A Three-year Survey Of Class II Malocclusions With And Without Headgear Therapy*

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Introduction

Trying to say something new about headgear treatment is becoming increasingly difficult. The obvious things have already been said and the obscure things remain just as elusive. One author[1] recently solved this problem by measuring points on bones at some distance from the teeth undergoing headgear therapy. While the findings were necessarily limited to very small changes and the measurement technique was rather involved, the paper met with great success. Here at least was something new to look at! Those of us who content ourselves with observations of the teeth and jaws may have a much harder time finding anything amazing or revolutionary to report.

A few years ago I reported[2] on the changes noted at the end of one year of headgear therapy in a group of Class II mixed dentition cases and compared these with a matched group of untreated Class II cases. Observations were then continued for two more years on these patients, taking headfilms at annual intervals. The problems in interpretation of data in the first report have not been simplified now that the data have been multiplied three times. Several concepts have emerged, however, which may add to our understanding of headgear treatment:

1. The amount of tooth movement observed in a given patient is highly variable according to the exact time of observation, as well as the duration and intensity of the therapy. When this is combined with the variable of superimposition techniques used by various authors, comparison of one case with another and one study to another can be very difficult.
2. The significance of the movement can be judged only in relationship to the growth of that patient during the observation period as well as an understanding of growth in similar untreated patients. For instance, a measurement of 5 mm of distal molar movement in one situation might be no more significant than just holding the molar still in another circumstance.
3. The direction of headgear pull is very important in controlling the balance between vertical and horizontal movements of the upper arch.

Methods and Material

In the first report a group of eighteen boys and eleven girls at an average age of 10 years 4 months were included. All possessed Class II, Division 1 malocclusions with good lower arches. Complete headfilm records were available on twenty-two of these cases at the end of three years and it is these cases which are analyzed here. All of the clinical phases of this study and the taking of records were carried out as part of the clinical research program of the National Institute of Dental Research, Bethesda, Maryland. The con-

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Fig. 1 Headgear of the type used in original NIDR treatment group.

Fig. 2 Elastic headgear currently used in some cases by UC School of Dentistry, Division of Orthodontics Clinic.

tinuing care and supervision of these patients were handled by Dr. P. J. Coccaro. A matching group of untreated cases from the files of Dr. W. M. Krogman at the Philadelphia Growth Center was followed for an identical length of time.

The patients in the treatment group wore occipital headgear attached to an upper edgewise arch with bands on the permanent incisors and molars. The headgears used were the Steiner type (Fig. 1). The design is essentially the same as the Johnson headgear which has been widely used and which in turn differs only slightly from that shown by Angle in 1889. The elastic headgear (Fig. 2) is available prefabricated and is a convenient means of producing essentially the same force.

Method of Measurement

Lateral headfilms taken in the Broadbent-Bolton cephalometer were the basis for all measurements. Standard tracing techniques were used and serial tracings were superimposed on the midcranial base as utilized by Björk and more recently by Moore and his students. This area has been recognized as the most stable and unchanging area for superposition during the period of growth with which we are generally concerned[3].

The measurements as reported here have been simplified somewhat from the original study and a chart form of presentation has been developed in an attempt to make the interrelationships of the various measurements clearer. The individual measurements indicate the change in position of that point when the tracings are superimposed on the cranial base. The horizontal changes were recorded in millimeters measured perpendicular to the original facial plane (N-Po). The length of the mandible was measured parallel to its inferior border from points Po to Ar.

The essence of three years of continuous observation is summarized in the graphs. Although many measurements were recorded and tabulated, the seven features selected here seem to con-

