Changes In Class II Malocclusions With And Without Occipital Headgear Therapy*

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INTRODUCTION

The current interest of the orthodontic profession in extraoral force is reflected by the numerous reports on its use which have recently appeared. The application of this force to the upper dental arch is considered by many to be the treatment of choice in Class II, Division 1 malocclusion, the most prevalent malrelation of the jaws. An important factor has been the realization that treatment of Class II cases without extraoral force can rarely be accomplished without some forward displacement of the lower dental arch.

As investigators come to place greater emphasis on objective measurement and less on clinical impression, the limitations and possibilities of a given appliance should become clear. Since it is generally accepted that there is no better method of accurately recording the changes due to facial growth and orthodontic therapy[1], roentgenographic cephalometry was used for the interpretation of treatment results. In any attempt to compare the conclusions of various investigators on this problem, the appliance used, the length of therapy, the type of sample and the degree of patient cooperation must be carefully evaluated. In this report, changes in a group of Class II patients treated with an occipital headgear will be compared with changes in a similar but untreated group at the end of a twelve-month period.

This uniform period of study eliminated some of the variability in the amount of growth occurring during the period of observation. The studies on extraoral force by Epstein[2], Graber[3], and King[4] are based on records taken fourteen months to four years apart and thus, some details of tooth movement and facial change may have been obscured. The ultimate importance of the changes observed in this report can be evaluated only by the future study of the dental relationships which have remained stable in these patients over a three or four year period. This project was designed to show as clearly as possible the changes in a group of patients treated with an occipital headgear appliance.

MATERIAL

Most cephalometric evaluations of orthodontic therapy have relied on studies of normal dentofacial growth and development to distinguish between treatment and growth changes. Investigations such as those of Brodie[5] and Björk[6] have provided the cornerstones of knowledge in this field. While studies in malocclusion cases have not established a growth pattern different from the normal, an investigator cannot predict in detail growth changes which will occur in the sample of cases he may have under treatment. The need to study an untreated group comparable in every way to the patients undergoing treatment was pointed out

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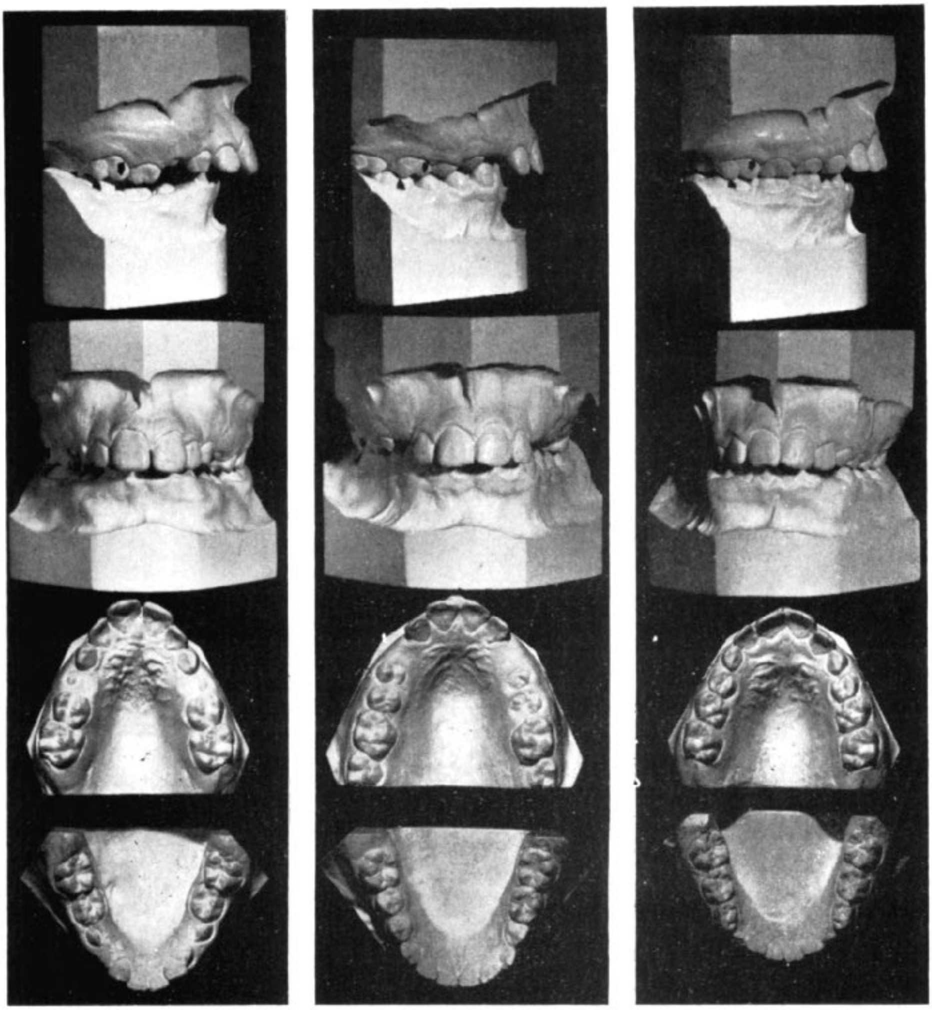

Fig. 1, Typical malocclusions.

by Klein[7] in his study of extraoral force therapy.

Treatment Group

Patients were accepted into this study on the basis of possessing the following characteristics:

1. A Class II, Division 1 malocclusion. The severity of Class II molar relation varied from cusp to cusp occlusion to extreme cases in which the upper molars were more than a whole cusp forward (Fig. 1). Even in the less severe cases, the Class II relation was noted to be present in the canine and premolar areas.
2. An occlusion in the mixed dentition stage of development.
3. A lower dental arch in acceptable alignment and in good relationship to the mandibular base.
4. A malocclusion not complicated by prematurely lost deciduous or permanent teeth.

The mean age of the twenty-nine

cases in the treatment sample was 10 years 4 months at the beginning of treatment and consisted of: eighteen males, ranging from 8 years 9 months to 11 years 11 months of age, and eleven females, ages ranging from 8 years 3 months to 11 years 1 month.

