Analysis of Changes During and Subsequent to Orthodontic Management of Class III Malocclusions

ALLAN G. BRODIE

All cases of permanent dentition shown were treated according to the methods advocated in the author's published articles.[3] Briefly, this consists of maintaining the mandibular teeth as a unit of stationary anchorage while the maxillary teeth are tipped forward by reverse second order bends and elastics. The axes of the teeth are subsequently corrected.

Case E.K., Female

Age at beginning of treatment, 14 years, 15 days.

Fig. 58 represents the models of the case before and after treatment.

Fig. 59 represents the cephalometric tracings of the case before and after treatment.

Fig. 60 is a composite of the two previous tracings analyzed by the use of straight lines. It reveals the following:

1. The angle BSN has opened very slightly and there are slight indications of cranial growth.
2. The pterygomaxillary fissure has gone back very slightly.
3. The angle formed by the nasal floor and Bolton plane has closed a fraction of a degree.
4. Gonion has gone backward 1.25 mm. and downward 1 mm.
5. Gnathion has gone forward 4 mm. and downward 4 mm. (Both of these findings are indicative of growth of the mandibular base.)
6. The angle of the mandible has not changed.
7. Upper 6 has moved forward 4 mm. and downward 3.5 mm. It has been tipped 3°.
8. Lower 6 has moved forward 3.75 mm., downward 4 mm. and has not been tipped.
9. Upper 1 has moved forward 7.5 mm., upward .5 mm., and has changed its inclination 9°. Lower 1 has moved forward 3.5 mm., upward 1 mm. and has tipped forward 1.75°.
10. The occlusal plane has been tipped downward in back and upward in front 8.25°.

This case required a short second period of treatment, but is counted as clinically successful and has been watched for two and one-half years.

Case R.I., Male

Age at beginning of treatment, 20 years, 5 months.

Fig. 61 shows models of case before and after treatment.

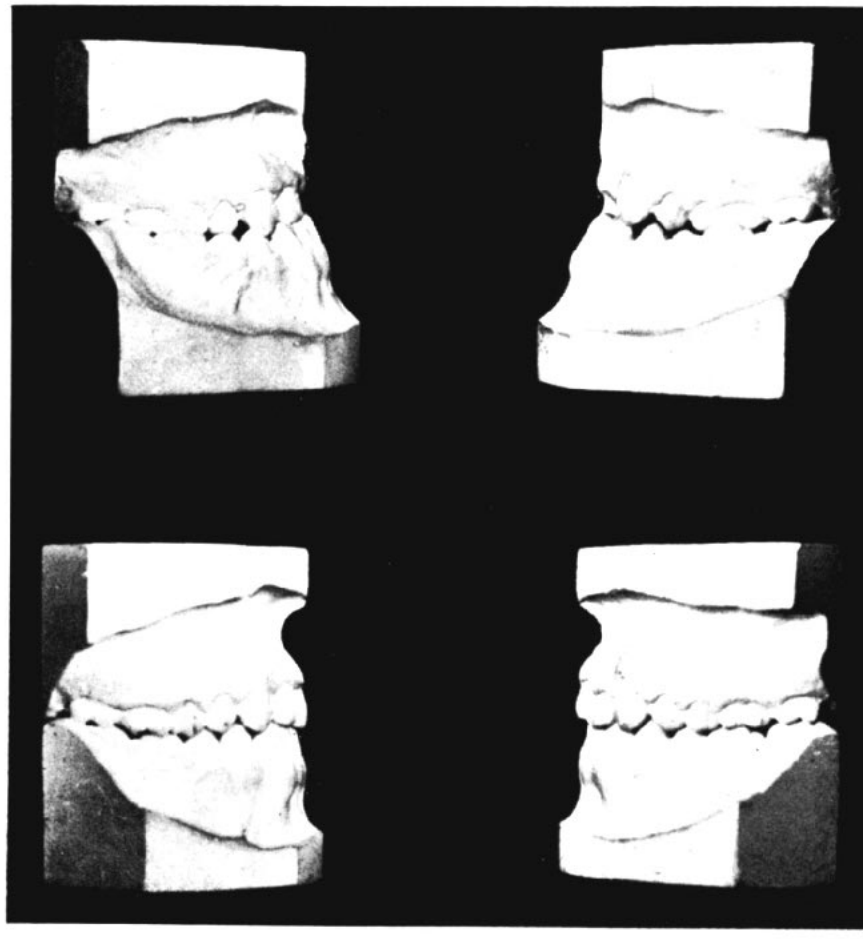


Fig. 58
Case E. K., female, aged 14 years, 15 days, before and after treatment.

Fig. 62 represents tracings of x-rays of case before and after treatment.

Fig. 63 is a composite tracing reduced to straight lines of the case before and after active treatment. It reveals:

1. The angle BSN has not changed nor has the cranial outline.
2. No change in the angle or position of the nasal floor.
3. The angle of the mandible has opened 1°. (This is probably only a shifting in mandibular position.)
4. Gonion has gone backward .75 mm. but has not dropped.

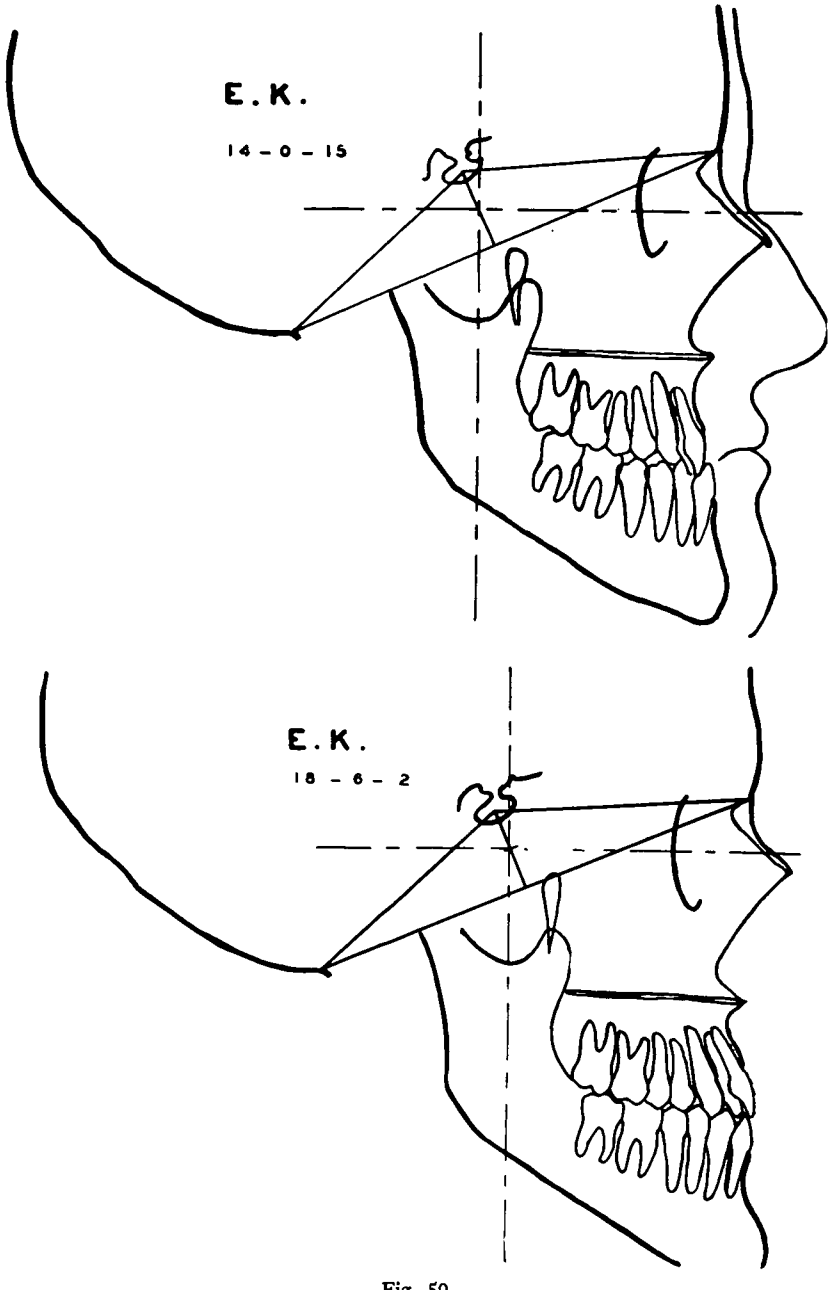


Fig. 59
Cephalometric tracings of Case E. K. before and after treatment.

