	-0.37	0.77	0.86	*
MIDLINES						
MAXILLA	1.45	1.13	0.95	1.22	0.49	
MANDIBLE	0.72	0.87	0.90	0.96	-0.18	
ARCH WIDTH CUSPID						
MAXILLA	33.47	3.39	34.22	2.61	-0.75	
MANDIBLE	28.30	9.53	26.65	1.46	1.65	
ARCH WIDTH MOLAR						
MAXILLA	52.97	3.32	52.77	2.65	0.20	
MANDIBLE	46.14	3.38	46.76	2.37	-0.63	
ARCH LENGTH MAXILLA						
LEFT	30.65	4.48	32.78	1.84	-2.14	
RIGHT	31.40	4.30	32.11	1.38	-0.71	
MEAN	31.05	4.21	32.45	1.22	-1.40	
ARCH LENGTH MANDIBLE						
LEFT	27.23	3.21	27.82	1.46	-0.59	
RIGHT	27.72	3.14	28.97	1.23	-1.26	
ARCH SYMMETRY						
MAXILLA	0.35	0.46	0.29	0.49	0.06	
MANDIBLE	0.20	0.22	1.45	3.01	-1.25	
TOOTH MATERIAL						
MAXILLA	7.84	6.41	6.33	2.63	1.51	
MANDIBLE	4.59	5.79	5.82	3.28	-1.23	
TOOTH SIZE - ARCH SIZE						
MAXILLA	7.84	6.41	6.33	2.63	1.51	
MANDIBLE	4.59	5.79	5.82	3.28	-1.23	
BOLTON RATIO						
OVERALL	90.03	3.76	89.68	4.01	0.35	
ANTERIOR	77.34	4.71	76.72	3.92	0.62	

* STATISTICALLY SIGNIFICANT. $P < 0.01$
** STATISTICALLY SIGNIFICANT. $P < 0.05$

TABLE 4

CINEFLUOROGRAPHIC ANALYSIS
(MEAN CHANGE FROM REST POSITION TO INITIAL CONTACT)

VARIABLE	PRE-TREATMENT MEAN	PRE-TREATMENT S.D.	POST-TREATMENT MEAN	POST-TREATMENT S.D.	DIFFERENCE	SIGNIFICANCE
VERTICAL (MM)						
LOWER INCISOR	4.58	2.66	3.59	1.89	-0.99	
LOWER MOLAR	2.36	1.72	2.21	1.91	-0.15	
MENTON	4.90	3.18	2.60	2.84	-2.31	*
TONGUE TIP	3.54	2.91	3.06	2.65	-0.49	
DORSUM	1.87	3.33	0.70	2.65	-1.17	
HYOID	1.25	4.95	0.38	5.40	-0.87	
HORIZONTAL (MM)						
LOWER INCISOR	1.28	2.11	-0.46	2.34	-1.74	*
POGONION	2.48	1.85	0.18	2.77	-2.31	*
TONGUE TIP	0.58	1.93	-0.71	2.55	-1.29	
HYOID	0.91	3.76	-1.45	5.98	-2.36	
ANGLES (DEGREES)						
LOWER INCISOR	-1.46	6.13	8.03	10.83	9.49	
POGONION	-1.70	1.47	8.90	12.28	10.60	
TONGUE TIP	-0.58	4.77	-2.24	5.23	-1.66	
CERVICAL VERTEBRAE	-0.18	2.60	0.53	3.93	0.71	
TRUE VERTICAL	0.47	1.30	-0.69	2.16	-1.16	**
SPINE CURVATURE	1.48	5.61	-1.32	3.08	-1.80	

* STATISTICALLY SIGNIFICANT, P < 0.01
** STATISTICALLY SIGNIFICANT, P < 0.05

TABLE 5

CINEFLUOROGRAPHIC ANALYSIS
(MEAN CHANGE FROM INITIAL CONTACT TO OCCLUSION)