Control group

The control group was assembled from the case records of the Philadelphia Center for Research in Child Growth, through the courtesy of Dr. W. M. Krogman. The enthusiastic cooperation received from this source gave our study a sample matching the treatment group in age, sex, dental stage and type of occlusion. Although an individual treated and control case cannot be directly compared, each treatment case was matched with a control case of the same age and sex to assure the comparability of the two groups. Both samples are composed of white Caucasian stock predominantly Mediterranean in origin.

The comparison, then, is between two groups of children with similar malocclusions, identical in sex and age. Subsequent annual evaluations will be made of the changes in both groups, thereby increasing our knowledge of the extent to which the dentofacial pattern can be altered.

Appliance Therapy

The intraoral appliance consisted of bands with edgewise attachments placed on the upper first permanent molars and the four upper incisors. A .021 x .025 archwire was used with hooks for attaching the headgear distal to the central incisors. Since all of the upper teeth were to be moved posteriorly with as little change in axial inclination as possible, it was important to have torque control over the upper incisors; the edgewise arch was placed with active lingual root torque in the anterior region. Stops

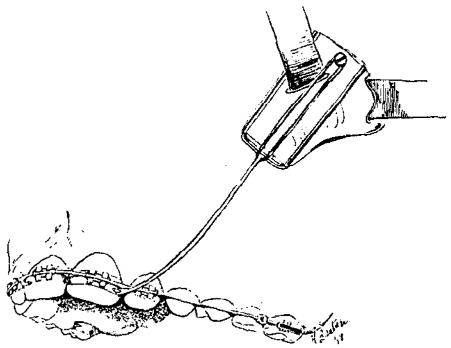

Fig. 2.

on the archwire mesial to the molars consisted of short sections of push springs slightly activated by Russell locks. This permitted ease of adjustment in changing the relative amount of force directed against the molars and incisors. *No* appliances were placed in the lower dental arch in any case.

The headgear itself is a commercially fabricated appliance that is light and easily adjusted (Fig. 2). Cloth straps pass both above and below the ear from a rigid plastic section on the cheek, and active force is supplied by elastics attached both to the plastic section and to hooks linked on the archwire. The patients reported that the appliance was reasonably comfortable and that no difficulty was en-

Fig. 3, This patient is typical of those in whom the position of the lower headstrap in relation to the ear prevented any higher angle of pull.

countered in sleeping with it in place. It was noted that adjustment was limited because the position of the lower strap passing beneath the ear prevents an effectively high angle of pull in some patients. (Fig. 3)

The treatment objective was to produce the maximum amount of desirable change in the shortest period of time, while keeping the appliance uncomplicated and not in need of frequent adjustment.

The excessively long period of treatment required by therapeutic methods stressing minimum tooth movement and maximum reliance on growth has been cited as a serious deterrent to satisfactory patient cooperation, optimum treatment results and efficient office management[8]. Therefore, treatment was directed at producing distal bodily movement of the upper teeth and correction of any rotation and spacing in the upper anterior segment.

Patient Cooperation

It was known from the start that patient cooperation was essential, and therefore a method of checking this factor was incorporated into the design of the experiment. Charts designed for the easy recording of hours of daily headgear wear (Fig. 4) were attached to the envelope in which the removable portion of the appliance was kept. The recorded hours were checked and tabulated at each patient visit. It was repeatedly stressed to each patient and parent that accuracy in keeping these records was far more important than merely showing a good record. After considerable experience with these charts it was felt that we had a reliable and accurate method of recording patient cooperation.

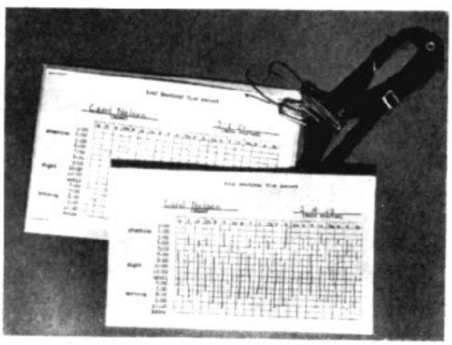

Fig. 4. The lower time chart has been filled in by a patient for a three week period; the upper unmarked chart is stapled to the envelope in which the headgear is kept.

Patients were instructed to wear the headgear appliance a minimum of twelve hours a day and more if possible. The average amount of headgear wear varied in individuals from ten to fourteen hours per day with an overall average of 12.3 hours. It was noted that with few exceptions once a pattern of headgear wear had been established for an individual, the average number of hours per day did not vary greatly during the treatment period.

Method of Measurement

Lateral films taken in the Broadbent-Bolton cephalometer were the basis for all measurements on both treatment and control samples. The initial film and that taken one year later in each individual were traced according to standard cephalometric procedures and measurements made by direct comparison of the two tracings.

For this study, the tracings were superimposed on a non-growing area of the cranium rather than on a plane determined by points which move with growth. This was done by utilizing the line originally described by Keith and Campion[9] and introduced into roentgenographic cephalometrics by De Coster[10]. The line is formed by the anterior border of sella turcica, the planum, the superior surface of the ethmoid plate and the inner surface of the frontal bone (Fig. 5). It has

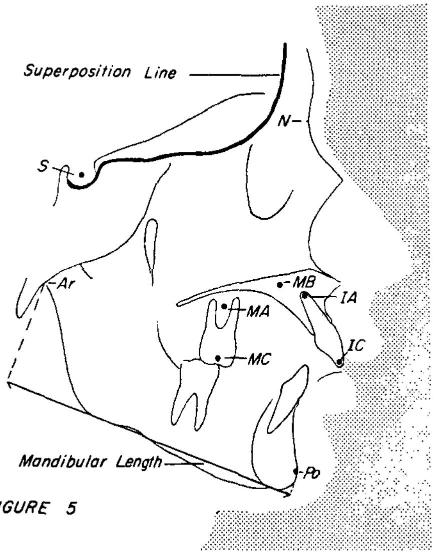

Fig. 5. The location of points used for measurement and the cranial base line used as the basis of superposition in this study. The points were duplicated on subsequent tracings by superimposing contours of the individual teeth and jaws.

been utilized by Björk[11] and can be consistently located in serial films. The entire contour of the line can be superimposed on films taken after seven years of age, giving a good basis of orientation for comparative purposes. In some cases, difficulty was encountered locating the line in the ethmoid plate area. It was noted that orientation could be made more consistent also by superimposing on the line which extends from basion superiorly and forward along the lesser wing of the sphenoid to the cranial base.