5. Gnathion has gone backward 2 mm. (only one line shows in the drawing) and downward .75 mm.
6. Upper 6 has moved forward 2 mm. and downward 1 mm. Its axis has shifted 3.5°.
7. Lower 6 has moved backward 3.5 mm. and downward 1.5 mm. Its inclination has shifted 19°.

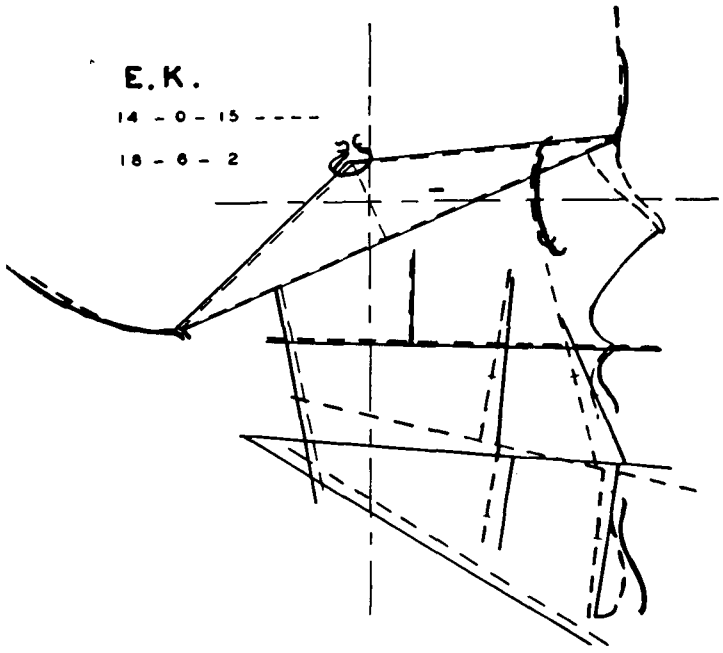


Fig. 60
Straight line composite of tracings shown in Fig. 59.

8. Upper 1 has gone forward 4 mm. and upward 3 mm. Its inclination has shifted 10°.
9. Lower 1 has gone backward 1 mm. and upward 3 mm. Its inclination has changed 2°, the apex being the point of greatest movement.
10. The occlusal plane has been tipped 7.5°.

Fig. 64 represents a composite tracing of the case after treatment and three years, five months later. It shows the following post-treatment changes.

1. No change in the angle BSN, although the cranium shows evidence of some growth.
2. The angle formed by the nasal floor with the Bolton plane has closed

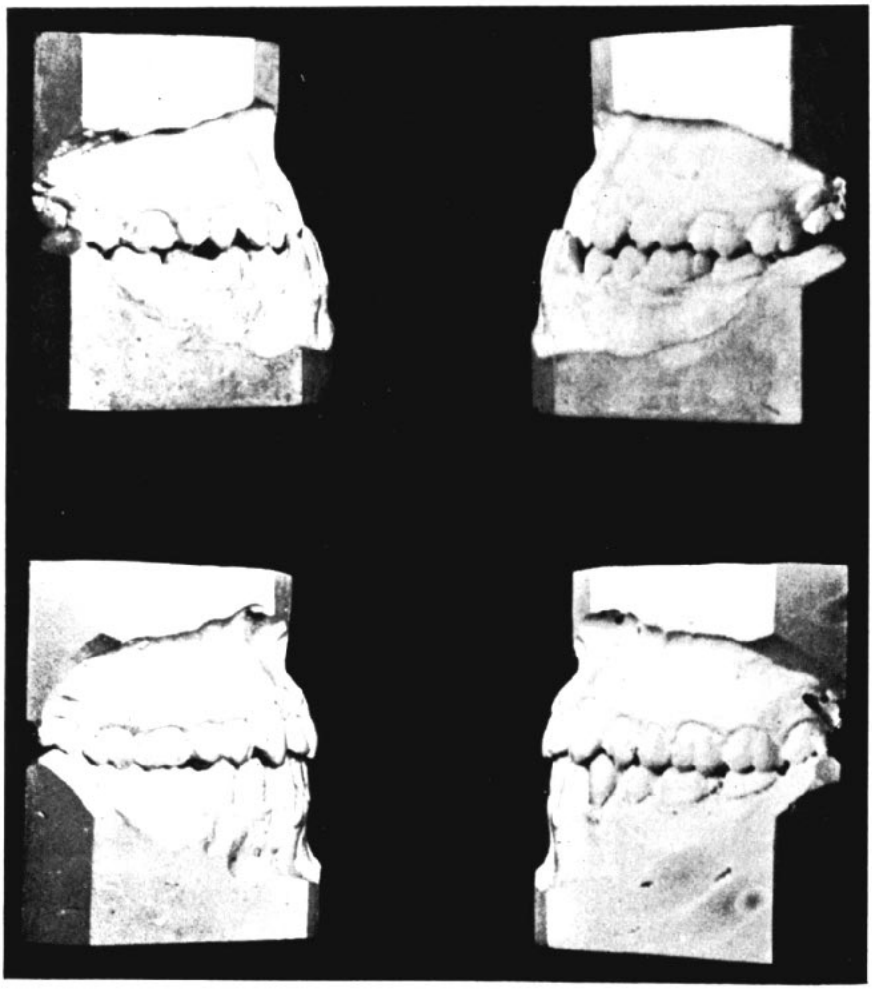


Fig. 61
Case R. I., male, aged 20 years, 5 months, before and after treatment.

1° through a slight lowering of the posterior end.

3. The angle of the mandible has closed 2°.
4. Gonion has gone downward 6 mm. and back 1 mm.
5. Gnathion has gone downward 1.25 mm. and forward 1 mm.
6. The descent of the occlusal plane, in back particularly, has resulted in a further closure of its angle with Bolton of 4°.
7. The angle formed by the occlusal plane with the lower border of the