VARIABLE	PRE-TREATMENT MEAN	PRE-TREATMENT S.D.	POST-TREATMENT MEAN	POST-TREATMENT S.D.	DIFFERENCE	SIGNIFICANCE
VERTICAL (MM)						
LOWER INCISOR	0.45	1.85	-0.18	3.46	-0.63	
LOWER MOLAR	-0.77	1.23	0.24	1.34	1.01	
MENTON	-0.42	1.54	0.14	0.92	0.56	
TONGUE TIP	0.60	3.09	0.63	1.65	0.03	
DORSUM	-.0.04	2.69	0.65	2.82	0.69	
HYOID	-2.47	6.98	-1.81	5.38	0.67	
HORIZONTAL (MM)						
LOWER INCISOR	-0.87	3.09	-0.50	3.20	0.37	
POGONION	-1.28	6.57	-0.51	2.29	0.77	
TONGUE TIP	-0.88	3.50	-0.08	2.07	0.80	
HYOID	-0.57	4.37	-0.37	5.34	0.20	
ANGLES (DEGREES)						
LOWER INCISOR	-1.74	6.76	-0.42	2.66	1.33	
POGONION	-0.92	4.69	8.42	10.39	9.34	
TONGUE TIP	-1.62	6.70	-0.10	5.00	1.52	
CERVICAL VERTEBRAE	1.00	4.34	-0.56	2.81	-1.56	
TRUE VERTICAL	-1.36	4.71	0.36	1.74	1.71	
SPINE CURVATURE	-0.88	4.15	1.19	3.34	2.08	

TABLE 6

CORRELATION OF CEPHALOMETRIC, MODEL AND CINEFLUOROGRAPHIC VARIABLES

(PRE-TREATMENT DATA)

TYPE OF RECORDS				
CEPHALOMETRIC	MODELS	CINEFLUOROGRAPHIC	'r' VALUE	SIGNIFICANCE
ANGLE OF CONVEXITY	ARCH RELATIONSHIP		0.651	*
MANDIBULAR PLANE		VERTICAL MENTON	0.667	*
SNB	COMPENSATING CURVE		-0.531	*
INTERINCISAL	COMPENSATING CURVE		0.486	*
OVERBITE	COMPENSATING CURVE		0.603	*
	COMPENSATING CURVE	HORIZONTAL LOWER INCISOR	0.672	*

* 'r' VALUES SIGNIFICANT AT THE 1% LEVEL OF CONFIDENCE.

Correlations

Data showing statistically significant changes with treatment were evaluated further. Multiple correlations among pretreatment variables were examined in an effort to uncover relationships which might be masked when the mean data were tested for differences. Those correlations considered worthy of discussion are presented in Table 6.

The positive correlation between the convexity of the face and a class II molar relationship was to be expected. The compensating curve (depth of curve of Spee in the upper arch) was compared with several cephalometric variables. A deep curve was associated with a more posterior position of point B, a greater interincisal angle, and a deeper overbite.

The cinefluorographic data showed few reliable correlations, but it did show that when the distance traveled by the mandible from rest to initial contact was greater, the mandibular plane angle tended to be steeper. Also, more distal movement of the mandible was noted in those subjects with the large compensating curve values.

Summary of Data Analysis

The morphological characteristics of II/2, as determined from the cephalometric and dental cast data, suggest that the major problems lie in the dental relationships. Deep overbite, retroclination of the upper central incisors, and distoclusion all require careful treatment planning and execution.

Treatment readily took care of the buccal segments, but the overbite was corrected largely by extrusion of the buccal teeth. The literature seems to suggest that many view the intrusion of incisors, especially the uppers, as a difficult tooth movement (Levin[6]).

During treatment of these cases, the upper and lower incisors were proclined, with some palatal root torque in the maxillary teeth, but on the average, little intrusion was accomplished.

The functional aspects of this study are more difficult to interpret. It could not be documented either clinically or cinefluorographically whether the distal shift before treatment was due to incisal guidance. Studies have shown that considerable distal movement may take place even in subjects with good occlusions (Ingervall[5]). Similarly, the posttreatment data could not be used to distinguish between relief of a true distal shift and development of a forward "bite of convenience."

It would seem that treatment possibilities in II/2 must include the clinician's ability to avoid proclination of the upper incisors and ensure that the buccal segments are handled so that a true distal shift can be relieved without encouraging a forward bite of convenience. Clinical assessment of anteroposterior functional movements of the mandible for differential diagnosis of these cases is at best uncertain.

In order to correct the retroclined central incisors and the deep overbite, an efficient incisor intrusion technique must be considered. Ideally, the clinician would like to offset any forward mandibular growth rotation by some buccal segment extrusion, completely correct the molar relationship, and not procline the lower incisors off basal bone. The reduction of the overbite by intrusion of incisors in both arches while torquing the "droopy" upper incisor can be most important. A case from the sample under study illustrating some of these treatment changes is shown in figure 8.