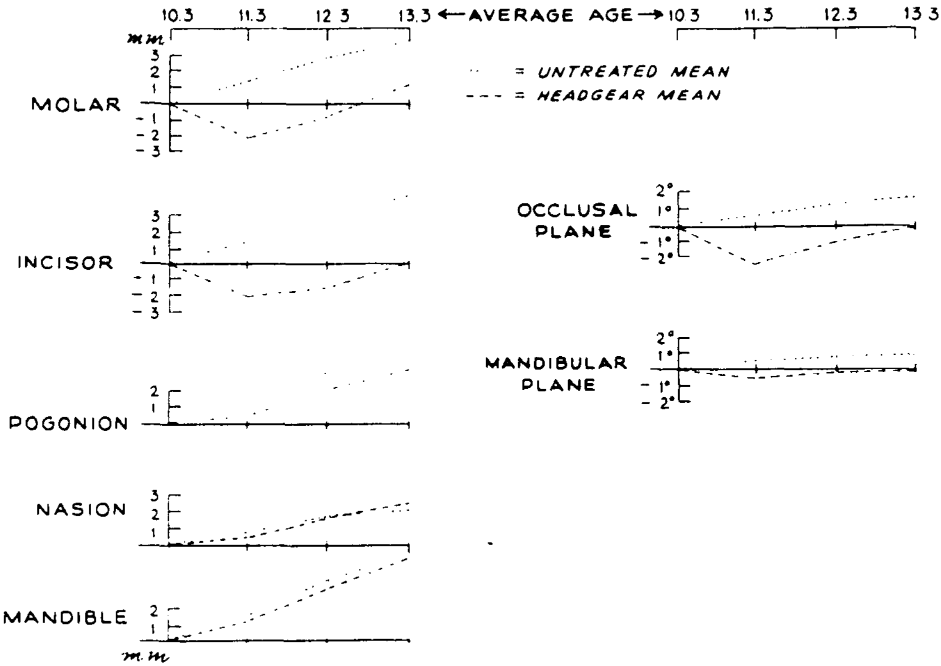


Fig. 3 Graph showing the average changes in the seven points measured in the treatment and control groups during the study period.

vey the essential points of tooth movement and growth without confusing the picture more than necessary. Because of the structural interdependence of the dentofacial parts, it is useful to consider them in relationship to each other.

All measurements on the graphs are arranged so that normal growth changes carry the curve upward with the average age of the subject reading across. Each measurement is recorded to the same scale in millimeters except for the angular changes in the occlusal and mandibular planes which are recorded in degrees. Although the changes in the position of molar and incisor roots and crowns were recorded separately, an average of root and crown movement was used in these charts for brevity.

Findings — Control Group

The measurements for the twenty-two untreated Class II cases are indicated by the dotted lines (Fig. 3).

The upper molars and incisors moved forward at rates about equal to pogonion, while nasion moved forward about one-half as fast. The close relationship between the forward movement of the upper molar and the chin point (and mandibular dentition) bears out the clinical observation that, in spite of good mandibular growth, untreated Class II molar relationships do not improve. This was borne out recently by Fröhlich[4] in a study of occlusion through dental casts. The growth of the mandible when measured parallel to its inferior border was greater than any other measurement recorded here. The amount of this growth which would be expressed in a forward direction would depend on the angle of the mandibular plane and the direction of mandibular growth. The angular readings of the occlusal and mandibular planes showed the characteristic slight posterior drop in these planes that has been found by other investigators.

It is important to bear in mind that these curves, representing mean values on a group of untreated Class II cases, can be meaningfully compared only with similar groups of patients. The age of initiation for this study was 10.3 years, and these values would not be applicable to other age groups. Particular caution must be used in any attempt to apply such findings to individuals either in treatment assessment or growth determination. A survey of the wide individual variation in amount, direction and timing of growth quickly demonstrates the impossibility of predicting the details of growth in any given individual from group averages.

Findings — Treatment Group

The tabulations of the treatment group findings are recorded in the same table with the control group to demonstrate the significance of the tooth movement obtained. It is not possible to assess the importance of the treatment changes without concurrent consideration of the control results.[5]

The movement recorded for the upper first permanent molar is interesting to observe in the light of controversy over whether this tooth can be moved distally, and how far. The amount of movement depends in part on when the observations were made. The average case here showed 2 mm distal movement at the end of one year, while at the end of two years only 0.8 mm distal movement was found. At the end of three years 0.9 mm mesial movement was recorded.

Does this mean that the upper first permanent molar cannot really be moved distally? No, it is simply due to the fact that we are measuring posterior movement in a structure which is being carried forward through normal growth. The actual amount of tooth movement recorded at any given time is of far less significance than the difference between treated and untreated cases. In the patients measured here, the difference between treated and untreated molar position is about 3 mm at the end of the first year and remains so at the end of the second and third years.

For each of the measurements listed, it is the divergence between the headgear group and control group plot lines that shows the influence of the treatment. The widest divergence appears in the incisor recordings: the least difference shows at the nasion and mandibular growth recordings. This bears out the not surprising fact that this type of headgear treatment has more influence over the position of the upper incisors than it does over the nasal bone or mandibular growth.