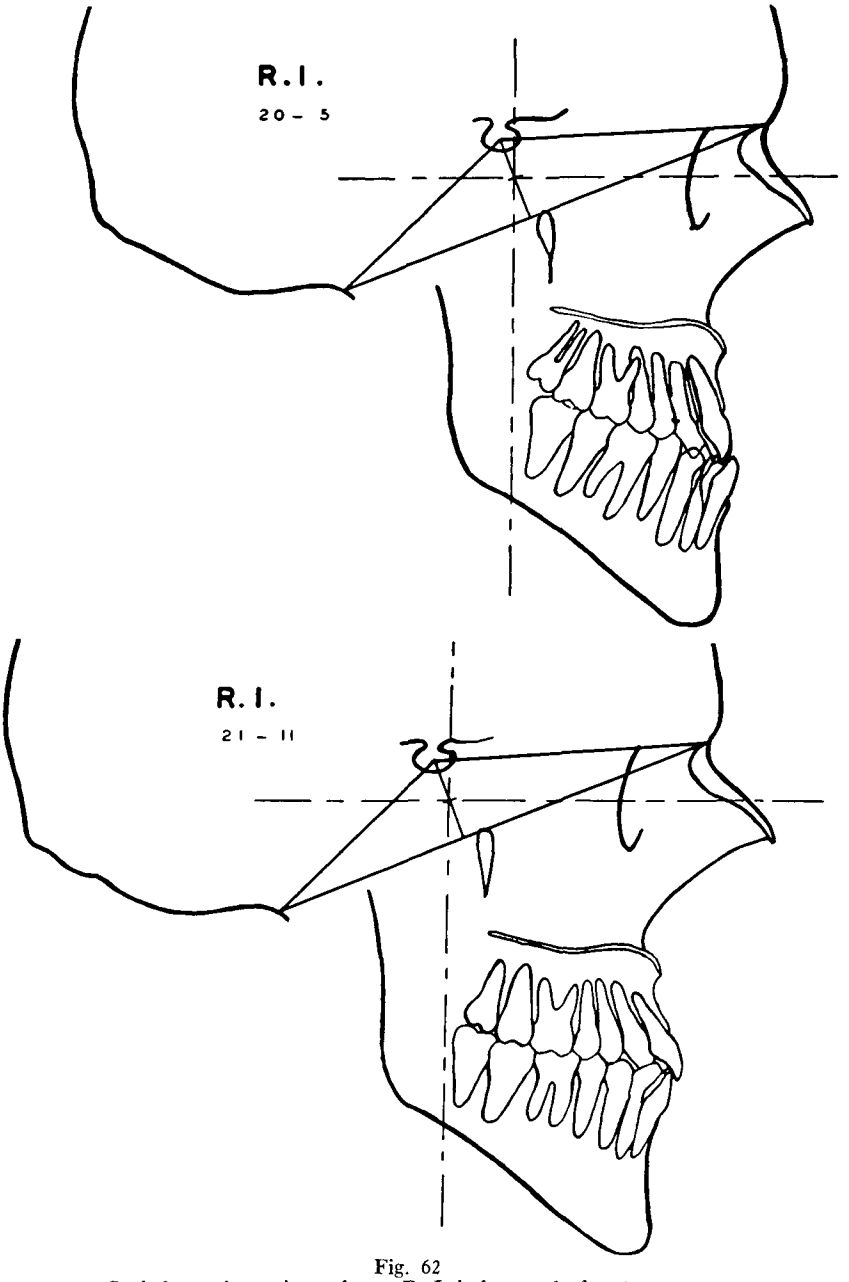


Fig. 62
Cephalometric tracings of case R. I. before and after treatment.

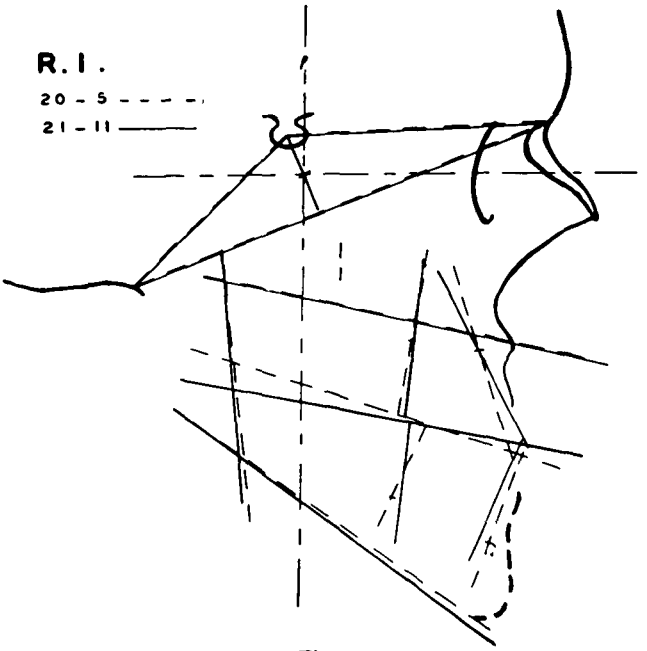


Fig. 63
Straight line composite of tracings shown in Fig. 62.

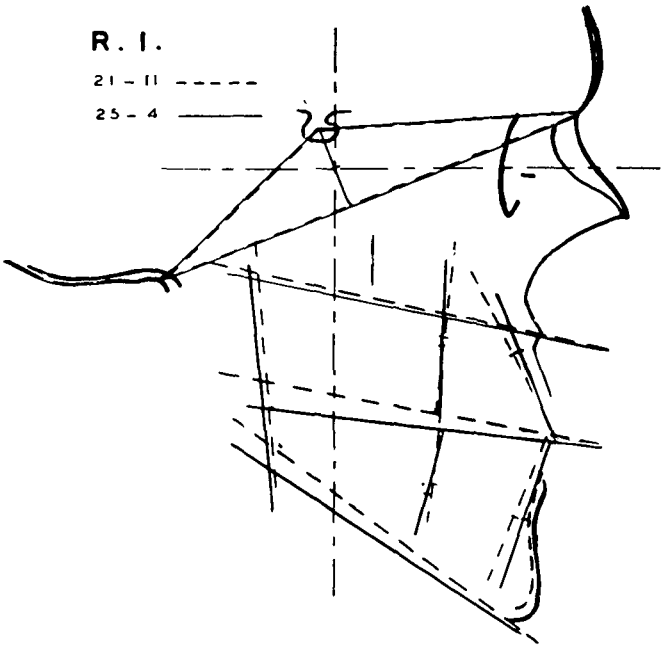


Fig. 64
Straight line composite of tracings of R. I. at end of treatment and 3 years, 5 months later.

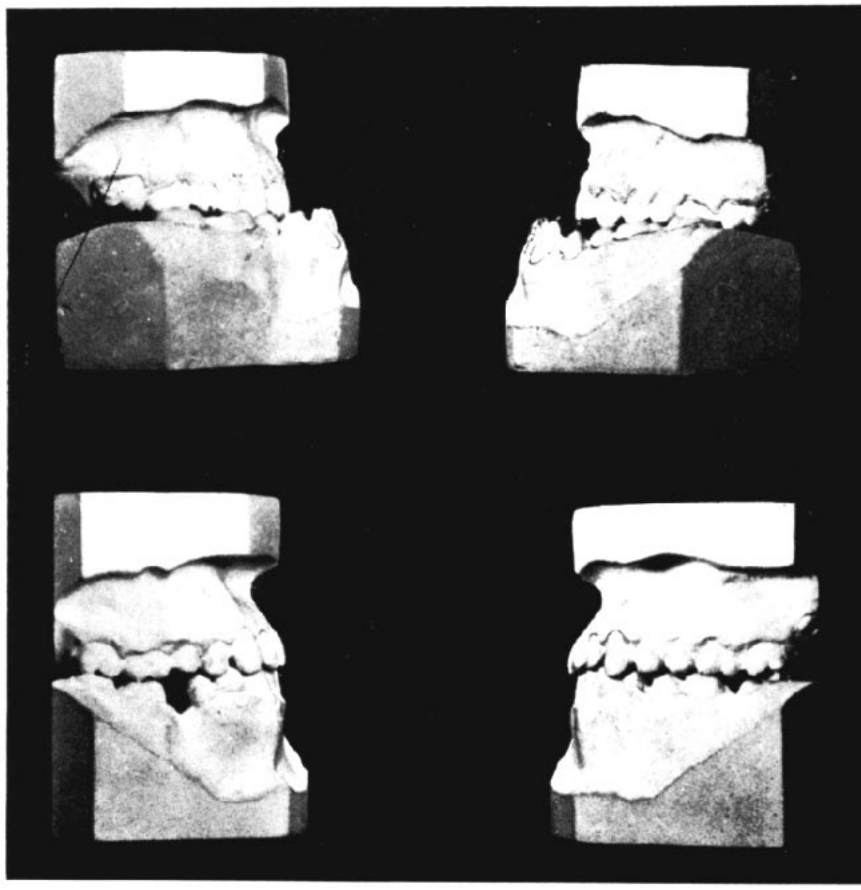


Fig. 65
Case B. J., male, aged 19 years, 5 months, before and after treatment.

mandible, although disturbed 8.5° during treatment, remains almost unchanged thereafter, recovering only 1.5°.

8. The molars have changed their axial inclinations less than 1° but the incisors both show a tendency for the roots to effect a more upright position.

The case is counted as clinically successful after observation of three and one-half years.