Growing patients in the late mixed or early permanent dentition, especially if a distal shift during closure can be demonstrated, are best treated if recourse to extractions can be avoided. The upper incisors should be intruded, torqued, and the Class II molar relationship completely corrected. The lower arch is leveled and aligned with the technique most appropriate to space requirements.

Nongrowing permanent dentition cases, especially with a good lower arch and little or no distal shift during closure, are often best handled with the extraction of upper first bicuspids. Appliance therapy is then begun with upper incisor intrusion and good molar control, which may require extraoral traction. Lower arch leveling and alignment and final palatal root torque of upper central incisors follow.

The statistical data covers only those subjects with cinefluorographic records before and after treatment. However, most of the total group (115 subjects) had casts and cephalometric radiographs at all stages of treatment, at the end of retention and at least two years postretention.

While not handled statistically, a subjective evaluation of the material in terms of overall posttreatment stability is consistent with the statistical data from the subsample. This includes the importance of limited molar extrusion to offset an upward and forward condylar growth vector, the importance of incisor intrusion and the need to adequately torque the upper central incisors.

Mechanotherapy

A primary treatment objective in many cases of II/2 should be upper incisor intrusion. Palatal root torque and upper molar distallization (in nonextraction cases) must also be major goals. These changes should be achieved with minimal buccal segment extrusion, except that required

