Macrognathia: Diagnosis, Treatment And Cephalometric Appraisal

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Macrognathia, an enlargement of the jaw, is a developmental deformity of the mandible, characterized by a marked Class III dentofacial relationship, requiring surgical intervention in connection with orthodontic therapy.

Noteworthy progress in the therapeutic approach to mandibular prognathism has been achieved in the fields of orthodontics and oral surgery in the past few years, mainly due to the efforts of Reed O. Dingman and Gerald V. Barrow.[1] The dentist, orthodontist, oral surgeon, and psychiatrist alike are accepting the orthodontic-surgical approach to this problem. The cooperation between the two fields of therapy results in a diagnosis and orthodontic surgical procedure so well planned in advance that it is possible to attain a most creditable correction of these deformities.

All of us are aware of the unsightly appearance of the patient with the concomitant Class III jaw and denture relationship and lack of complete functional occlusion. Indication for surgery in these persons is apparent when orthodontic intervention alone is obviously out of the question or in those borderline cases in which orthodontic treatment has failed.

While a well-balanced occlusion with a good functional result is attained, the greatest benefit achieved for the patient by the orthodontic-surgical approach to this problem is the improvement in the facial esthetics and the relief from the neurosis induced by the prognathism. Successful therapeusis means freedom from detesting the sight of a mirror and change in personality from inadequate response to normal social appeal, with an active desire for participation and willingness to be part of the community.

The choice of operative procedure is dependent upon the anatomical, morphological and physiological limitations connected with the deformity. The operative procedure that least interferes with the patient's characteristic normal muscular function will permit a stable result of treatment. Treatment, as a rule, is most successful after growth has ceased to function.

Anatomical Considerations

Biologically the skull consists of two parts, the calvarium (skull less mandible) and the mandible. This statement is necessary in order to understand our problem. In facial growth the condyle of the mandible is one of the most important growth centers. The condyle and the mandibular fossa may be considered in a relatively fixed relationship connecting the mandible with the base of the skull. The height of the total face is determined to a large extent by the mandible and its growth. As the mandible grows in all directions, it creates space for the growth of the maxilla and the growth and eruption of the teeth, with growth and morphological development of the ascending ramus acting as the most important factor in the development of the facial pat-

The case presented is from the Department of Orthodontics, Graduate School of Medicine, University of Pennsylvania. The surgery was performed by Dr. P. Philip Gross.

tern. With the teeth erupting normally there is naturally an increase in the height of the ascending ramus. This takes place under the articular surface of the condyle; otherwise there would be a space between the condyle and the mandibular fossa. With the eruptive process of the teeth constantly present the cycle of the developmental growth characteristics of the mandible, consisting of bone deposition on the posterior border of the ascending ramus and beneath the articular cartilage of the condyle and the eruption of the teeth including the third molars, continues until eighteen to twenty years of age. Until this time the growth and development of the mandible may be compared to the pulling out of a drawer from a cabinet. The drawer can come forward until it is stopped by the limitations imposed upon it by the construction of the cabinet. The mandible, likewise, can come forward as growth takes place at the condyle because the joint remains a relatively fixed point. Operative procedures and orthodontic treatment of this deformity, therefore, should not be attempted until these growth centers, which can thrust the mandible forward and downward beyond the upper face, have ceased to function.

Between the time of the eruption of the second and third molars, as pointed out by Krogman,[5] relatively slight changes occur in the dentition while vigorous bony growth in the face is going on. Krogman further remarks, "The mandible, as far as we know, has its own pattern of growth, though some authorities feel that mandibular growth is a functional response to maxillary occlusal forces. Should mandibular growth be aberrant, there may result an overshot jaw, a receding chin, impacted third molars or a permanent forward position of the condyle on the articular eminence."

The muscles involved are primarily those innervated by the trigeminal nerves, particularly the primary muscles of mastication, together with the mylohyoid and the anterior belly of the digastric. The primary muscles of mastication, the masseter, temporal, and the two pterygoids operate in the areas of the angle, ascending ramus and the condylar portion of the mandible thereby controlling all its movements. Under the circumstances any therapeutic procedure, orthodontic or surgical, that would interfere with this muscular action may court failure. Unless the deformity is mild in degree, the indicated procedure should be one not involving that portion of the mandible to which the primary muscles of mastication are attached. Thus muscular function is least hampered.