Case B.J., Male

Age at beginning of treatment, 19 years, 5 months.

Fig. 65 shows models of case before and after treatment.

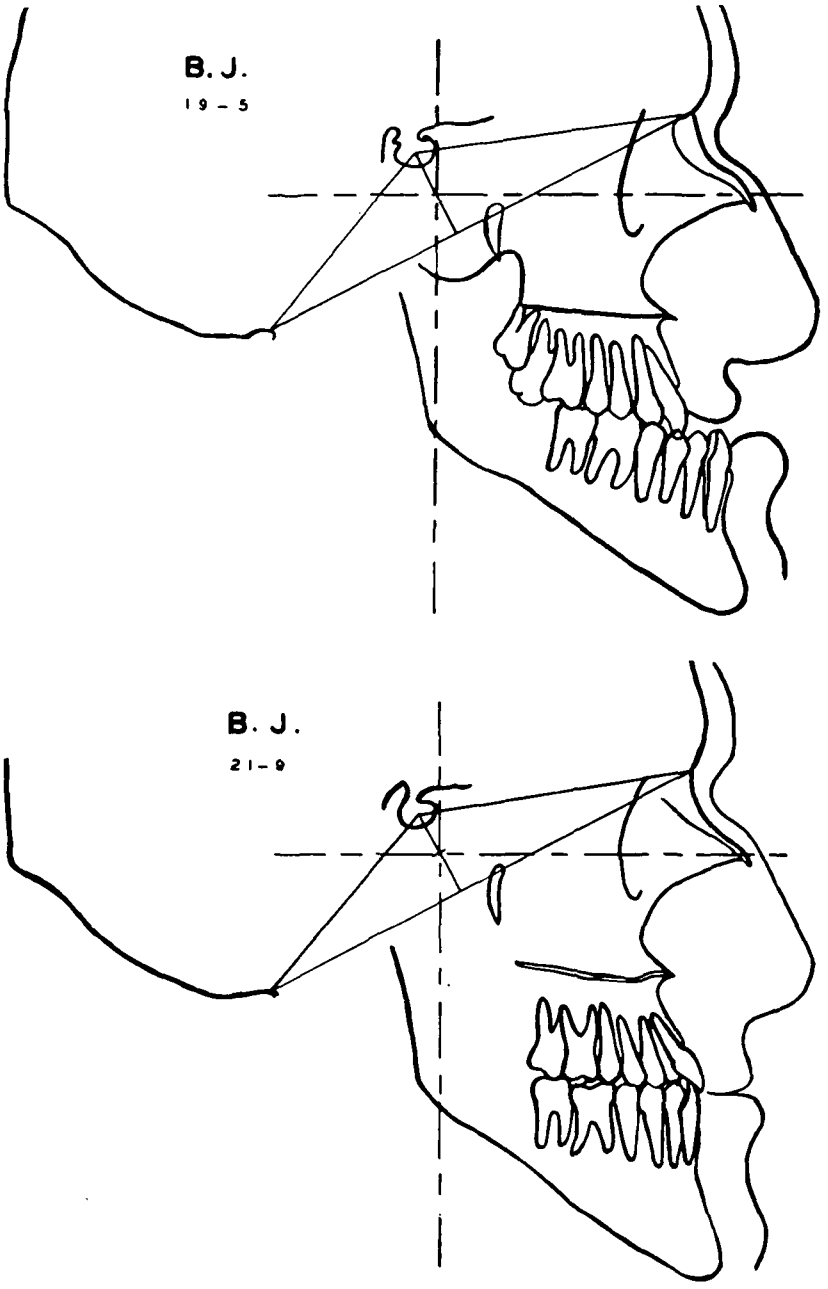


Fig. 66
Cephalometric tracings of Case B. J. before and after treatment.

Fig. 66 represents tracings of x-rays taken before and after treatment.

Fig. 67 represents a composite tracing of the previous two, reduced to straight lines. It reveals the following:

1. The angle BSN has not changed, nor has there been any growth of the cranium.
2. The pterygomaxillary fissure remains constant.

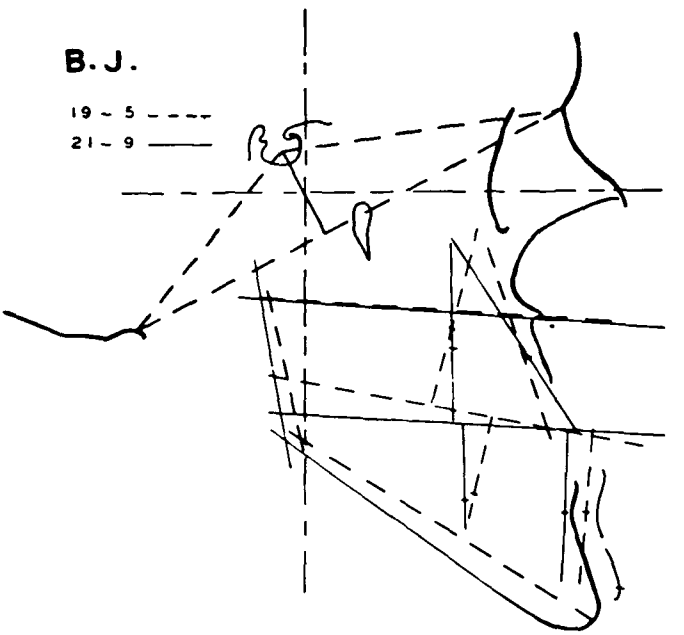


Fig. 67
Straight line composite of tracings shown in Fig. 66.

3. There has been no change in the angle formed by the floor of the nose with the Bolton plane.
4. There has been a backward movement of gonion of 5 mm., but no downward movement.
5. Gnathion has gone backward 7 mm. and downward 3.5 mm. (Since the lower border of the body and posterior border of the ramus coincide upon superposing, these changes must be viewed as a downward swing of the mandible and a bodily posterior shifting in the fossa rather than as a change in the form of the bone itself.)
6. Upper 6 has moved forward 4.75 mm. and downward 4.5 mm. It has been tipped 13.25°.

7. Lower 6 has gone backward 9 mm. and downward 4.5 mm. It has been tipped 15°. (Since about 5 mm. must be ascribed to mandibular shift, only the remainder, or 4 mm., can be attributed to tooth movement. When this correction is made, it seems likely that the apex of this tooth has actually gone forward in the bone.)
8. Upper 1 has moved forward, mainly by tipping, a distance of 6 mm. and upward 1 mm. Its inclination has increased 14.25°.

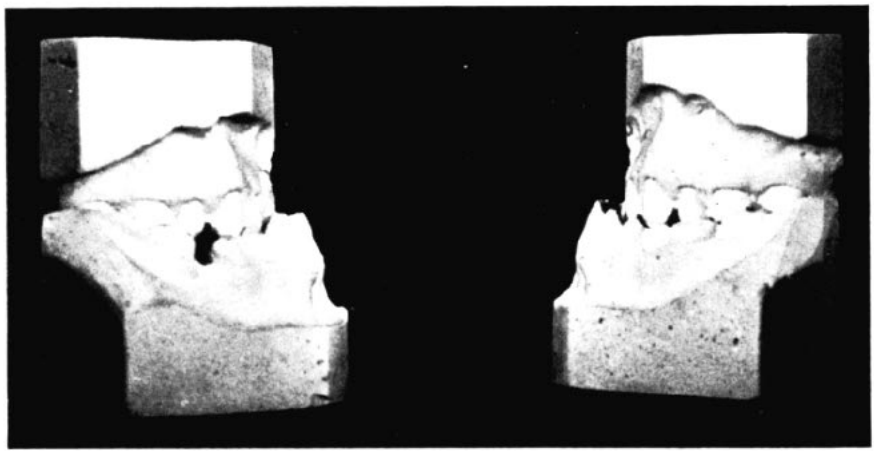


Fig. 68
Case G. W., male, aged 20 years, before treatment.