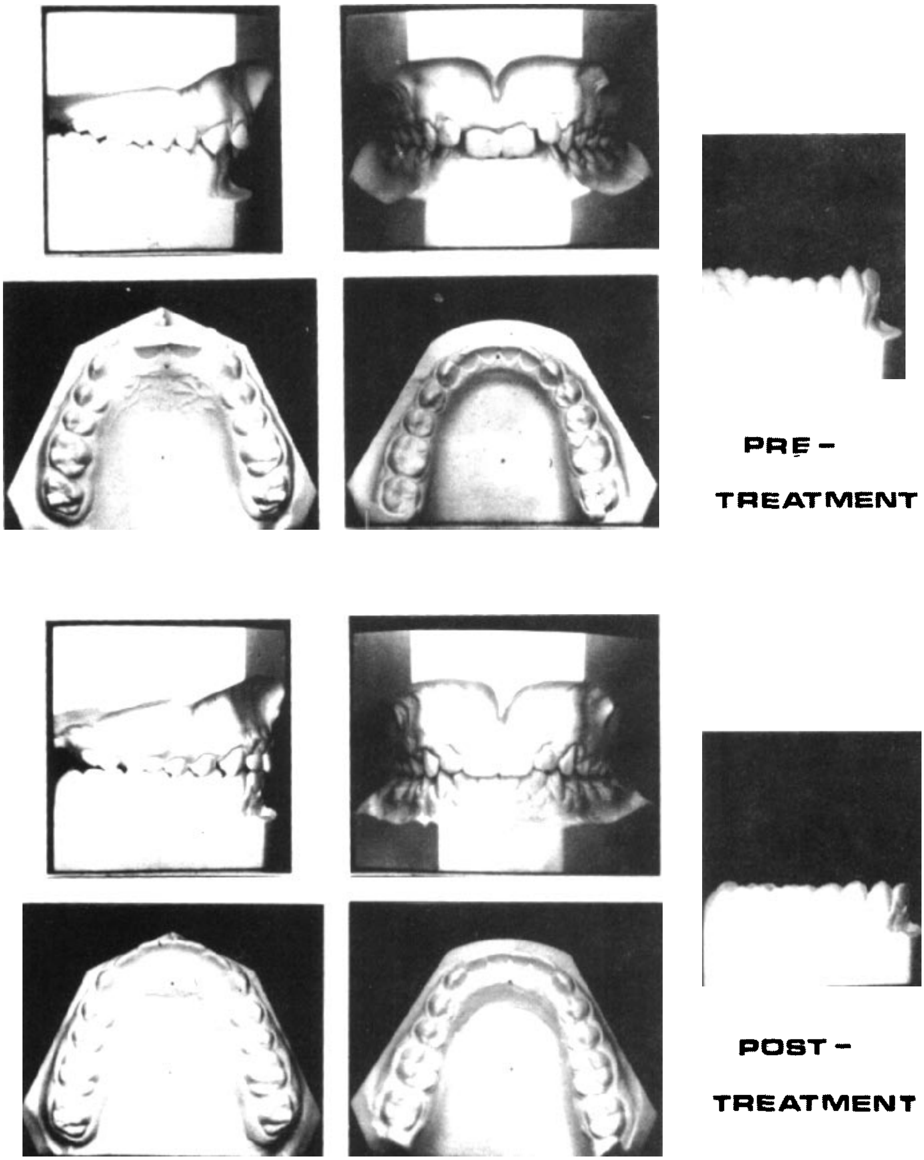


Fig. 8 Selected records of a patient who was treated without extraction.

A. Study casts show the dental changes to be adequate.

B. Cephalometric data showing the improvement of the profile, and the control of mandibular rotation during treatment. The incisor intrusion is also noteworthy.

C. Cephalometric plots showing the above changes.

(Continued on next page)

163 MALE A B C D

ILLINOIS ANALYSIS MEASURE	MEAN	S.D.	A 1311	B 1600	C 1611	D 1902
SKELETAL						
FACIAL ANGLE	88.30	3.00	89.88	93.93	93.84	93.50
CONVEX ANGLE	5.00	5.80	**11.71**	**3.18**	-0.19	-0.42
SNA	80.20	3.10	**84.48**	**81.60**	81.32	81.22
SNB	77.00	3.00	77.39	78.44	79.16	78.64
ANB	3.20	2.00	7.09	3.16	2.17	2.58
A-B PLANE	-6.10	3.40	-13.17	-7.18	-6.19	-7.46
MAND. PLANE	22.40	4.90	20.26	17.13	17.20	16.25
Y-AXIS ANGLE	57.30	3.40	**57.04**	**53.01**	53.72	53.53
DENTAL						
OCCL. PLANE	9.00	3.70	-0.42	-0.07	-1.77	-3.69
U1 - L1	129.70	11.9	**155.59**	**124.28**	137.16	139.46
L1 - OCCL. P	18.40		22.02	25.28	19.52	18.17
L1 - MP	4.80	7.70	**1.33**	**8.08**	0.55	-1.77
U1 - SN	105.10	6.10	**81.73**	**106.70**	102.67	103.97
U1 - AP	5.00	2.80	**-0.64**	**2.78**	2.12	1.25
L1 - AP	1.30	2.60	-2.96	0.85	-0.32	-1.18
MAXILLA						
MEASURE			B-A	C-A	D-C	D-A
U1(VERTICAL)	22.00	EXTD	**-0.97**	0.11	-0.49	-0.38
U1 (HORIZON.	25.00	PROT	**5.38**	7.06	-1.93	5.12
U1-PAL. PL.	125.00	PRCL	**24.10**	21.02	0.74	21.76
U1 - O.P.	47.00	PRCL	**20.24**	16.31	1.10	17.41
O.P-PAL PL	15.00	DPUA	**3.86**	4.71	-0.36	4.35
UM(VERTICAL)	20.00	EXTD	0.33	1.97	-0.67	1.29
UM(HORIZON.)	65.00	MESL	0.20	1.99	-1.65	0.33
ARCH LENGTH	36.00	INCR	4.84	4.65	-0.25	4.39
MANDIBLE						
MEASURE			B-A	C-A	D-C	D-A
L1(VERTICAL)	22.00	EXTD	**-1.04**	0.23	1.46	1.69
L1(HORIZON.)	26.00	PROT	**2.76**	2.06	-1.24	0.83
L1 - M.P.	61.00	PRCL	**6.16**	0.20	-3.39	-3.19
L1 - O.P.	62.00	PRCL	**3.26**	-2.50	-1.35	-3.85
O.P-M.P.	15.00	DPUA	-2.90	-2.70	2.04	-0.66
LM(VERTICAL)	19.00	EXTD	0.66	1.68	0.37	2.05
LM(HORIZON.)	72.00	MESL	0.83	2.13	-1.29	0.84
ARCH LENGTH	36.00	INCR	2.01	0.0	-0.00	-0.00