Linear millimeter measurements were used to determine the change in position of the features studied here. The use of angular readings for this purpose tends to be less exact because of the many variables which may affect an angle. A decrease in the size of the angle SNPo, for instance, might mean that point Po moved backward, but it could also mean a forward or superior movement of point N. Angles which are smaller, such as the SN-upper molar angle, are even more susceptible to this sort of difficulty in interpretation.

In comparing the increments measured in this study with those of another group, the age range, time span and cephalometric technique used must be borne in mind. Superposition of tracings with registration on the SN plane at sella as employed by Björk[11] would be essentially the same, while the registration at nasion used by Lande[12] and Steiner[13] would greatly reduce the horizontal anterior measurements. Registration by the methods of Broadbent[14] or Ricketts[15] would show the same proportional changes in the average case, but would reduce both horizontal and vertical measurements. Since we superimposed a non-growing area and compared treated and untreated cases, no assumption concerning amount or direction of growth was necessary.

Points A and B, the subjects of much recent cephalometric investigation, were not included here. It was found that point pogonion gives a more accurate indication than point B of the position of the anterior portion of the mandibular body. The location of point A yielded no new information since both the upper incisor and the maxillary body positions were measured directly. Observations in treated cases showed a marked thickening of the labial alveolar process due to lingual movement of the upper incisors (Figs. 10 and 12) and thus, later thinning of the bone on which point A is located may be expected. The posttreatment changes in point A position will be one of the important observations to be made on these patients in subsequent reports.

The effect of occipital headgear treatment was determined by measuring changes in position of the following points (Fig. 5):

1. MC and MA, the crown and the root apex of the maxillary first permanent molar, horizontal measurement.
2. IC and IA, the crown and the root apex of the maxillary central incisor, horizontal and vertical measurement.
3. MB, drawn near the center of the hard palate outline, indicating the location of the maxillary body, horizontal measurement.
4. Po, the anterior mandibular body, horizontal and vertical measurement.

Each of these points was drawn on a tooth or jaw to represent the position of that portion of the dentofacial complex at the time of the initial film. The outlines of the same individual structures seen in subsequent films were then superimposed on the original and the point reproduced by tracing. The exact location of any point on the original tracing is not critical for only the movement of the point is measured, indicating movement of the structure on which the point is located. The only point which was not easily and consistently reproduced was MB (maxillary body) because of the difficulty in visualizing anterior nasal spine and nasal floor contour and the changes in alveolar contour during the period of changing dentition and orthodontic treatment. The original facial plane (NPo) was the vertical axis on which all positional changes were based; horizontal changes were measured at right angles to this plane.

Two additional measurements were made showing growth over which the therapy was not expected to have any effect:

5. Length of the line from sella turcica to nasion.
6. Length of the mandible; measured between points Po and Ar (defined by Björk[6]). This is the effective mandibular length as employed by Blair[16] and is a modification of Wylie's[17] method.

During the course of this study most of the tracings were done twice to check the limits of accuracy and it was determined that no measurement less than the nearest whole millimeter could be repeated consistently, as pointed out by Graber[18]. Since all films were taken using the same technique, the use of a correctional scale was not indicated (Higley[19]).

Findings of Control Group

In reporting the lineal changes, the discussion is centered on the mean value or average behavior of the point in question. This procedure has been criticized when applied to certain types of data in the orthodontic literature as ignoring the individual pattern and presenting only an unreal average pattern. The use of average values is justified here because the variables affecting the measurement have been held to a minimum and the readings from most of the individual cases follow rather closely the mean trend.

The changes occurring over twelve months in the group of untreated Class II malocclusions are shown in Table I.

Fig. 6 is a composite showing the mean changes occurring within this group. It indicates that the mandible grew forward somewhat more than the maxilla and upper face and that the dentition, both upper and lower, moved forward at least as much as the lower jaw. In this group it was observed that anteroposterior relationships within the dentition remained constant for both the erupted teeth and the unerupted bicuspid and cuspid tooth buds. No significant changes in occlusion occurred.

It would be unwise to make any generalizations about dentofacial growth and development from a one-

TABLE I

CHANGE DURING ONE YEAR IN UNTREATED CLASS II CASES

		Mean (mm)	*S.D. (mm)*	*Range (mm)*
FORWARD CHANGES	Molar crown	1.4	.7	0 to 3
	Molar apex	1.2	.9	0 to 3
	Incisor crown	1.3	.8	0 to 3
	Incisor apex	1.3	.9	0 to 3
	Maxillary body	0.7	.7	0 to 2
	Pogonion	1.1	1.1	—1 to 3
DOWNWARD CHANGES	Incisor crown	1.2	.6	0 to 3
	Pogonion	1.5	1.1	0 to 5
LENGTHENING CHANGES	Sella to nasion	0.9	.6	0 to 2
	Mandible	1.7	1.0	0 to 5

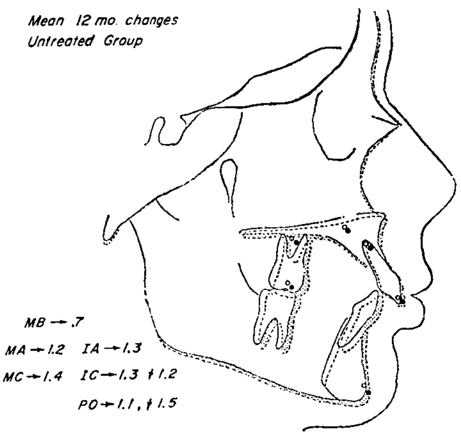

Fig. 6. A graphic construction of the changes recorded in Table 1. It shows the average growth changes over one year in 29 untreated Class II (1) cases with an initial mean age of 10.3 years.

year study of twenty-nine cases. However, the slight increase in mandibular prominence which was noted is consistent with the findings of Björk[6] and Lande[12]. If these mean growth changes occurred in every Class II patient under treatment, it would seem that a relatively small amount of occlusal alteration and distal pressure on the upper arch could disturb the synchronous forward movement of the dentition and allow improvement in arch relationship to occur. Our dilemma is that these changes do not occur in every case. The extremes in favorable and unfavorable growth occurring in the untreated sample as shown in Fig. 7, would almost certainly have shown a wide difference in response to an identical orthodontic treatment procedure.