Case History

This nineteen year old girl, of Italian ancestry, has the usual clinical characteristics of macrognathia: (1) a marked Class III malocclusion, (2) underdeveloped maxillae—particularly in the premaxillary area, (3) restricted downward and backward growth and development in the gonial region, (4) condyles are directed upward and backward, and (5) lingual axial inclination of the mandibular incisors. Birth was at term with no instruments; breast feeding continued until she was ten months of age. Other than the usual childhood diseases general health has been good. Tonsils and adenoids were removed at seven years. Menarche occurred at eleven. Her dietary habits contribute nothing significant.

Dental History

The deciduous dentition was good so far as the patient and her family remember. She first noticed the Class III tendency at eleven years of age. Her maxillary canines erupted high and labially and were blocked out. They

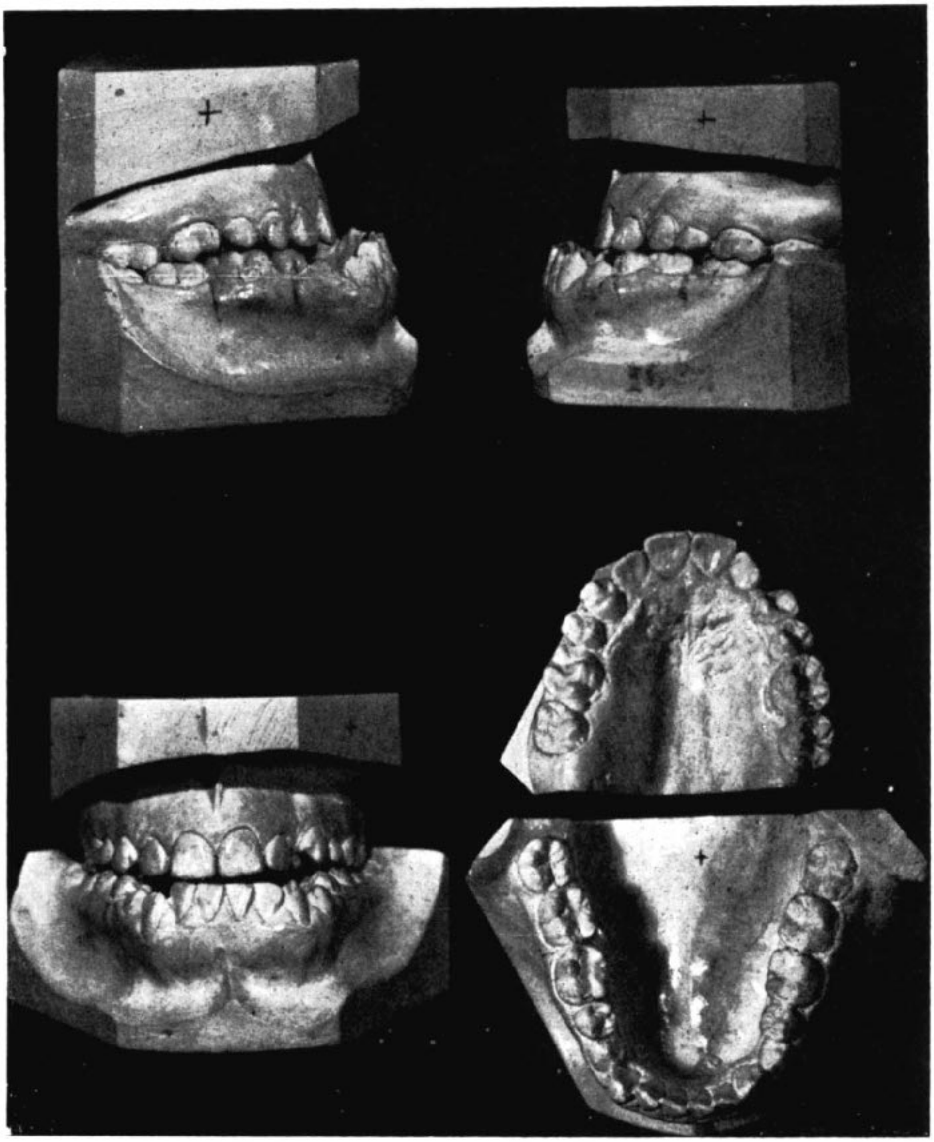

Fig. 1 Pre-operative models.

were extracted at approximately twelve years of age. At this time she and her family became acutely aware of the appearance of the Class III deformity.