The average total changes found here correspond quite closely with the amount of molar crown movement found at the end of three years by Wieslander (Table I). He compared untreated cases with Class II cases treated with a face bow, and used a virtually identical method of superim-

TABLE I

FORWARD CHANGES IN THREE YEARS

		Molar crown	*Point A*
Wieslander	Face bow	1.2 mm	1.5 mm
	Control	4.9 mm	3.4 mm
			Incisor root
This study	Headgear	1.0 mm	0.9 mm
	Control	4.0 mm	4.1 mm

position and measurement.

Wieslander also studied the changes in several facial structures separated by some distance from the teeth and found changes which seemed to be due to the face bow therapy. The amount of change in these areas was so small (generally around 1 mm) that even though these changes might be measurable, their clinical significance would be slight compared to the very obvious tooth movement which can be obtained by either occipital or cervical anchorage.

The oft-repeated phrase, "The effects of orthodontic treatment are limited to the teeth and alveolar process", may be challenged when small but measurable changes in position of certain maxillary and mandibular structures are considered.[6] When we look more realistically at clinically significant changes in the average run of patients, however, the phrase still seems to embody the greater part of truth.

Individual Case Studies

The details of the changes observed in four representative cases (all males) will be presented. These will be compared with the average values of the entire group, illustrating the amount of difference between the untreated average, the treated average, and the individual case. Termination of active treatment is indicated on each of the graphs by "end Rx".

Each of these cases will also be illustrated by four different superimposed cephalometric tracings. Two of the tracings will illustrate the over-all changes over the entire period of study; one superimposed on the midcranial base as previously described for measurement purposes, the other superimposed on the maxilla and hard palate to make the change in tooth and jaw relationship easier to visualize. The other two tracings show the changes from the beginning to the finish of active therapy, and again from the end of treatment to the postretention period.

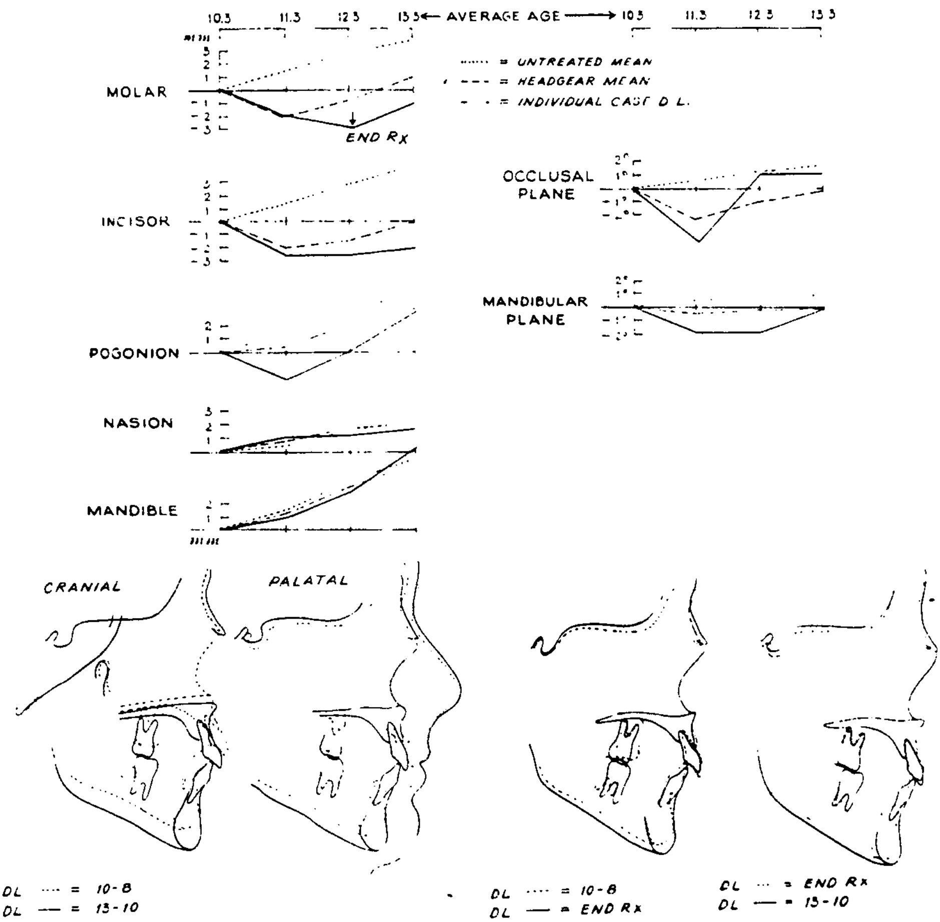
Patient DL: (Fig. 4) The total time of headgear wear was longer than average in this case (over two years) and, because of consistently good cooperation, a greater than average amount of molar and incisor movement was recorded. The molar was still 3 mm posterior to its original position at the end of two years and, considering that nasion had grown forward 1.5 mm by this time, this is a very significant alteration in the maxillary dentition.