Clinical Response of Treatment Group

Clinically, the headgear was effective in changing the molar relationship to Class I. Only four cases in the study did not attain full molar correction in 12 months time and nearly all the patients showed a substantial decrease in incisal overjet. Fig. 8 shows the original and one-year progress models on several of the patients.

In the hope of finding factors to explain the wide difference in the speed of clinical response, the cases were divided into three groups on the basis of treatment time. Placement in the rapid, intermediate or slow group depended on the number of months required for correction and on the amount of original discrepancy in molar relationship. Information which was analyzed for each group included the sex, chronological age, developmental age (from wrist film analysis) and dental maturity. The type and severity of facial skeletal deviation producing the Class II and the prevalence of this condition in other members of the immediate family were also recorded. None of these factors showed

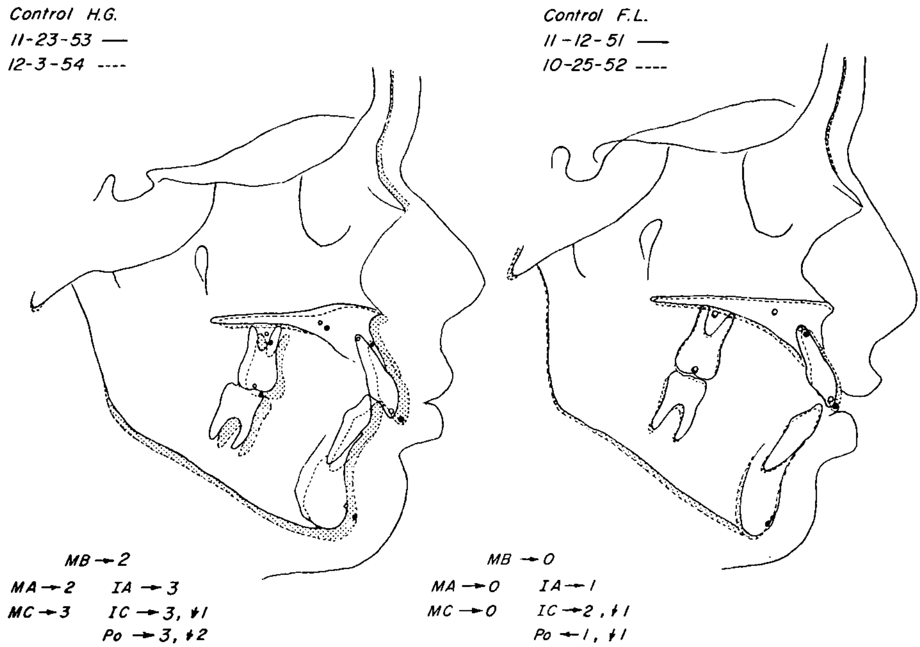

FIGURE 7

Fig. 7. Tracings of two individual untreated cases demonstrating extremes in the amount and direction of facial growth during one year. Marked differences in response to orthodontic treatment could be expected.

any significant difference among the three groups. From the variability seen in this study, any trends which might exist among these factors could be demonstrated only on a very large treatment sample.

As analysis of the study proceeded, the difference between the groups in growth and cooperation became apparent and data on these factors is shown in Table II:

Upper facial growth (S to N) was not critical to treatment speed, but the fast treating group averaged twice as much mandibular growth as the slow. This simply reconfirms what has been said countless times about the beneficial effects of mandibular growth during the treatment of Class II malocclusion. From the data recorded here it would not be possible to predict when this growth would occur. If the study of various maturation criteria eventually leads to the prediction of facial growth timing, the efficiency of orthodontic treatment can be greatly increased.

TABLE II

SIGNIFICANT FACTORS IN SPEED OF TREATMENT RESPONSE

		Rapid Group	*Intermediate Group*	*Slow Group*
GROWTH	S to N	1.0 mm	0.9 mm	1.0 mm
	Mandible	2.4 mm	1.4 mm	1.2 mm
COOPERATION	Hours / day	12.9 hrs.	12.2 hrs.	11.9 hrs.
	Inconsistent	0 %	13 %	37 %
	No. cases	10	11	8