Mouth habits in so far as finger or thumb sucking, tongue pushing, nail or lip biting, and mouth breathing are negative. She sleeps with her arm pressed against the right side of her face.

Outline of Treatment

Dingman and Barrow[1,2] devised a method of case analysis and therapy that was utilized in the treatment of this case.

As outlined by Barrow "The orthodontic considerations were:

1. Determination of the size and shape of the bone segments to be removed.

2. Construction and management of appliances in preparation for surgery and during healing.
3. Maintenance of pre- and post-operative orthodontic adjustment if indicated."

Impressions were taken and models made in duplicate (Fig. 1). Pre-operative cephalometric roentgenograms (Fig. 2), cephalometric measurements, intra-oral radiographs, photographs (Fig. 3) and intra-oral photographs were obtained together with a complete case history.

Fig. 2 Pre-operative head plate.

The duplicate set of the occluded models was mounted on an articulator. The lower model was set in a frame work that permitted its removal and posterior movement. Moving the mandibular model posteriorly to the desired position permitted estimation of the approximate size of the bone segments to be excised surgically from each side in order to shift the anterior portion backward and upward into the desired occlusion.

The case was a mutilated one complicated by the missing maxillary canines.

Fig. 3 Pre-operative photograph.

The segments of the mandibular model occupied by the second premolars and first molars were removed on both the right and left side to permit the anterior portion of the model to be moved distally and occlusally into the desired relationship with the maxillary denture. Moving the anterior segment of the model into its original position on the framework made it possible to measure the amount of bone segment to be removed on each side. Templates of lead were cut to size to fit each side so that the surgeon could place them on the exposed mandible at the time of surgery and make accurate markings for the size of the bone segments to be removed on each side.

The anterior segment of the mandibular model was articulated with the maxillary model and waxed to the distal segment so that the desired occlusion of the sectioned mandibular and maxillary models could be used by both the orthodontist and surgeon as a guide (Fig. 4).

Treatment

Treatment was instituted in four stages:

1. Insertion of orthodontic appliances with pre-operative treatment.
2. Extraction of second premolars and first molars on each side.