9. Lower 1 has gone back 8 mm. but again a correction of 5 mm. must be applied against mandibular shift. An uprighting of less than 3° has occurred.
10. The occlusal plane has been tipped 8.25°.

This case is counted as clinically successful after observation of two years.

Case G.W., Male

Age at beginning of treatment, 20 years.

Fig. 68 shows casts of case before treatment.

Fig. 69 shows tracings of x-rays of case before treatment and 5 years, 9 months later. (Owing to unavoidable circumstances, no records were taken upon removal of appliances. The teeth missing from the second tracing were removed by a dentist in a vain search for the cause of a "neuralgia," subsequently traced to a pulpitis of carious origin.)

Fig. 70 represents a composite of the two previous tracings. It reveals the following:

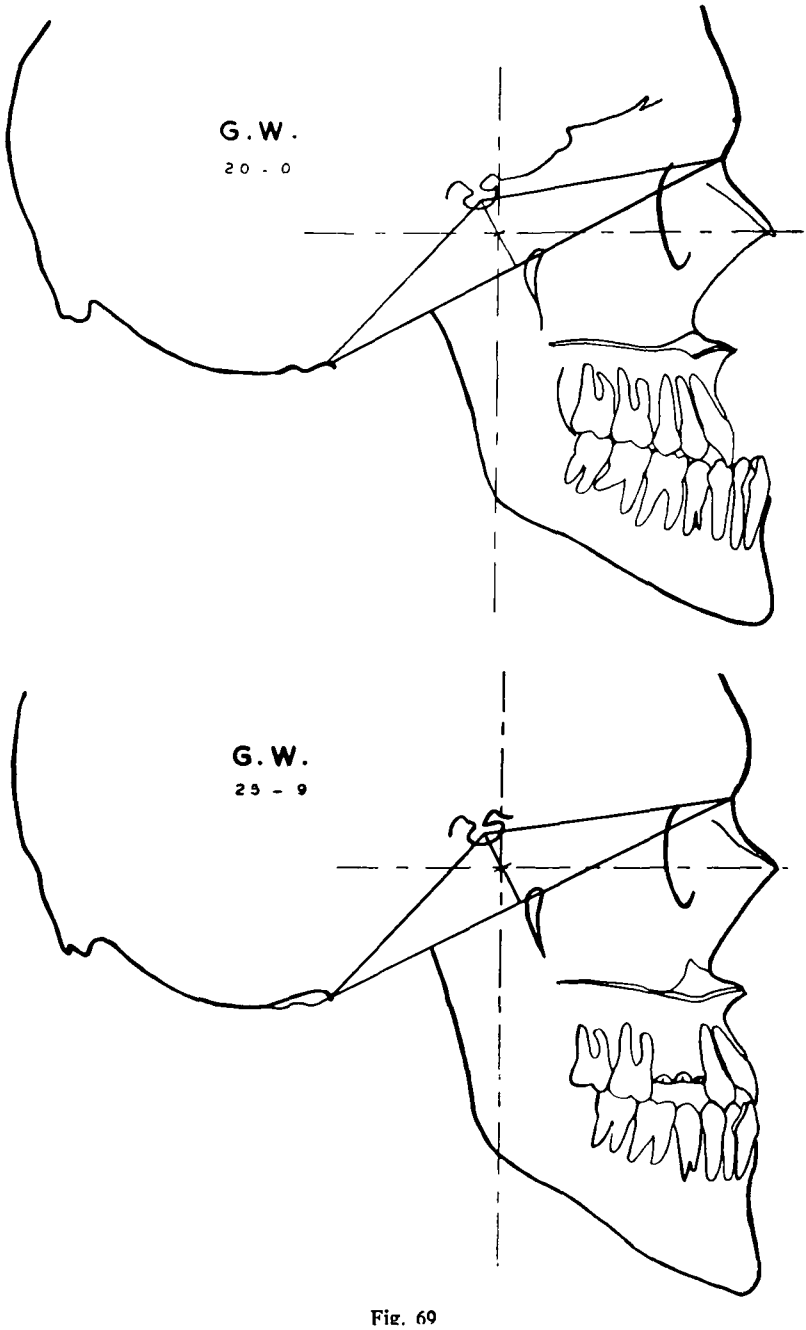


Fig. 69
Cephalometric tracings of Case G. W. before treatment and 5 years, 9 months later.

1. No change in the angle BSN and no cranial growth.
2. No shift in the pterygomaxillary fissure.
3. No change in the angle or position of the floor of the nose.
4. Gonion has gone downward 1.5 mm. and backward 5 mm.
5. Gnathion has gone backward 5.5 mm. and downward 8 mm.
6. The angle of the lower border of the mandible to Bolton plane has

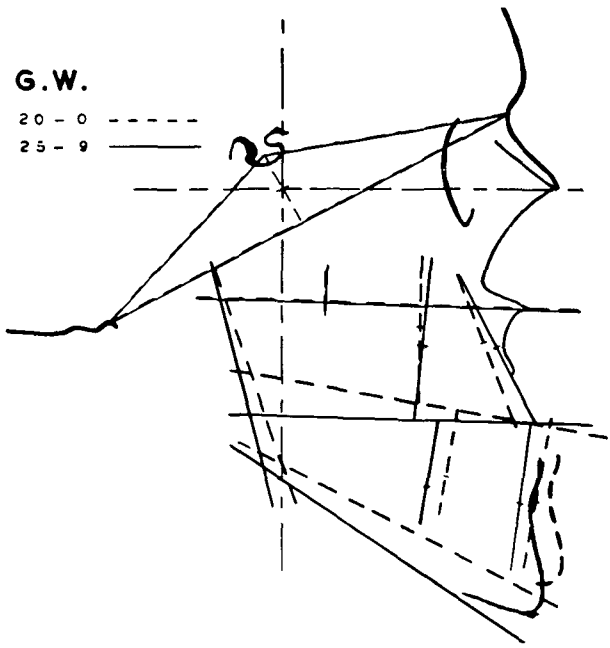


Fig. 70
Straight line composite of tracings shown in Fig. 69.

opened 5°. (This is principally accounted for by a downward swing of the mandible with the condyle as a center.)
7. Upper 6 stands within 1.5 mm. of its original position, with a change in axial inclination of 4°.
8. Upper 1 is 5 mm. further forward and 1 mm. higher. Its angle has changed 6.5°.
9. Lower 6 is back of its original position 5 mm. and down 3 mm. (Note should be made of the fact that the entire mandible has swung backward 5 mm. This tooth has probably been only slightly tipped during treatment.)