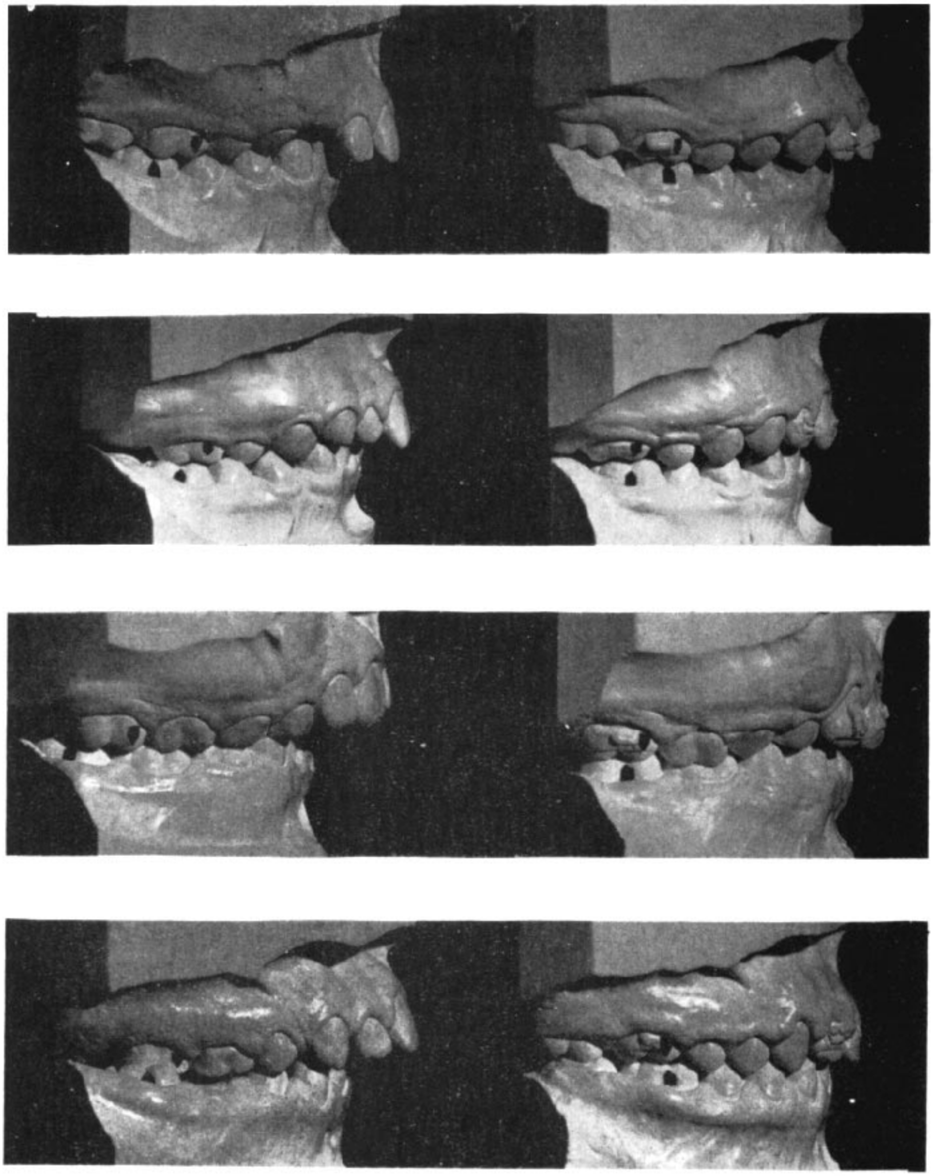

Fig. 8. Changes after one year of treatment.

Data on cooperation were obtained from the time charts described before and show that the average number of hours of headgear wear did not differ greatly among the groups. Although a slight trend exists, the difference between the mean hours of the fast and slow group was not statistically significant.

The other factor which was noted on these charts is summarized in Table II as percentage of "inconsistent" wearing of the appliance. Some patients failed to wear the appliance regularly due to various circumstances including illness, local complaints involving ir-

TABLE III

CHANGE DURING ONE YEAR OF OCCIPITAL HEADGEAR TREATMENT

		Mean (mm)	*S.D. (mm)*	*Range (mm)*
FORWARD CHANGES	Molar crown	—2.3	1.7	0 to —7
	Molar apex	—1.6	1.0	0 to —4
	Incisor crown	—2.3	2.3	2 to —9
	Incisor apex	—1.1	1.0	1 to —3
	Maxillary body	0.1	0.8	1 to —1
	Pogonion	0.4	1.4	3 to —2
DOWNWARD CHANGES	Incisor crown	2.3	1.8	0 to 6
	Pogonion	2.6	1.6	0 to 6
LENGTHENING CHANGES	Sella to nasion	0.9	0.5	0 to 2
	Mandible (Po-Ar)	1.7	1.0	0 to 5

ritation or appliance adjustment, and other less plausible excuses. With a few patients it became obvious that the time charts were not honestly marked and questioning of patient and parent revealed breaks in routine which were then noted on the chart. The percentage recorded in Table II reflects the number of time charts in that group which showed lapses in headgear wear of three or more days. Wearing the headgear every day would appear to be very important for most effective treatment.

Cephalometric Findings

Changes occurring in the group of Class II, Division 1 cases treated with an occipital headgear for 12 months are shown in Table III.

Fig. 9 is a composite illustrating the mean changes recorded in Table III. In the table, minus values in the "Forward Changes" column indicate millimeters of distal movement. Molar crowns averaged 2.3 mm distal movement, and in one case, 7 mm of distal molar movement was recorded. Distal molar root movement averaged 1.6 mm; no mesial root movement was found in any case under treatment. Posterior movement of the central incisor crowns averaged 2.3 mm as did the molars, but individual cases showed more variation, ranging from 9 mm posterior movement to 2 mm anterior movement. Only 1.1 mm average posterior incisor root movement was obtained, although individual cases showed up to 3 mm.

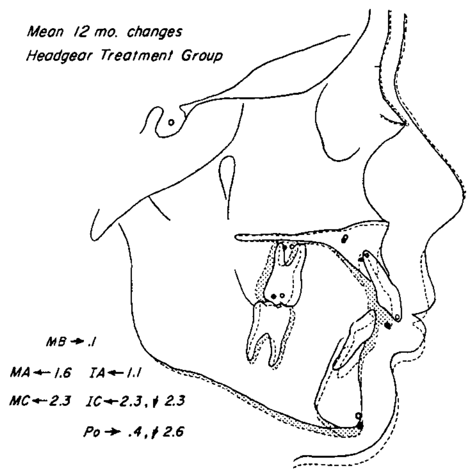

FIGURE 9

Fig. 9. A graphic construction of the changes recorded in Table 3. It shows the average treatment and growth changes over one year in the twenty-nine Class II (1) patients treated with occipital headgear.

