EXTRA - ORAL FORCE

IN

ORTHODONTICS

This Critical Review of Literature is Submitted in Support of Candidature for the Degree of Master of Dental Surgery.

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EXTRA-ORAL FORCE.

1. HISTORY.

2. MECHANICS.

   i. Construction.

   ii. Uni-Lateral Force.

   iii. Forces Applied.

   iv. Modifications and Accessories.

3. RESULTS OF TREATMENT.

   A. i. Distal Movement of Maxillary Molars.

   ii. Distal Tipping of Maxillary Molars.

   iii. Lingual Tipping of Maxillary Anterior Teeth.

   iv. Occlusal Plane Tipping.

   v. Overbite Considerations.

   vi. Molar Eruption.

   vii. Maxillary Development.

   viii. Maxillary Alveolar Development.

   B. i. Mandibular Growth.

   ii. Changes Relating to Gnathion and Pogonion.

   iii. Change in Supramentale (Pt.B)

   iv. Effect on Lower Teeth.

4. AIMS OF TREATMENT.

5. INDICATIONS AND ADVANTAGES.

6. COMMENCING TIME FOR TREATMENT.

7. LIMITATIONS AND CONTRA-INDICATIONS.

8. OTHER USES OF EXTRA-ORAL FORCE.

HISTORY.

Extra-oral force is not new. Its use has been put to advantage even from the time of 1822 when according to Weinberger [72] in his book of "Orthodontic Review, Evolution and Progress", he reports J.S. Gunnel as first using the head gear for occipital anchorage in 1822 or 1823. Later in 1836 Kneisel used the head gear in the treatment for mandibular protrusion. In 1841 Schange published a report on the use of the head gear appliance.

Nelson [55] in an article in the Am. J. Ortho. reports that in 1855 Norman Kingsley first used occipital anchorage to retract upper protruding incisors. Kingsley was again reported by Bien [4] as using the occipital headgear to depress and drive anterior teeth distally after having extracted the maxillary first premolars on each side. Later Bien again reports on an article by Kingsley in the Dental Cosmos in 1892 which describes a technique, by means of a headgear for driving upper teeth distally without any extractions. Fischer [22] in an article in November 1947, states that occipital force was used extensively by Calvin S. Case [17] in the treatment of cases with blocked out canines. Cases' article was reported in the Dental Orthopedia of 1921.

It is interesting to note the popularity of the occipital appliance rise and fall with the changes in treatments generally in Orthodontics, and with the changes in philosophies and diagnosis of malocclusions. In 1889 Angle [1], in his text book on Orthodontia, discussing occipital anchorage, stated, "The value of the occipital bandage as a means of anchorage is, I believe, becoming more and more appreciated and is especially applicable in this class of cases (meaning maxillary protrusion). I am using this appliance here-in described in my 16th case and I consider

it much more satisfactory than any of the new devices which are described in our literature on this subject."

However, not long after, Angle was to develop appliance techniques incorporating the use of Class II inter-maxillary elastics for these cases of protrusions. Therefore it is interesting to compare the above statement with another statement occurring in the 7th edition of Angle's[2] book "Malocclusion of the Teeth" published in 1907. Again referring to occipital anchorage, he states "Not withstanding the efficiency of this appliance, the present demands of Orthodontia are best fulfilled in these cases (meaning maxillary protrusions) by the Baker form of intermaxillary anchorage, later to be considered, by means of which extraction is avoided and normal occlusion established, instead of merely 'improved' occlusion as in the former plan of treatment. For this reason, this appliance has been superseded in the author's practice, and though it may occasionally be used as an auxillary to intermaxillary anchorage, yet the necessity for its use will become lessened as greater skill in the employment of intermaxillary anchorage is developed."

Fischer [22] best explains this change in Angle's attitude toward occipital anchorage when he says that inter-maxillary force fitted in better with his (Angle's) change of views on diagnosis, classification and treatment of malocclusion. Angle based his classification of treatment upon two hypotheses: (1)"That the maxillary first permanent molar always erupts in the correct relationship to cranial anatomy."