This case illustrates the interrelation of occlusal plane tipping and pogonion position. Because of a relatively downward pull of the headgear on the incisors during the first year, the occlusal plane was tipped down 4°. This influenced the mandible downward to the extent that pogonion moved backward 2 mm. During the subsequent period of treatment, pogonion moved forward rapidly and the occlusal plane was tipped back up partly because of a much higher angle of headgear pull used during this time.

Mandibular growth was just about average during the first two years with 1 mm the first year and 2 mm the second; 3.5 mm growth occurred during the third year which was considerably above average and helped carry pogonion (and the mandibular dentition) 3 mm forward.

The over-all changes on the tracings (Fig. 5) show a considerable vertical growth with posterior movement of the upper molar about equaled by the anterior growth of the lower dentition. Both the upper molar and incisor were carried back bodily which should assist the ultimate stability of the correction.

When the changes are broken down into the treatment and posttreatment components (Fig. 6), it can be seen that most of the molar movement oc-



Figs. 4, 5 & 6 Graph and tracings of headgear treatment case DL.

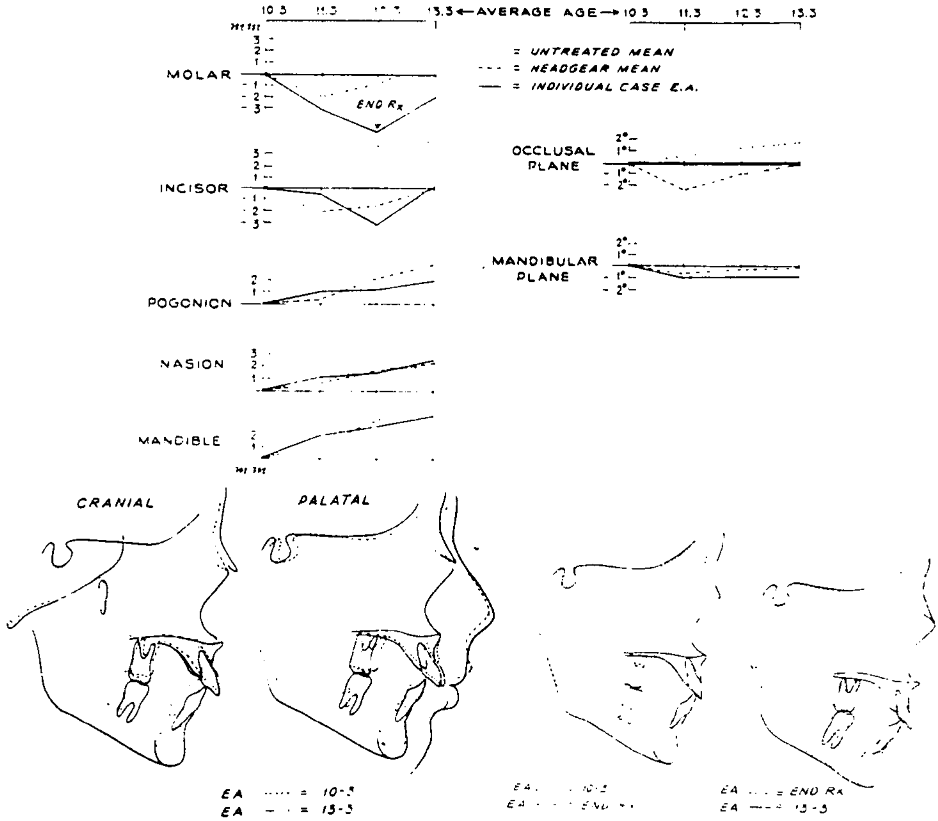
curred during treatment and most of the forward growth of the mandible after treatment.

Patient EA: (Fig. 7) The headgear was worn 22 months in this case for an average of 13 hours each day which produced 5 mm distal movement of the upper first molar. Posterior movement of the upper incisors was somewhat slow at first, but greater progress was made during the second year of treatment. While both the molars and incisors showed a marked forward movement after the headgear pressure was released, the corrected occlusion was fairly stable.

The forward progress of nasion and the mandible followed the averages quite closely with just under 1 mm per year of forward growth at nasion and mandibular growth of 2 mm the first year and 1 mm each of the following years.