By comparing these values with the relatively small amount that pogonion came forward, 0.4 mm, one can readily see that by far the greatest part of the occlusal correction was due to distal movement of the upper teeth. Fig. 10 shows the twelve month changes in two of the cases. An important observation in both of these cases is that by using an appliance which moved the roots lingually, a significant posterior movement of the unerupted cus-

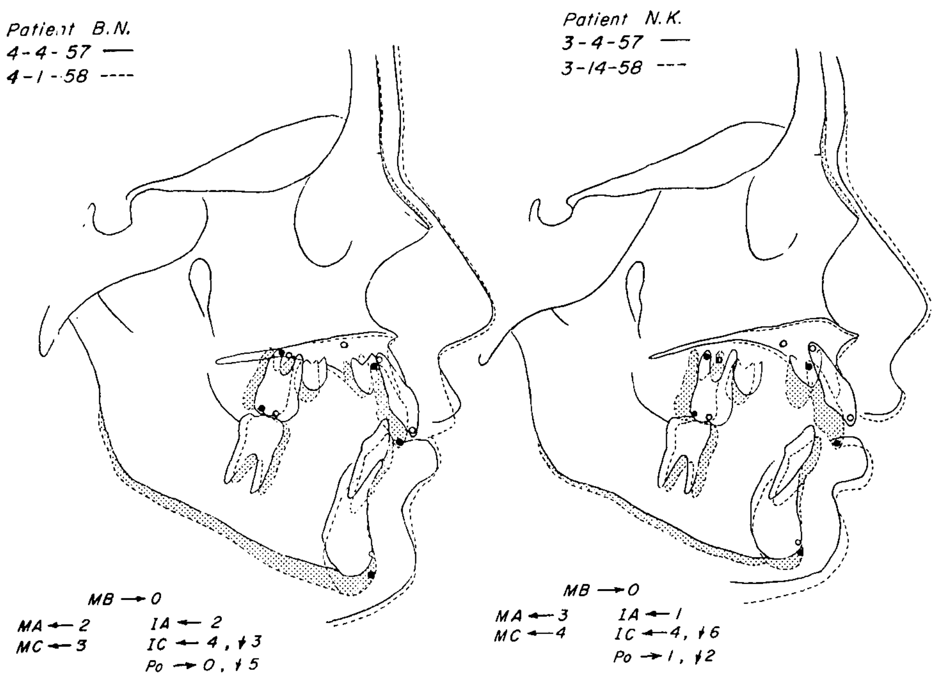

FIGURE 10

Fig. 10. Tracings of two patients undergoing headgear treatment. Posterior movement of the molars and incisors as well as the cuspid and bicuspid buds can be seen.

pid and bicuspid tooth buds was obtained. Upper tooth buds were moved posteriorly about the same distance as were the upper molar roots in every case.

Net Changes Produced

While the values in Table III show what actually happened in the treatment group, the difference between the treatment and control groups is more important. Table IV shows this difference and reflects the treatment change without the growth change; that is, Table III values minus Table I values.

TABLE IV

DIFFERENCE IN ONE YEAR BETWEEN TREATED AND UNTREATED CLASS II CASES

		Difference	*Significance*
FORWARD CHANGES	Molar crown	—3.7	+++(<.01)
	Molar apex	—2.8	+++(<.01)
	Incisor crown	—3.6	+++(<.01)
	Incisor apex	—2.4	+++(<.01)
	Maxillary body	—0.6	+(.05)
	Pogonion	—0.7	+(.05)
DOWNWARD CHANGES	Incisor crown	1.1	++(.01)
	Pogonion	1.1	++(.01)
LENGTHENING CHANGES	Sella to nasion	0.0	0
	Mandible (Po-Ar)	0.0	0

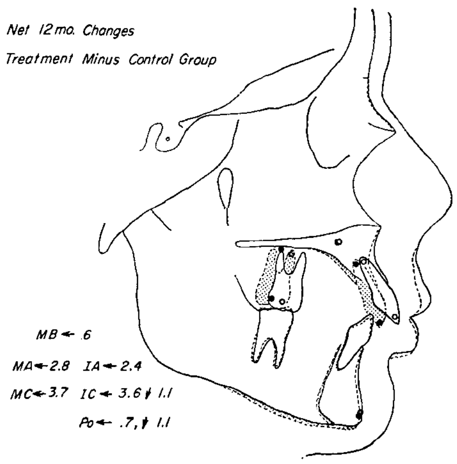

FIGURE 11

Fig. 11. A graphic construction of the differences between treatment and control groups as recorded in Table 4. The positions of the teeth and jaws under treatment are compared with the positions they would have occupied without treatment.

The degree of individual variation was such that treated and untreated cases could not be compared on an individual basis, but valid conclusions can be drawn from the statistical comparison of large enough samples. Fig. 11 is a graphic representation of the group differences as seen in Table IV. It shows where the teeth and jaws were as compared with where they might be presumed to have been without treatment.

Posterior movement of upper teeth, the primary goal of treatment, was well accomplished. The entire maxillary dentition, including both the erupted and the unerupted teeth, was about 3 mm farther back than it would have been without treatment.

It was hoped that this movement could be obtained without the excess upper incisor extrusion and increase in lower face height which often occur during Class II correction procedures. Incisor extrusion tends to increase the vertical overbite, which initially is often deep in a Class II case. The excessive downward movement of the chin is really an opening swing of the mandible, resulting in an inhibition of the normal forward chin progress. Even though this retardation is slight, it may accentuate the retrusive profile common in Class II malocclusion. The excess vertical movement found in this study was 1.1 mm for both the incisor and the chin. This resulted in a retardation of forward pogonion movement of 0.7 mm on the average. In the case shown in Fig. 12, where downward movement was 4 mm and mandibular growth was slight, a 2 mm posterior movement of pogonion occurred.