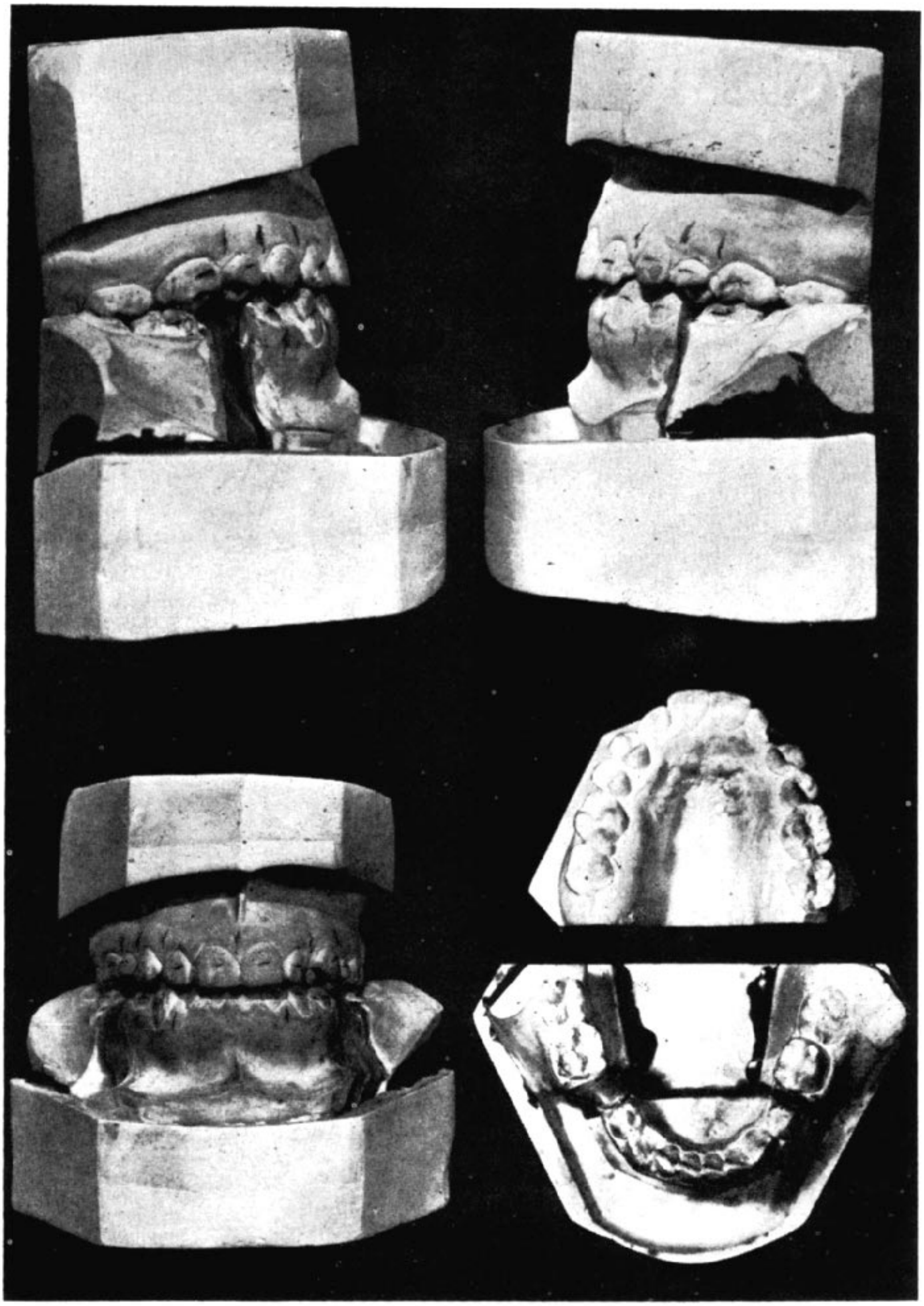

Fig. 4 Corrected diagnostic occlusion.

3. Osteectomy.
4. Completion of orthodontic therapy.

The appliance therapy was the Angle edgewise with bands and brackets cemented to all the teeth mesial to the first molars. The molar bands had buccal tubes attached wtih a lumen .022 x .028. In the maxillary arch a .016 round stainless steel archwire was inserted to obtain bracket engagement. This was followed at two week intervals by a .020, .021 x .025 and finally an edgewise archwire .022 x .028 to which were soldered ligature traction spurs 1/8″ mesial to the buccal tubes. Vertical spurs were soldered gingivally and interproximally for the reception of vertical ligatures and elastics. This archwire was inserted in all the brackets, securely ligated and tied to the molar teeth.

In the mandibular arch the same procedure was followed in the band attachment and cementation except for the teeth to be extracted. At this point in treatment the mandibular first molars and the second premolars were removed. Ten days later a .022 x .028 stainless steel archwire was passively adjusted to the existing dental irregularity. The archwire length was determined by the previously prepared diagnostic articulated casts. To this archwire were soldered ligature traction spurs 1/8″ mesial to the buccal tubes and vertical spurs gingivally for the reception of vertical ligatures or elastics. This archwire was set aside for use in the operating room at the completion of surgery.

In surgery, following the removal of the bone segments, the previously fashioned mandibular archwire was ligated to the brackets on the teeth of the anterior segment of the mandible. After ligation was completed, the anterior and posterior segments of the mandible were brought together so that the archwire could be inserted in the buccal tubes. Two strands of soft annealed .010 stainless steel ligature wire were passed distally around the archwire in the buccal tubes to the mesially located ligature traction spurs on the archwire and tied securely.

After this was accomplished on both sides we had a duplication of our previously prepared models (Fig. 4). The surgeon then tied the bone segments at the inferior border of the mandible on both sides with heavy stainless steel wire. Soft stainless steel .010 ligature wires were attached vertically in the buccal segments, from molar to canine, in a Class III direction from the vertical spurs of the maxillary archwire to the vertical spurs of the mandibular archwire. In one week elastics were used to replace the ligature wires.

Cephalometric Appraisal

Biederman[2] has declared that "In the successful treatment of mandibular prognathism or macrognathia, improvement in esthetics and occlusion is so marked, and the site of change so definite, and the change itself so intensive and so rapid, that here, it was thought, would be a promising method for testing the validity of these implications and perhaps of formulating criteria for such testing."

A cephalometric appraisal of the cephalometric radiographs as shown in Table I before surgery and treatment, immediately following, and three years later—when compared to the means of the measurements used by Riedel at Northwestern University—gives a vivid portrayal of the skeletal and dental deformity, their relationship to each other, and the changes resulting from treatment.