The occlusal plane measurements did not vary in this case.

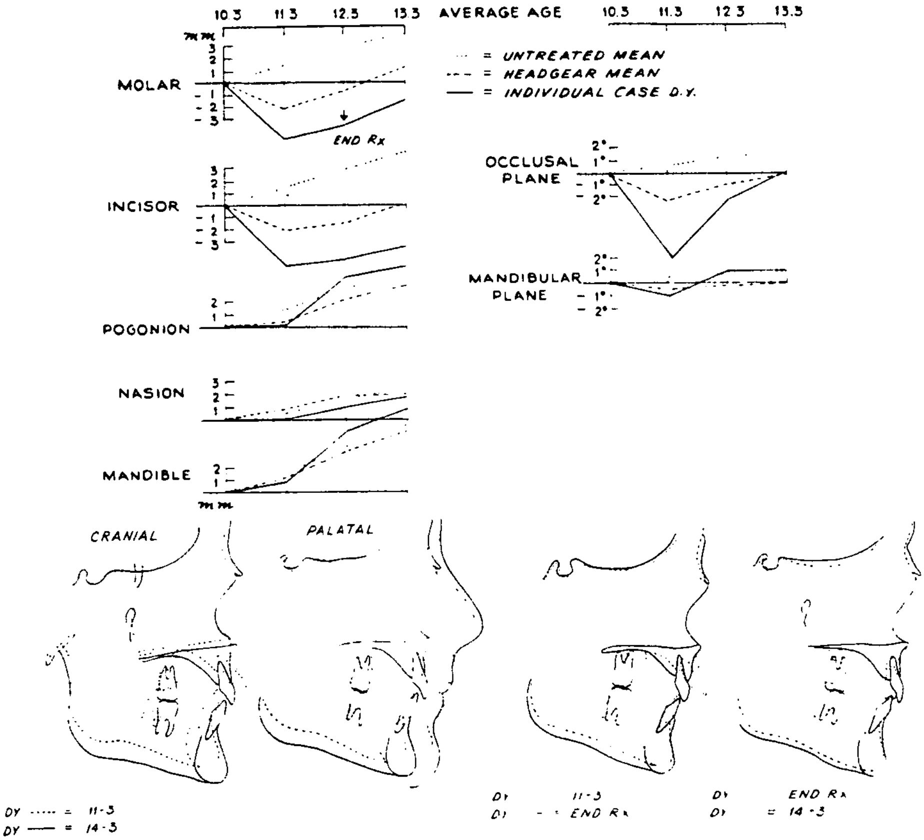
The tracings (Fig. 8) show a satisfactory amount of forward growth of the mandible with an approximately equal change in the maxilla. In the tracing superimposed on the palate the distal influence of the headgear treatment can be seen more clearly.



Figs. 7, 8 & 9 Graph and tracings of headgear treatment case EA.

Turning to the comparison of changes during and after treatment (Fig. 9), it is obvious how far the corrected incisor relationship relapsed due to unsatisfactory retention. This could have been prevented if continued headgear pressure to an upper retainer had been employed. Using a headgear to the retainer has proven over a period of several years to be capable of not only holding a Class II molar and incisor correction, but also improving the correction during the retention period. In many mixed dentition cases the retention period can easily be more important than the treatment period.

Patient DY: (Fig. 10) This case demonstrated exceptionally rapid molar and incisor posterior movement with the molar moving 4.5 mm and the incisor 5 mm during the first year of headgear wear. Because of the unfavorable downward tipping of the occlusal plane which was produced by the relatively low angle of headgear pull used, the subsequent year of treatment was directed more toward correction of the vertical discrepancy than the distal movement of the teeth. This was done by switching to a high-pull type of headgear which largely corrected the occlusal plane angle and allowed the continuing mandibular growth to be expressed in a more forward direction while still holding the molar and incisor back. Whereas the upper incisor crown