The lack of difference noted in the "Lengthening Changes" column of Table IV demonstrates that the areas measured were not affected in any way by treatment. The inhibition of forward chin movement was not due to any lessening in growth of the mandible,

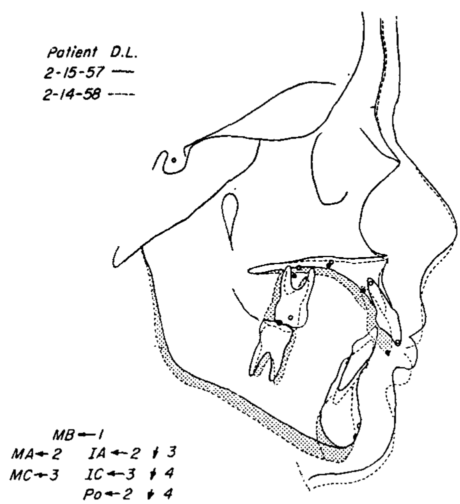

FIGURE 12

Fig. 12. Tracings showing progress in one headgear patient. The excess downward movement accompanying the distal movement has resulted in the hinging-open of the mandible. Pogonion has moved 2 mm distally from the original N-Po line.

but a difference in direction of mandibular growth. From present knowledge it seems doubtful that any treatment method could materially affect growth in length of the mandible.

The inhibition of forward growth of the maxillary body was only .6 mm and, as was noted, the location of the measurement point less certain than other points used. Nevertheless, observations in individual cases confirmed the trend, and an actual posterior movement and slight downward tipping of the maxilla (the palatal plane) was recorded in several cases. This was the same effect noted by Klein[8] in his report of cervical traction therapy.

Headgear therapy is, therefore, observed to affect the position of both the mandible and maxilla. The absolute size of these changes is very small when compared to changes in tooth position and they are not of any great assistance in the clinical correction of a Class II malocclusion. It is also apparent that in studies covering longer periods of time and less active treatment mechanics, these changes would be largely obscured by normal growth, if indeed they persisted at all.

Discussion

The amount of distal tooth movement obtained in these cases was greater than that reported with the cervical type of extraoral force appliance. Klein, using the maxillary outline for superposition, reported 1 mm average distal upper molar movement, but probably would have recorded less if a cranial registration were employed. However, the effect of headgear force on the maxilla itself makes exact comparison difficult. A small amount of posterior movement was reported by Epstein in a few of his cases, and Graber and King found that in most cases a maintenance of the normal forward molar movement was all that could be expected.

Occipital headgear treatment appears to be capable of substantial tooth movement in very young patients for West[20] found an average of approximately 4 mm distal movement of upper deciduous molars. This measurement includes an increase equal to the amount of forward growth at nasion because of the superposition method. It is impossible to determine exactly what effect the length of therapy period or the degree of patient cooperation had on the findings of most treatment evaluation studies. However, until other evidence is forthcoming, I would agree with the conclusion of West that distal movement of upper teeth is best accomplished with an occipital headgear.

The amount of anterior movement of the upper dentition recorded in the untreated group points out the need for an appliance capable of distal tooth movement. The dentition came forward about 1.3 mm in one year, which was more than the forward growth at nasion. Even so, it would take five years to correct a moderate Class II case with 6 mm of molar discrepancy using an appliance capable of no more than a holding action. The possibility of tissue damage and loss of patient cooperation would make therapy of this length unacceptable to many.

To gain a more thorough understanding of the action of the occipital headgear, changes in occlusal plane angulation in relationship to other facial changes were examined. The plane was located on all the tracings by bisecting molar and incisal cusp height. While the angle of the occlusal plane to the anterior cranial base did not change in the untreated group, a mean downward tip of 2.8° (±2.4°) was noted in the treatment group. The scattergram in Fig. 13 shows that with an increase in occlusal plane tipping, a decrease in forward pogonion movement occurred; the correlation is high

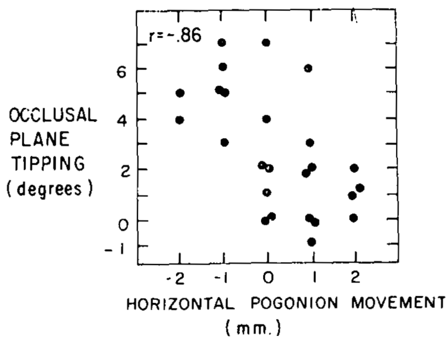

Fig. 13. A scattergram showing the degree of correlation between the horizontal movement of pogonion and tipping of the occlusal plane.

(r = —.86).

This relationship was also observed by Tovstein[21] in studying the effects of intraoral Class II elastics on the occlusal plane. The elastic force produced a downward tip averaging between 4° and 7° and it could be inferred that this would be associated with a proportionately larger inhibition of forward chin movement. Ricketts[15] observed an increased inclination of the mandible in cases treated with Class II elastics. This same type of unfavorable change was noted by King in cases treated with cervical anchorage and a full or partial edgewise appliance. Klein found this effect when treating cases with the Kloehn[22] type of cervical anchorage.

Downward tipping of the occlusal and mandibular planes is therefore common in most Class II correction mechanics. The appliance therapy used in "preparation of mandibular anchorage" seems to be one means of avoiding this tendency. Stoner, et al.[23], in studying a group of cases treated by Tweed, found very little tipping action and little inhibition of forward chin movement. The use of Class III elastics and very high pull headgear are undoubtedly instrumental in this achievement. An important part of the profile improvement associated with this treatment is due to control of the downward tipping of the occlusal and mandibular planes.

Appliance Improvement

Clinical and cephalometric observation has been continued in some patients where longer therapy with the occipital headgear was necessary. The vertical overbite was not decreasing and, in many cases, normal downward growth of the upper molars was being restricted. In a few instances an actual open bite in the molar area was created. Analysis of this behavior of the teeth made the mechanics of the headgear clearer.

Fig. 14(a) shows the appliance used here in relationship to dentofacial structures as recorded in cephalometric films of patients wearing the headgear. The facebow is pulling at an angle superior to the occlusal plane, but a downward tipping of this plane was observed. The stippled area indicates the location of the maxillary dental roots and alveolar process, and the letter "M" is the geometric center of this mass. With "M" considered as the center of resistance to the pull of the facebow, the behavior of the teeth was exactly as might be expected. Even the position of the hook extending downward from the archwire tends to give an undesirable torquing action.