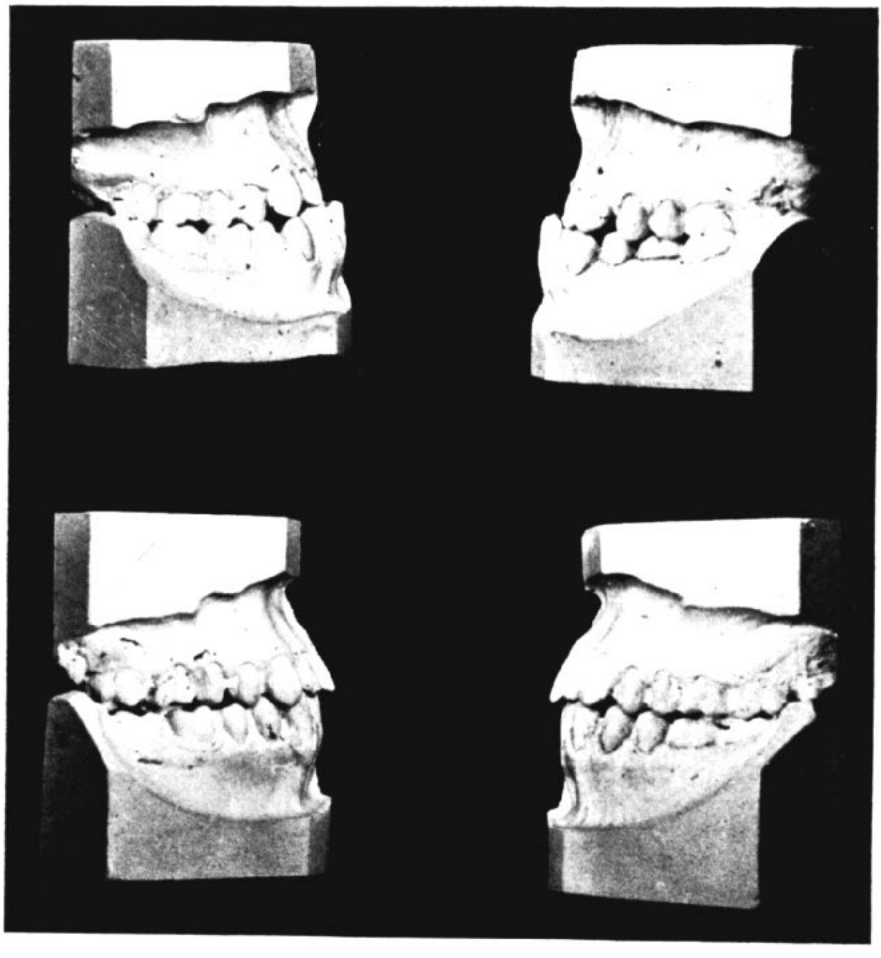


Fig. 71
Case F. B., male, aged 20 years, before treatment.

10. Lower 1 is 5.5 mm. back of its original position in space and its axis has uprighted 3.5°.
11. The occlusal plane has been shifted 9.25°.

The case is clinically successful, judged from the maintenance of occlusal relations for over five years.

Case F.B., Male

Age at beginning of treatment, 20 years.

Fig. 71 shows the models of the case before and after treatment.

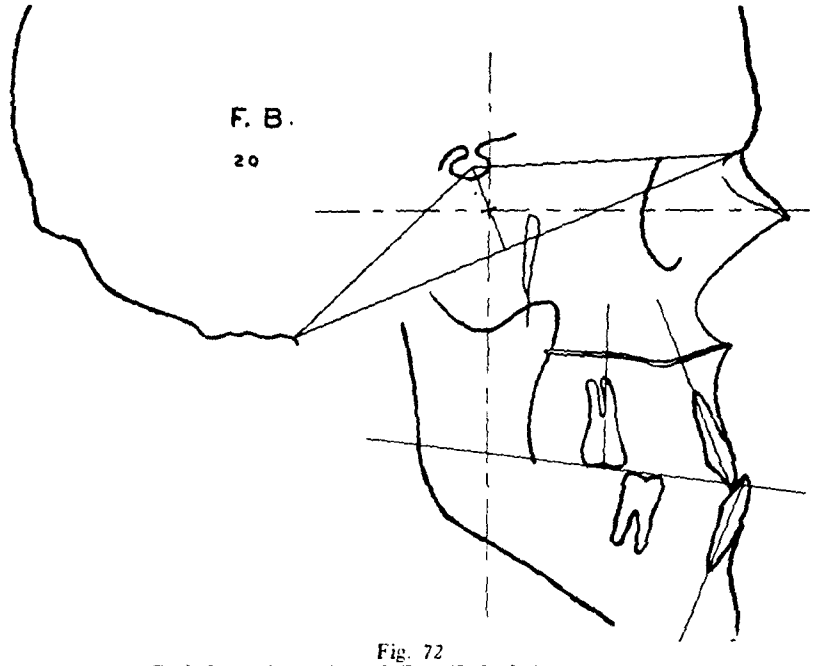


Fig. 72
Cephalometric tracing of Case F. B. before treatment.

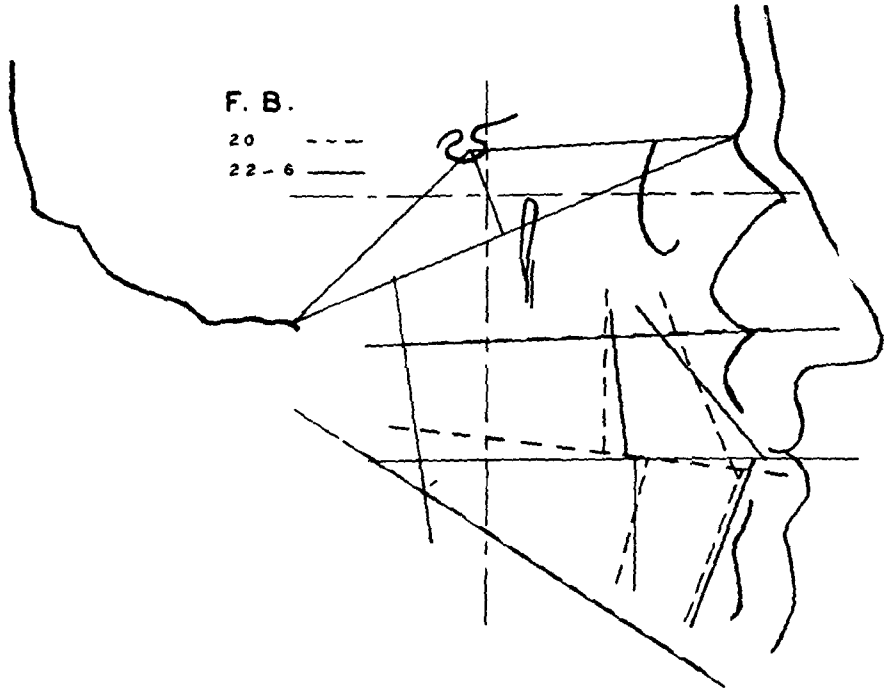


Fig. 73
Straight line composite of tracings before and immediately after treatment.

Fig. 72 represents the tracings of x-rays of the case before treatment.

Fig. 73 is a composite of tracings made prior to and immediately after treatment. It reveals:

1. The angle BSN has remained unchanged, as has also the cranial outline.
2. The pterygomaxillary fissure has gone back .5 mm.

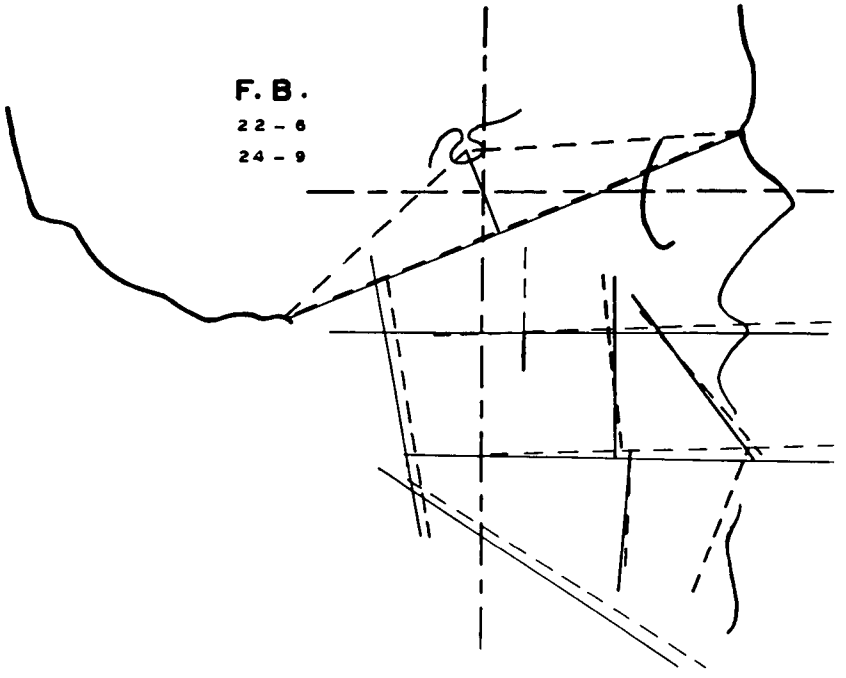


Fig. 74
Straight line composite of tracings at end of treatment and 2 years, 3 months later.