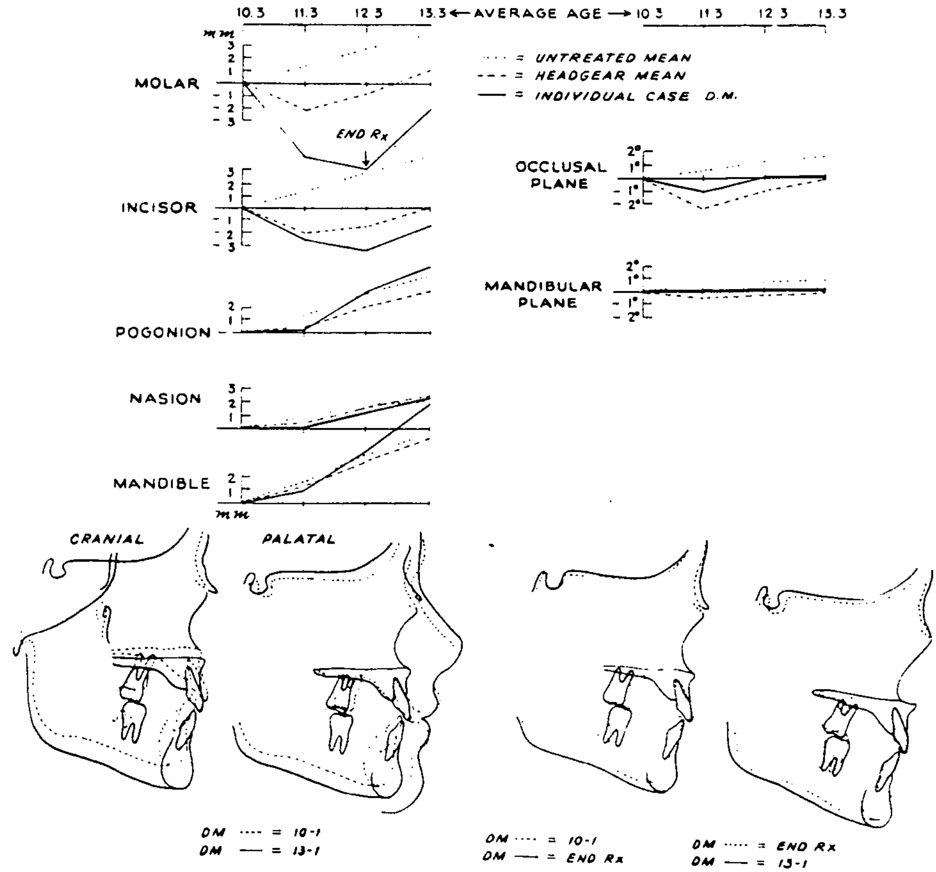


Figs. 10, 11 & 12 Graph and tracings of headgear treatment case DY.

was moved downward 7 mm during the first year, it was held at a constant level during the second year. Since the mandible continued with a downward growth of 2 mm this second year, the overbite was reduced. A 6 mm difference between the treated molar position in this case and the untreated average was established during the first year and remained essentially unchanged.

The over-all changes seen on the tracings (Fig. 11) show the excellent mandibular growth which occurred, accompanied by a very gratifying change in the soft tissue profile. The tracings also illustrate the apparent lack of appreciable molar movement in the cranial superimposition which is often seen on final headfilms. However, when the changes are broken down into pre and posttreatment changes (Fig. 12) it can be seen, as was indicated on the chart, that the molar first was moved back a considerable distance and later carried forward through normal growth. This shows the importance of the time at which molar movement is measured in determining the amount and the importance of knowing the amount of growth which was occurring at the same time. If the same amount of posttreatment forward movement of the molar as shown here were to occur without an equal forward growth of the mandible, it would constitute a serious relapse.

Patient DM: (Fig. 13) A maximum



Figs. 13, 14 & 15 Graph and tracings of headgear treatment case DM.

in both distal molar movement (7 mm) and forward mandibular growth (8 mm) is seen in this case. The incisor movement was satisfactory although less marked. Very little disturbance of the occlusal plane occurred during treatment which may be one reason for the marked forward position of pogonion at the end of active treatment. On the other hand, it might be suggested that the good mandibular growth aided in keeping the occlusal plane from tipping; at least we know for certain that the growth cannot be attributed to either Class II elastics or to anchorage preparation.

The tracings (Fig. 14) show the excellent mandibular growth which occurred along with a good amount of posterior movement of the upper teeth. When treatment changes alone are studied (Fig. 15), the marked molar movement is seen along with an uprighting of the lower molar and incisor. Since there were no appliances on the lower arch, this change must be attributed to the combined influence of the occlusion of the posteriorly moving upper teeth and the forward growing mandible.

The posttreatment changes show little incisor change but some forward movement of the molars and of the mandible.