For those patients requiring additional treatment, the headgear has been modified as shown in Fig. 14(b). The hook has been moved forward, extending upward from the archwire and the direction of facebow pull has been raised, which requires a different type of head strap in most cases. On the basis of these observations, distal pull on the upper dentition should be aligned through "M", the center of the maxillary root mass, to avoid undesirable tipping movements. If opening of the bite is desired, the force should

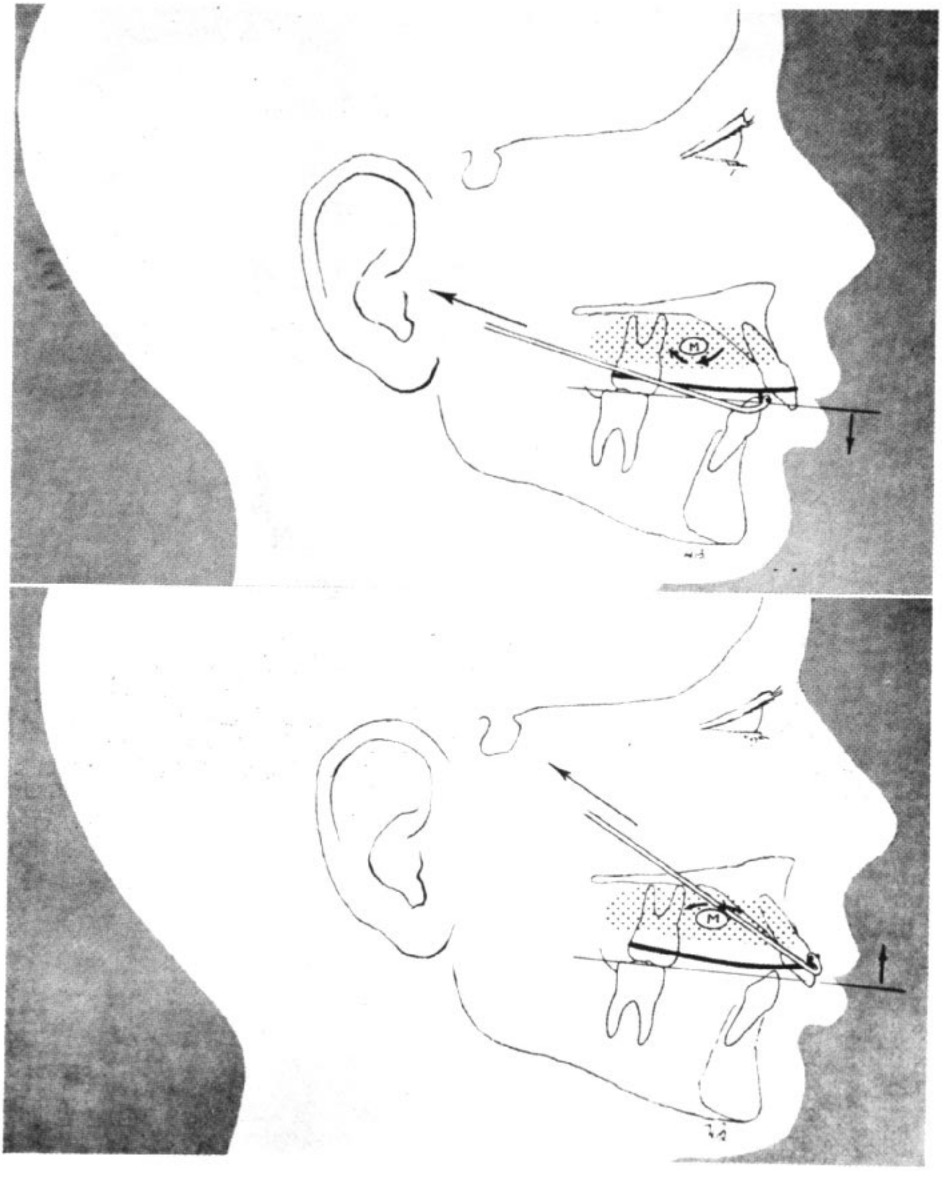

Fig. 14. above. The relationship of dentofacial structures to the occipital headgear appliance as recorded from lateral headfilms of patients wearing the appliance. The stippled area indicates the roots and alveolar process of the maxillary dentition and "M" is the center of this mass. Arrows indicate the movement as a resultant of the applied force. Fig. 14, below. A higher line of force and point of attachment would be indicated to correct excessive overbite and avoid downward tipping of the mandible. The amount of distal movement possible with this set-up has not been studied.

be aligned forward and superior to "M".

This type of "high-pull" headgear is currently coming into wide use in orthodontic practice, especially during therapy requiring reduction of incisor overbite. The initial treatment results are demonstrating the effectiveness of the appliance in upper incisor intrusion. Because a headgear appliance shows a wide variation in the relationship of the direction of pull to the teeth in different patients, a "high-pull" or any other type of headgear should be selected according to the individual and to the malocclusion.

Through the continued efforts of the orthodontic profession to objectively report treatment results obtained with the various appliance regimes, it will ultimately be possible to appreciate the therapeutic possibilities of every available appliance. Only in this way can the problems of each patient be met with the most ideal, permanent and economical form of treatment.

Summary

A group of 29 mixed dentition, Class II, Division 1 patients were treated with an occipital headgear and compared with a closely matched group of untreated cases. Differences in dentofacial changes between the groups were analyzed at the end of one year utilizing lateral cephalometric films.

1. Molar relationships were corrected and incisor positions improved in nearly all the treated cases, largely by a substantial distal movement of the upper dentition. Most cases showed a marked distal position of the maxillary roots and unerupted tooth buds.
2. Comparison with the control group revealed some inhibition of forward maxillary growth and a slightly greater increase in lower face height. The dentition in the control group moved forward more than the upper face.
3. Regular daily wearing of the headgear and the amount of mandibular growth were shown to be the most important factors in obtaining a prompt treatment response.
4. Analysis of the mechanics of the headgear force used here suggested that changing the attachment and direction of pull in relation to the maxillary roots might improve the action of the appliance.
5. From comparisons with tooth movement reported in other studies, the occipital headgear appears to be the most effective appliance for moving upper teeth posteriorly.

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