3. The angle formed by Bolton and the nasal floor has not changed, nor has the palate descended.
4. There is no change in the angle or position of the lower border of the mandible.
5. Gonion has not changed.
6. Gnathion has not changed.
7. Upper 6 has moved forward 6 mm., downward 2 mm., and changed its angle 4°.
8. Lower 6 has moved backward 2 mm. and changed its inclination 4°.
9. Upper 1 has moved forward 8.5 mm., upward 3.5 mm., and changed its inclination 18°.

10. Lower 1 has moved forward bodily 1.5 mm. without tipping.
11. The occlusal plane has been tipped downward in back and upward in front 10°.

Fig. 74 represents a composite of the tracings made at the end of treatment and two years, three months later. This figure reveals:

1. A slight descent of the Bolton plane, indicating a faint growth of the cranium.
2. No change in the angle BSN.
3. The pterygomaxillary fissure has not changed its position.
4. The angle of the palate to Bolton has changed 1.25°, going down in front.
5. Gonion has gone backward 2.25 mm. and downward 1 mm.
6. Gnathion has gone downward 1.5 mm. but has not changed its anteroposterior position.
7. The angle of the mandible has opened 1°.
8. Upper 6 has dropped back 1.5 mm. and downward 1.75 mm. It has come within 1° of recovering its original axial inclination.
9. Upper 1 has moved back 2 mm. and down 2 mm. Its angle of inclination is 4° less than at the end of treatment.
10. Lower 6 has recovered 1° from its disturbance and has moved down.
11. Lower 1 has moved down without change in its inclination.

This case is clinically successful after three and one-half years of observation.

Case G.S., Female

Age at beginning of treatment, 2 years, 6 months.

Fig. 75 represents a tracing of the x-ray taken at the beginning of treatment.

Fig. 76 represents a composite of the tracing at the beginning of treatment and one taken a year and a half later. It reveals the following:

1. There has been a descent of .5 mm. of the Bolton plane, no change in the angle BSN, but marked anteroposterior cranial growth.
2. The pterygomaxillary fissure has moved forward.
3. The nasal floor has descended, more in back than in front, closing its angle with the Bolton plane 2.75°.
4. The angle of the mandibular lower border with the Bolton plane has opened 1.5°.
5. Gonion has gone downward 2 mm. and backward 2 mm.
6. Gnathion has gone downward 6.25 mm. and forward 2 mm.
7. The upper second deciduous molar has moved forward 4 mm. and downward 3 mm. Its angle has changed 9°, *but in a direction opposite*

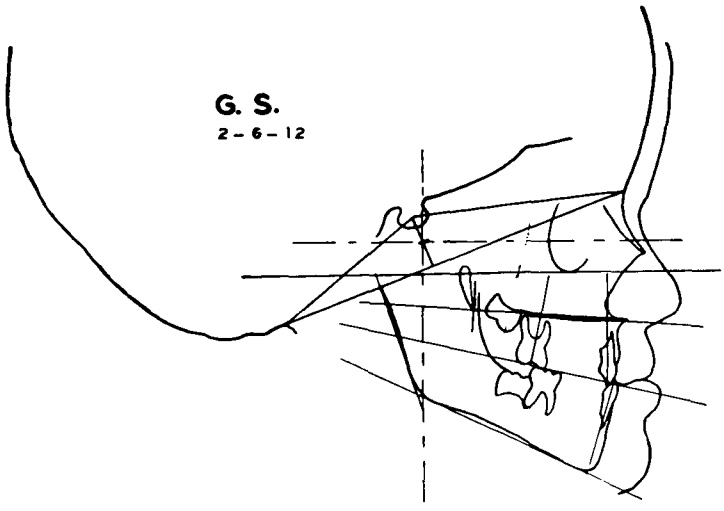


Fig. 75
Case G. S., female, aged 2 years, 6 months. Cephalometric tracings of case before treatment.

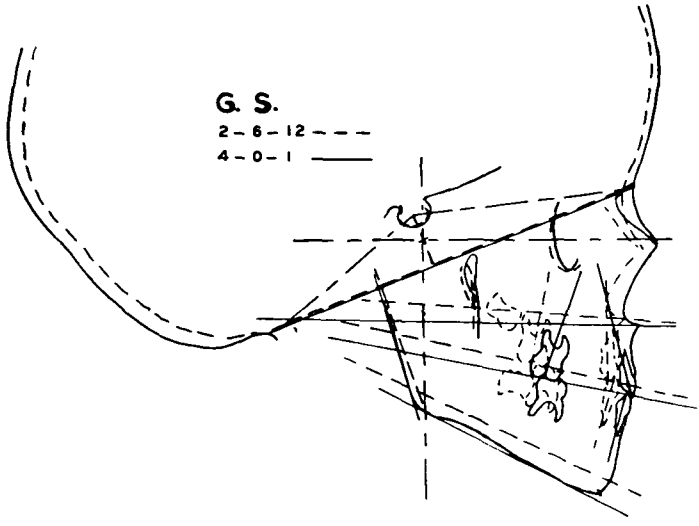


Fig. 76
Straight line composite of Case G. S. from tracings before treatment and one and one-half years later.

to that seen in any of the other cases.

8. The lower second deciduous molar has gone downward 3 mm. and forward 1 mm. without change in its axis.
9. The upper deciduous central incisor has moved forward 5.5 mm. and downward 3.4 mm. with a change in angle of 11.5°.
10. The lower deciduous central incisor has moved forward 5 mm. and downward with 3 mm. with no appreciable change in its axis.

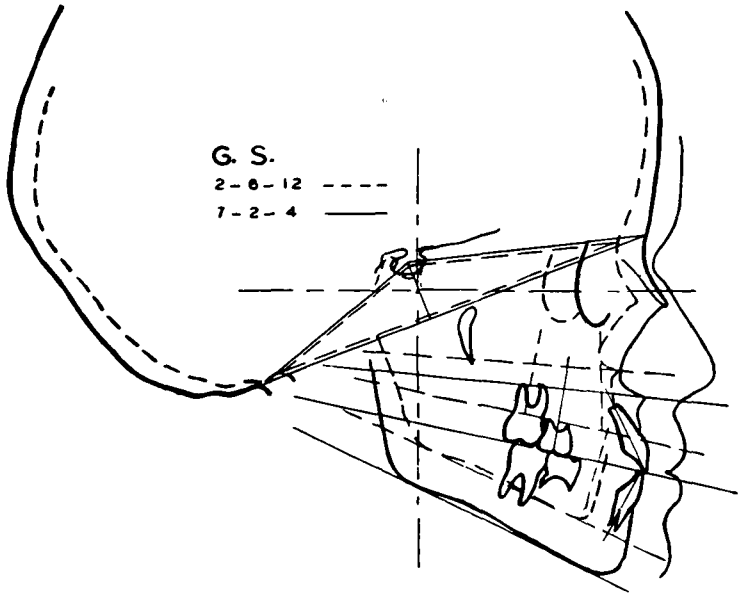


Fig. 77
Straight line composite of Case G. S. from tracings before treatment and 4 years, 8 months later.

11. The occlusal plane has tipped 2°.

Fig. 77 represents a composite tracing of the x-rays taken before treatment and four years, eight months later.

1. The angle BSN has opened .5°.
2. Bolton plane has descended 2 mm.
3. The pterygomaxillary fissure is now back in its original position.
4. The nasal floor has descended 4.5 mm. and its angle with the Bolton plane is within 1° of its original relation.
5. The lower border of the mandible forms the same angle with the Bolton plane as at the beginning.

6. Gonion has gone backward 5.75 mm. and downward 8 mm.
7. Gnathion has gone downward 14 mm. and forward 7.5 mm.
8. The upper deciduous second molar has moved forward 8 mm. and downward 10.5 mm. and is ready to be shed. Upper 6 is now 1 mm. forward of the original position of this tooth.
9. Changes in the position of the lower second deciduous molar are corresponding in amount and direction.
10. Upper 1 has taken the place of the deciduous central and is 12 mm. further forward and 10.5 mm. lower than the original position of this tooth. Its angle of inclination is 24° greater.
11. Lower 1 shows corresponding changes and its axial inclination is 8.5° greater than that of its predecessor.
12. The occlusal plane is now only .5° from its original relation to Bolton.