Skeletal Analysis

S-N-A, the angular measurement which indicates the relative antero-posterior position of the maxilla at its apical base to the cranial base, before

TABLE I

Skeletal	1-17-52	4-4-52	3-15-55	Mean (Riedel)
S.N.A.	82.5°	82.5°	82.5°	82.01
S.N.B.	84.5	78.0	78.5	79.97
Difference	+2.0	—4.5	—4.0	—2.04
*S.N.P.	84.0	79.0	80.0	
S.N.-GO.GN.	44.0	43.0	45.0	31.0
Dental				
S.N. 1	103.5	104.5	105.0	103.0
GO.GN $\overline{1}$	74.5	81.0	80.0	91.92
N.P 1	1.5 mm.	10 mm.	9 mm.	5.51 mm.
N.P. $\overline{1}$	+7.5 mm.	—5 mm.	—5.5 mm	

* S.N.P. Difference; reduction in mandibular corpus length. Mean —4.5°.

treatment is 82.5° and differs insignificantly from the mean.

S-N-B, the angular measurement which shows the antero-posterior position of the mandibular base relative to the cranial base, before treatment is 84.5°, 4.5° greater than the mean.

The angular difference between S-N-A and S-N-B which is normally about —2 degrees indicates a significant difference between the maxillary and mandibular apical bases of +2° or a total difference as related to the mean of 4°.

S-N-P, the angular measurement indicating the relative antero-posterior position of the mandible to the cranial base is 84°.

S-N-GoGn, used as the mandibular plane angle, is rather steep—44° compared to the mean of 31°. Such a value is often considered indicative of lack of ramal height thereby indicating deficient condylar growth. This is not so in this case but rather a result of anatomical morphology, as mentioned earlier, due to a ramus that is markedly directed upward and backward. In either event the skeletal limitations of treatment imposed upon us by this steep angle are constant and ever present.

Denture Analysis

S-N 1, the angulation of the upper incisor axis relative to sella-nasion, is 103.5° which falls within the mean range.

Go-Gn $\overline{1}$, the angular relationship of the lower incisor to the mandibular plane, is 74.5°, well below the mean of 92°. The discrepancy, though a tremendous 17°, is not too great when its interpretation is based on its relation to the skeletal pattern and the morphologic picture of the mandible. As Graber[4] has pointed out, "For interpretation, reference may be made to the table of values for clinically excellent occlusion, but here, again, more important, is the type of face, apical base relationship and inclinations of the teeth within the same individual."

N-P- 1, a horizontal linear measurement from the incisal edge of the maxillary incisor to the N-P (i.e. the facial plane), is 1.5 mm. as compared to a mean of 5.5 mm. for the standard, indicating a skeletal dysplasia.

N-P- $\overline{1}$ the relation of the mandibular incisor to the facial plane is also a horizontal linear measurement; its value in this patient is +7.5 mm., an indication of a skeletal dysplasia.

DISCUSSION

The angular measurements indicate the upper face is within the normal limits. The lower face is relatively well