Fig. 8B

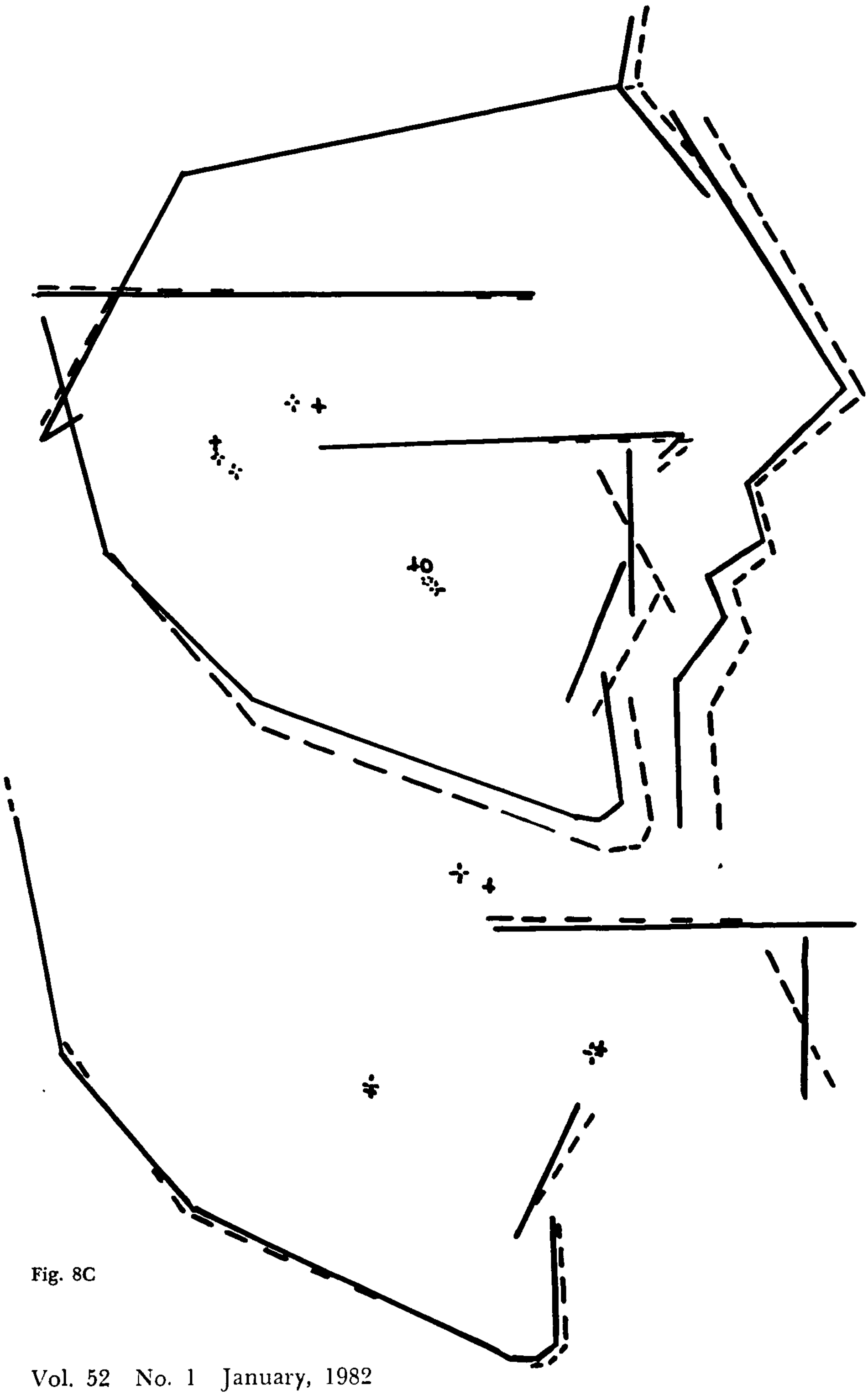


Fig. 8C

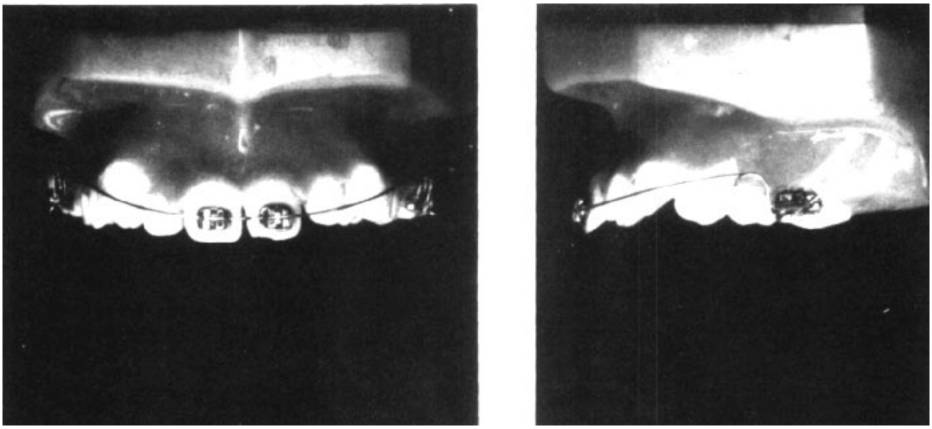


Fig. 9 A model showing the 0.016 inch round intrusion arch wire. The helix in the molar region is used to increase the amount of wire, and also as a stop (if required to control arch length). A bend behind the tube locks the wire in place.

to offset anterior growth rotation and a short lower face height.

Subsequent lower arch treatment will involve some leveling and either slight incisor advancement or molar distallization, depending on crowding and path of closure. While several simple and straightforward appliance systems could be devised to accomplish those primary objectives, the long lever arm approach would seem to be appropriate.

Initially, only upper first molars and upper incisors are banded. A light (.016″ or .4 mm round) intrusion arch wire, activated to 45 degrees, is used to provide the necessary tooth movement (Fig. 9). Treatment is begun in the late mixed or early permanent dentition period. An additional distal force for Class II molar correction can be applied by either cervical or high-pull extraoral traction.

Careful control of the extraoral appliance can help limit distal tipping of the upper molar during intrusion. Using this approach to intrude upper incisors during the initial phase of treatment may "unlock" the occlusion. This in turn may permit a modification of the path of closure of the mandible and aid in the correction of the Class II molar relationship. The same initial treatment can, of course, be used for Class II Division 1 when upper incisor intrusion is indicated. An example showing this initial phase of treatment is shown in figure 10.

During or following this initial phase of treatment, the lower arch is banded and leveled. This may require limited banding with incisor intrusion mechanics, or conventional full banding depending on the needs of the case.

Upper lateral incisors are included in the appliance when the centrals have been intruded. Arch length decisions are made on the basis of space available, mandibular movement pattern changes, etc. The remaining upper teeth are banded last. The final phase of treatment must accomplish arch relationship correction, continued overbite control, and upper incisor torquing.