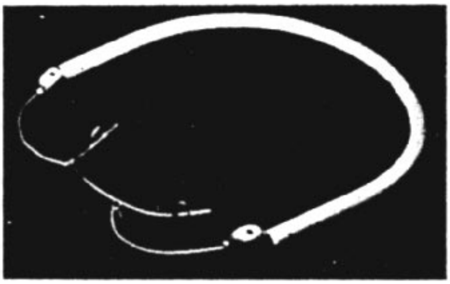


Fig. 16 Cervical traction appliance attaching loosely to a .045 inner arch.

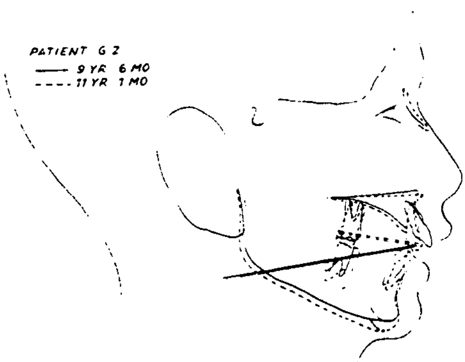


Fig. 17 Tracing showing tipping of molars and incisors as a result of one type of cervical traction.

Discussion

Critics of mixed dentition treatment have often wondered whether the movement which is gained in early treatment is of any lasting consequence when subsequent growth occurs. The slope of the curves showing treated and untreated cases here would indicate that the treatment effect is not lost since, on the average, the molars and incisors continue to move forward from their treated positions at about the same rate,but no faster than the teeth move forward in untreated cases.

Undoubtedly an important part of this stability of correction was due to the fact that an appliance was used which did not allow undue tipping of either incisors or molars. The root apices of these teeth were moved backward an appreciable amount and this in turn contributed to the movement of the entire maxillary alveolar process including the unerupted tooth buds.

With some forms of extraoral force appliances used for mixed dentition treatment (Fig.16) the teeth are allowed to tip backward most of the distance, which results in a less stable correction and very little favorable influence on the unerupted maxillary teeth. Tracings of a case treated in this manner (Fig. 17) show the tipping of the molar and incisor and the direction of headgear pull. It can be seen that, although some posterior movement of the molar and incisor crowns was obtained, the root apices were moved forward during active therapy. This led the author of a paper[7] reporting on treatment with this appliance to the conclusion that extraoral force causes excessive distal tipping of the maxillary first molars and incisors and increases the overbite. It is apparent that these factors are not necessarily inherent in extraoral force but rather in the lack of control of the particular appliance used. To attribute excessive tipping to extraoral force per se would be like accusing all labial archwires of having no torque control when only a plain round archwire was used.

A rather similar type of tooth movement was observed when fifteen cases treated with the ribbon arch appliance were analyzed cephalometrically. A case typical of those studied (Fig. 18) shows a pronounced downward movement of the upper incisor due to the direction of headgear pull. The gingival deflection of the archwire which was intended to produce intrusion of the upper incisors worked largely to tip the upper molars distally. Any decrease in incisor overbite was due to downward movement and growth of the mandible.

Control of tipping of the incisors and

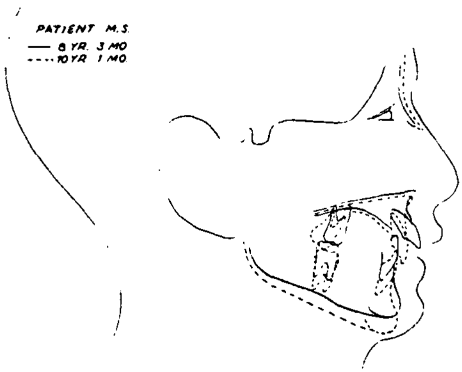


Fig. 18 Tracing of a case treated with ribbon arch appliance and occipital headgear. Gingival alignment of arch did not intrude upper incisors.

control of excessive overbite can be regulated according to the needs of the case with various designs of occipital headgear. Cephalometric films taken with headgears in place can be used to determine the actual direction of extraoral force pull in relation to the upper teeth. When considering the action of the headgear, it is the relationship of the angle of pull to the center of resistance of the maxillary teeth which must be considered.

When all possible directions of headgear pull are shown together (Fig. 19), it becomes clear that the appliance can be chosen according to the problems at hand. No. 1 and No. 2 would be the directions of pull which might be obtained from the "high-pull" type of headgear used in many cases. The action resulting from this force is very satisfactory in closed bite cases, but because the pull is generally much closer in direction to No. 1 than to No. 2, there may be relatively little posterior component of movement. Both Nos. 1 and 2 are shown attached gingivally in the anterior portion of the archwire which greatly enhances the control of the axial inclination of the upper incisors.