This case is considered clinically successful following five years of observation.

Summary

1. In all cases the occlusal plane is disturbed with the posterior end going downward. In the adult cases the anterior end goes slightly upward. The degree of tipping of the occlusal plane ranges in the series shown from a minimum of 2° to a maximum of 10°. The slightest disturbances are shown in the growing cases but are apparently not attributable to age alone. It is possible that the length of time the elastics are worn is the major factor.

2. In no case is there shown any influence on the spatial position of the nasal floor in those cases that were not growing.

3. In all of the non-growing cases, save one, there has been a change in the angle of the mandibular lower border to the Bolton plane. Superposition of the mandibular tracings indicates that this is a downward and backward swing of this bone rather than any change in its form. In one case there was not even this positional change.

4. In the growing cases there was found only one case where the nasal floor did not tip but descended evenly. The tip, however, was not always in the same direction, nor did NF always continue the same angulation in subsequent pictures.

5. These cases, although showing descent of the lower border of the mandible, do not exhibit a constant behavior. In some, gonion goes down more rapidly than does gnathion, and in others this condition is reversed. Still others show an even descent.

6. The growing cases exhibit some tendency for the occlusal plane to return to its original relation with Bolton.

7. In one case there has occurred an increase of 9 mm. in the length of the mandible between GN and GO, although the teeth have moved but 3 mm. This is the only case where any retreatment has been necessary.

8. Disturbed axial inclinations show a tendency to right themselves slowly following treatment. The axial inclination of the lower anterior teeth remains remarkably constant during and after treatment.

9. Because of the smallness of the sample, no definite conclusions may be drawn except that our treatment has seemed to have little or no effect on any structure other than the alveolar process.

General Summary

1. The orthodontist is able to move teeth and to do so without markedly disturbing their axial inclinations. Tipping is the predominating movement, however, unless great care is exercised to prevent it.

2. Although a number of cases exhibit mesial or distal movement of buccal teeth, the study was not deliberately laid out to show this point clearly. Final reports on this point will have to be based on material now being gathered.

3. Correction of overbite will also have to await further study. Behavior of incisors and molars in the cases shown varies too greatly to permit of definite statements.

4. In both growing and non-growing cases the angle BSN and the pterygomaxillary fissure are shown to be remarkably constant.

5. In all cases in which elastics were worn there was a disturbance in the angle formed by the occlusal plane and the Bolton plane. In Class II treatment the angle opens, and in Class III it closes.

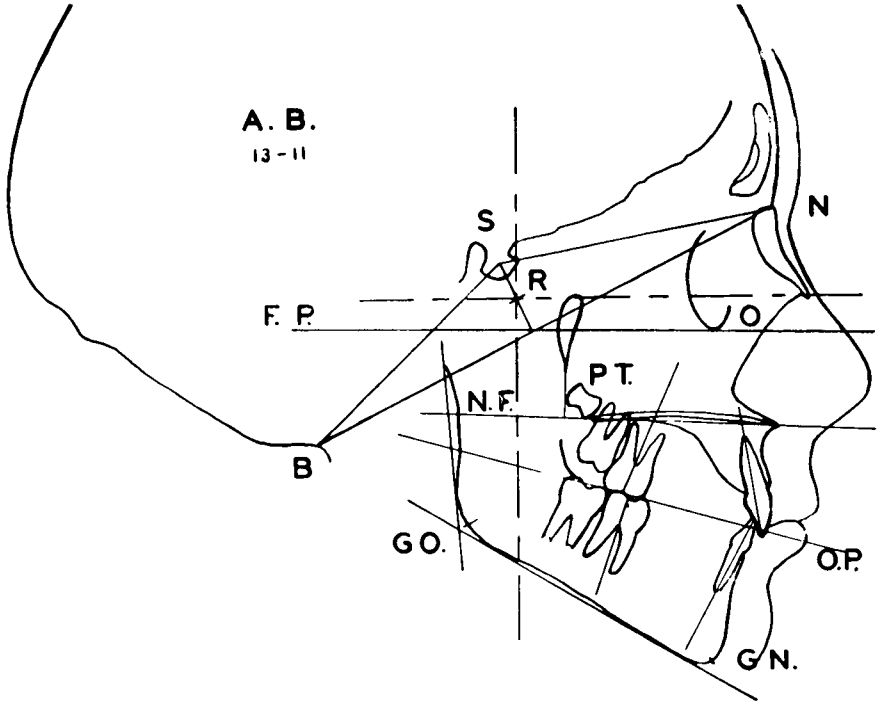
6. There is a tendency for the angle to return to its original size following treatment. This tendency diminishes as age advances.

7. In a number of cases of all classes a part of the result obtained is shown to be contributed by a change in the position of the mandible. This is occasionally a horizontal, anteroposterior shifting but more frequently it consists of a downward and backward rotation of the mandible.

8. Axial inclination of teeth, disturbed by orthodontic management, tends to correct itself following treatment.

9. Actual bone changes accompanying orthodontic management seem to be restricted to the alveolar process. The ability of this structure to adapt itself to changes in the positions of the teeth is extremely great.

10. Changes subsequent to treatment are limited to shiftings in the occlusal plane and to changes in axial positions of teeth in adult cases. In



B	Bolton point.
BN	Bolton plane.
F.P.	Frankfort Horizontal. This plane is taken from only the *first* tracing of a series. In all subsequent tracings the angle formed by the Frankfort and Bolton planes is maintained and planes parallel and perpendicular to it are drawn through the point R. These planes (dot-and-dash in the figure) are the bases from which vertical and anteroposterior measurements are taken.
G.N.	Gnathion. Point half-way between the most anterior and inferior points on the bony chin.
G.O.	Gonion. Bisection of the angle between the tangents to the lower and posterior borders of the mandible.
N	Nasion.
N.F.	Nasal floor and hard palate. A line connecting the anterior and posterior nasal spines.
O	Orbital.
O.P.	Occlusal plane. Line connecting incisors (half the depth of the overbite) with the molars (half the height of the cusps).
P.T.	Pterygomaxillary fissure. Junction between pterygoid process and tuberosity of maxilla.
R	Registration point. (Bisection of a perpendicular dropped from S to BN). In superposing successive tracings, this point is made to coincide, and the Bolton plane is made to parallel.
S	Center of sella turcica.

Lines representing tooth axes are determined by connecting the incisal edges and root apices in the case of the incisors, and by connecting a series of mid-line points in the case of the molars.

growing children there are, in addition, the typical changes that are expected in growth.

11. There seems to be a definite correlation between success in treatment and growth. The adult cases, although clinically successful so far as the maintenance of occlusal relations is concerned, are not so markedly improved esthetically.

12. The cephalometric method of appraisal is the best thus far devised for the study of the results of orthodontic treatment.

BIBLIOGRAPHY

1. Angle, Edward H.: The Latest and Best in Orthodontic Mechanism, D. Cosmos, 70:1143-1158, Dec. 1928, 71:164-174, Feb., 71:260-270, Mar., 71:409-421, Apr., 1929.

2. Broadbent, B. Holly: Bolton Standards and Technique in Orthodontic Practice, *Angle Orthodont.* 7:209-233, Oct. 1937.

3. Brodie, Allan G.: The Application of the Principles of the Edgewise Arch in the Treatment of Class II, Division I Malocclusions, *Angle Orthodont.* 7:1-14, Jan. 1937.
The New Angle Mechanism, J.A.D.A. 16:2085-2108, Nov. 1929.
Treatment of Class III Malocclusions, *Angle Orthodont.* Oct. 1932.

4. Wright, Chester F.: The Edgewise Arch Mechanism, Martin Dewey and George M. Anderson's Practical Orthodontia, 329-346, 5th rev. ed. 1935.