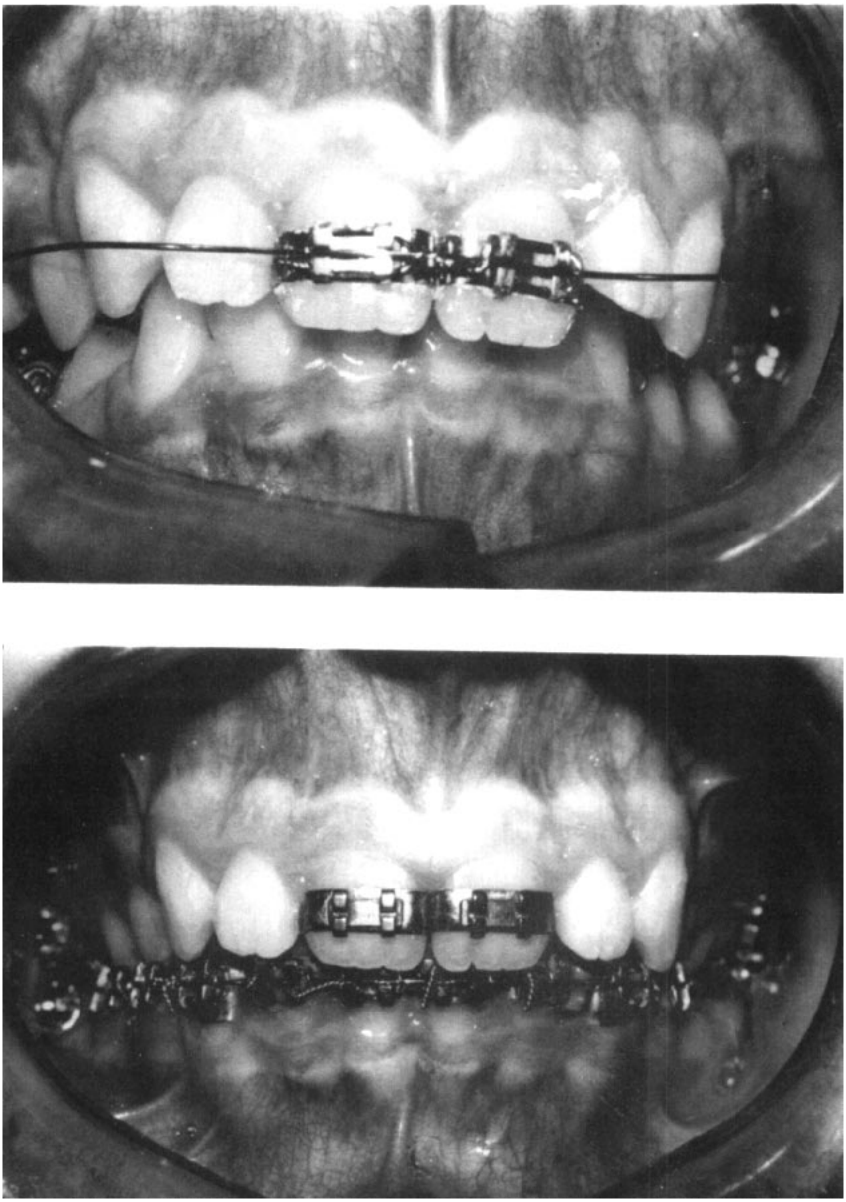


Fig. 10 Selected records of a Class II Division 1 case during the early phases of treatment, showing incisor intrusion.

SUMMARY

Class II, Division 2 malocclusions often have skeletal patterns more nearly approaching Class I than Class II, Division 1. Incisor relationships are unique. Treatment problems related to this malocclusion require that the clinician pay particular attention to the vertical dimension. Also, the prevalence of mandibular movement pattern irregularities, coupled with the "droopy incisor" phenomenon so characteristic of this malocclusion, requires careful individual case analysis.

The use of simplified initial appliance mechanics to rectify some of these problems is discussed.

REFERENCES

1. Beaton, W. D., Cleall, J. F.: Cinefluorographic and Cephalometric Study of Class I Acceptable Occlusion. Am. J. Orthod., 64:469-479, 1973.
2. BeGole, E. A., Cleall, J. F., and Gorny, H. C.: A Computer System for the Analysis of Dental Casts. Angle Orthod. 51: 252-258, 1981.
3. Chebib, F. S., Cleall, J. F., and Carpenter, K. J.: On-line Computer System for the Analysis of Cephalometric Radiographs. Angle Orthod., 46:305-311, 1976.
4. Coben, S. E.: The Integration of Facial Skeletal Variants, Am. J. Orthod., 41:407-434, 1955.
5. Ingervall, B.: Retarded Contact Position of the Mandible. Odontological Review, 15:130-149, 1964.
6. Levin, R. I.: Begg Orthodontic Therapy in Retrospect. Doctoral Thesis, State University, Grönigen, 1975.
7. Mulligan, T. F.: Common Sense Mechanics. J. Clin. Orthod., 762-766, 1979.
8. 8. Ricketts, R. M., Bench, R. W., Gugino, C. F., Hilgers, J. J., Schulhof, R. J.: *Bioprogressive Therapy*. Rocky Mountain Orthodontics, pp. 183-188, 1979.
9. Sondhi, A., Cleall, J. F., and BeGole, E. A.: Dimensional Changes in the Dental Arches of Orthodontically Treated Cases. Am. J. Orthod., 77:60-73, 1980.
10. Stone, A. C.: A Cinefluorographic Study of Mandibular Movements in Class II, Division 2 Malocclusions. Master's Thesis, University of Manitoba, 1971.
11. Strang, R. H., and Thompson, W. M.: *Orthodontia*. Philadelphia, Lea & Febiger, pp. 611-622, 1958.
12. Timmons, L. S.: Induced Change in the Anteroposterior Relationship of the Jaws. Angle Orthod., 42-245-251, 1972.
13. Wylie, W. L.: Assessment of Anteroposterior Dysplasia. Angle Orthod., 17:97-109, 1947.