No. 3 and No. 4 are shown attached to the more conventional type of hook which will tend to decrease the effectiveness of the incisor torque. A pull in the direction of No. 3 might be satisfactory in many Class II cases, but No. 4 should be used only if closing the bite is desired. A combination of several of these directions of pull used simultaneously has been advocated by some orthodontists, but good results can be obtained with careful selection of less complex arrangements. Switching from direction 2 to 3 or vice versa by changing headgears during the course of treatment has proven to be a satisfactory means of obtaining the desired movement in many instances.

By placing the headgear hooks gin-

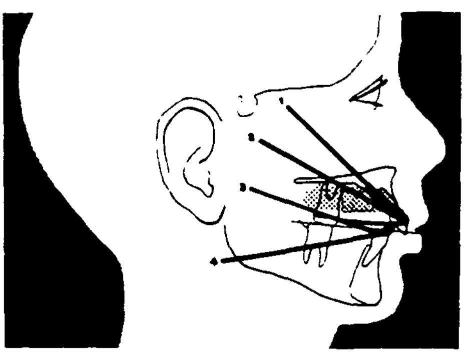


Fig. 19 Four directions of pull that may be exerted by a flexibly attached extraoral force appliance.

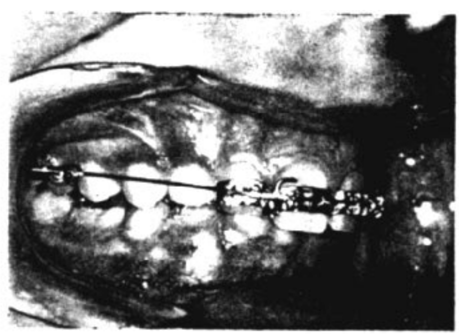


Fig. 20 Intraoral appliance currently used in mixed dentition treatment. Headgear hooks extend gingivally between central and lateral incisors to enhance torque control.

Fig. 21

givally in the positions shown (Fig. 20) between the centrals and laterals, the point of application of headgear force is brought much closer to the center of resistance of the incisors and, as a result, they can be retracted bodily with very little torquing of the archwire.

The "high-pull" type of headgear is now used routinely by many orthodontists during certain phases of treatment. Like so many mechanical devices we use, it is simply a rediscovery of Kingsley's 1875 model (Fig. 21). A cephalometric tracing of a patient wearing a "high-pull" headgear (Fig. 22) shows the position of the direction of pull related to the upper teeth, and also illustrates the type of tooth movement which may be obtained with this appliance. The upper incisors were retracted with considerable intrusion which allowed the overbite to be corrected without molar extrusion. Sufficient distal maxillary molar movement was obtained to correct the molar relationship to Class I. Use of the "high-pull" headgear for over six years has shown, however, that cases which can be treated successfully with this appliance alone are in the minority.

Conclusion

In assessing the results of orthodontic treatment no one measurement or observation can tell the whole story. The question is not, "Was it growth?" or "Was it treatment?", but rather, "How much of each was involved?" In addition, it is necessary to know just how long a period was involved and how much active treatment occurred during that time. For a thorough understanding of the effects of a particular regime of appliance therapy, several cephalometric films are necessary to show the active treatment results and the changes following treatment.

In this report changes over a three-year period in a group of twenty-two occipital headgear patients were presented simultaneously with a like group of untreated patients. The movements of the upper molars and incisors and the chin point, the growth of nasion and mandibular length, and the angles of the occlusal and mandibular planes were presented in graphic form. Changes in four individual headgear patients were compared with the group

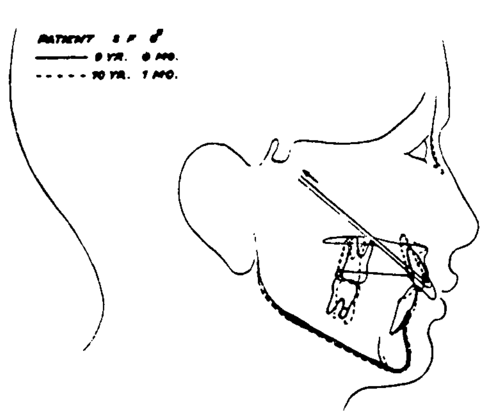


Fig. 22

averages to show the range of possibilities.

Although other types of extraoral force appliances can be used to very good advantage, the type of control which is possible with headgears of the type discussed here would indicate that they occupy an important place in the spectrum of orthodontic appliances.

The Medical Center

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