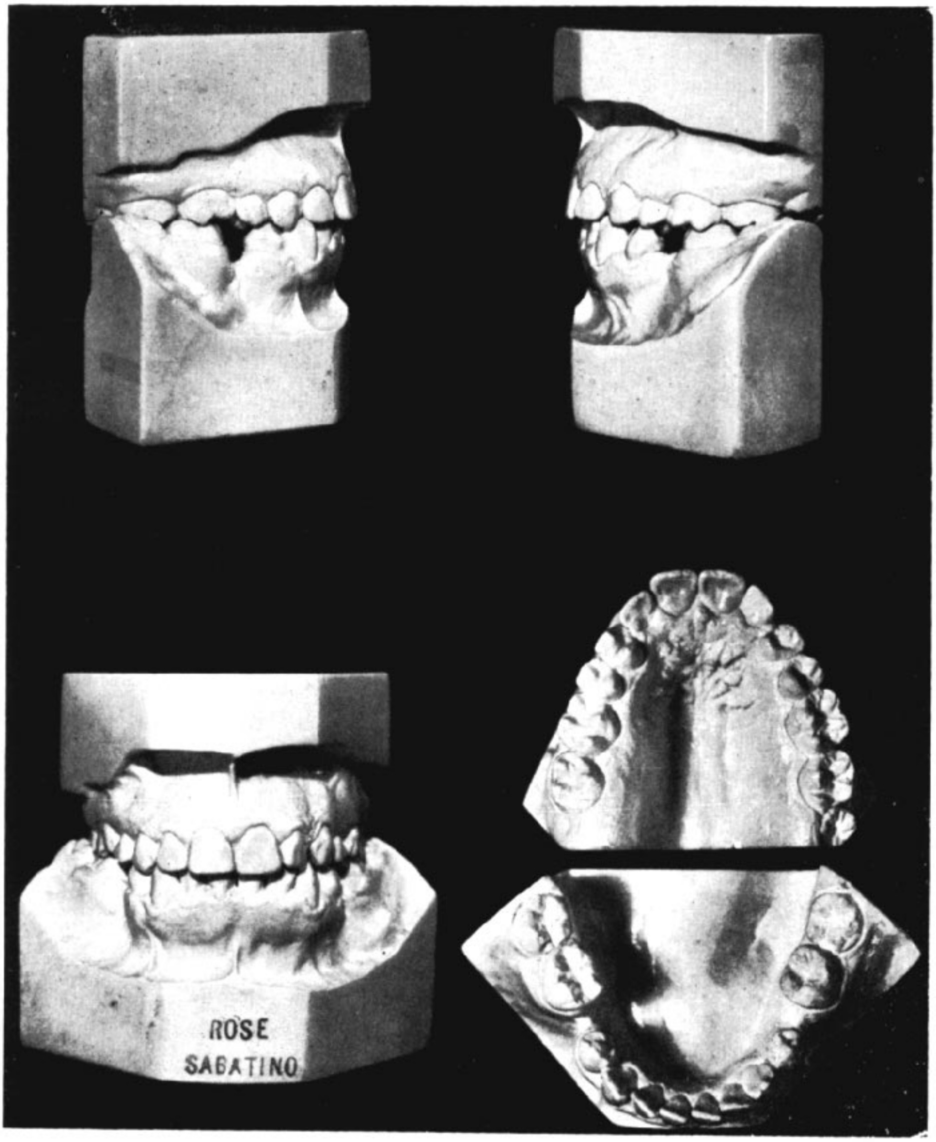

Fig. 5 Models, three years after treatment.

beyond the mean. The S-N-$\underline{1}$ angular relationship falls within the range; however, the horizontal linear relationships of the upper and lower incisors to the facial plane are far beyond the mean, indicating a skeletal deformity limited to the mandible.

Following treatment no change, other than that attributable to experimental error, was found in the measurements of the upper face. The significant skeletal changes in the lower face are due to the reduction in the facial angular relationship of the mandible to the cranium (S-N-P) by 4.5°, and the 6.5° reduction of the difference between the maxillary and mandibular apical bases, (S-N-A and S-N-B). The steep S-N-

GoGn angle has changed very little.

The S-N-$\underline{1}$ relationship remains approximately the same except for a slight increase of 1.5° in incisor labial procumbency during the three years since treatment. The Go-Gn $\overline{1}$ angle has increased 5°. Great changes have occurred in the relationships of the upper and lower incisors to the newly established facial (N-P) plane; N-P-$\underline{1}$ has increased 9 mm.; N-P-$\overline{1}$ has decreased from a +7.5 mm. to —5.5 mm., a net change to 13 mm.

Treatment has been limited to the reduction of corpus length of the mandible to harmonize with the patient's facial skeletal pattern. The skeletal changes in the facial angle (S-N-P), and the S-N-A S-N-B differences consequently resulted in the improvement of denture relationships.

Results

Figures 5, 6 and 7 depict the models, photographs and lateral headplate three years after treatment.

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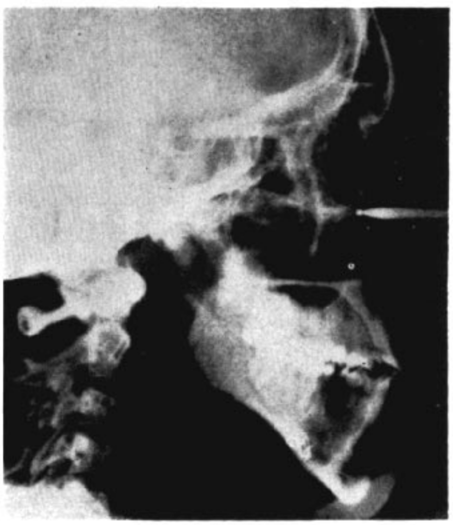

Fig. 6 Lateral head plate, three years after treatment.

Fig. 7 Photograph, three years after treatment.

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