(2)"that the best balance, the best harmony, the best proportions of the mouth in its relations to the other features require that there shall be the full complement of teeth, and that each tooth shall be

made to occupy its normal position - normal occlusion."

The difference in attitude between Angle's opinion on extra oral and occipital appliances as reflected in these two quotations and the attitude of the present day, is seen best in an article by Graber [29] on extra-oral therapy, when he (Graber) says "I could not conscientiously treat Class II, Division I malocclusions without extra-oral force, and Class II cases make up two-thirds of the total number of cases that I treat."

Kloehn, must be given a great deal of credit for reviving the interest in the use of extra-oral appliances, particularly in Class II, Division I malocclusions. Kloehn[46,47,48], has written numerous articles on the use of this appliance. In 1947 in the Angle Orthodontist an article entitled "Guiding Alveolar Growth, and eruption of the teeth to reduce treatment time and produce a more balanced denture and face." In 1953 articles appeared again from Kloehn [47,48] and in The Angle Ortho. and the Am. J. Ortho. Again both articles stressing the use of this appliance and indications for its use. However, Kloehn readily acknowledges the importance of A. Oppenheim of Austria, who contributed considerably towards the revival of extra-oral force.

Oppenheim reports the case of the actress, who, because of her profession, was not able to have fixed appliances in her mouth, but for whom he tried the extra-oral appliance for night wear only. Oppenheim was surprised after several months, that the actress, on returning to his surgery, showed a quite appreciable reduction in her protrusion. Oppenheim attributed the success of the treatment to light intermittent force, which his research findings had shown to be not only the most effective means of teeth movement, but also the means resulting

in the least damage to the root and its investing bone and periodontal membrane.

In his paper "Biologic Orthodontic Therapy and Reality", published in 1936, Oppenhein [58] says "for the treatment of similar cases, which form a great portion of our practice material and which deal with a forward wandering of the buccal teeth, especially the canines, and also in the treatment of Class II cases in which we carry the upper teeth backward rather than the lower teeth forward, this procedure is, in my opinion, most recommendable."

Although Angle, between 1889 and 1907, did revise his opinion on the use of the extra-oral as a direct means of appliance therapy, he did not completely give away the use of the occipital head gear, although he did feel that its use would become less and less as more refined appliances were developed. So that occipital force is used today in the preparation of mandibular anchorage prior to the use of intermaxillary Class II elastics as advocated by Tweed in the treatment of Class II, Division I cases of malocclusion.

From the above historical review, it may be seen that occipital anchorage has been in use in the practice of the speciality of orthodontics for over a century. Yet we find that it was not adopted generally, and that in the period 1945-1947 it was less popular with the orthodontic practitioner than before the turn of the century.

This seems surprising when the appliance is considered in the light of its simplicity and ease of management, and secondly in that it can be commenced on patients in both the deciduous and mixed dentitions in the suitable circumstances.

MECHANICS.

The extra-oral appliance consists essentially of two sections.

1. The head cap or cervical strap.
2. The face bow or double bow arch which is attached to the head cap or cervical strap.

The head cap consists of several pieces of material, e.g. belting material, which are joined in the region of the crest of the forehead, below the external occipital protuberance, and below and slightly anterior to the lobes of the right and left ears. (See Fig. 1)

The double bow arch as used by Kloehn consists of an outer or facial bow and an inner or dental bow. The inner bow is a round steel arch of .045 inches diameter which is shaped to the form of the maxillary arch, so as to lie passively in the buccal tubes on the molar bands when these molar bands are cemented to the molar teeth. The outer or facial bow is made of round steel of .050 inches diamter and is soldered to the inner bow in the anterior region. This outer bow is shaped so that the double bow arch will fit in the mouth without pinching on the angles of the mouth. The ends of the outer bow are shaped into a hook for retention of elastics which will stretch back to hooks sewn on the head cap (See Fig.2)

The position of the hooks on the head cap will depend both on the length of the elastic bands which will be connecting the double bow to the head cap, and also depend on the amount of pressure required to be transmitted to the molar teeth, or to the maxillary arch, as the case may be. The cervical appliance is the same in principle, only the double bow arch is connected to wide elastic banding material which stretches around

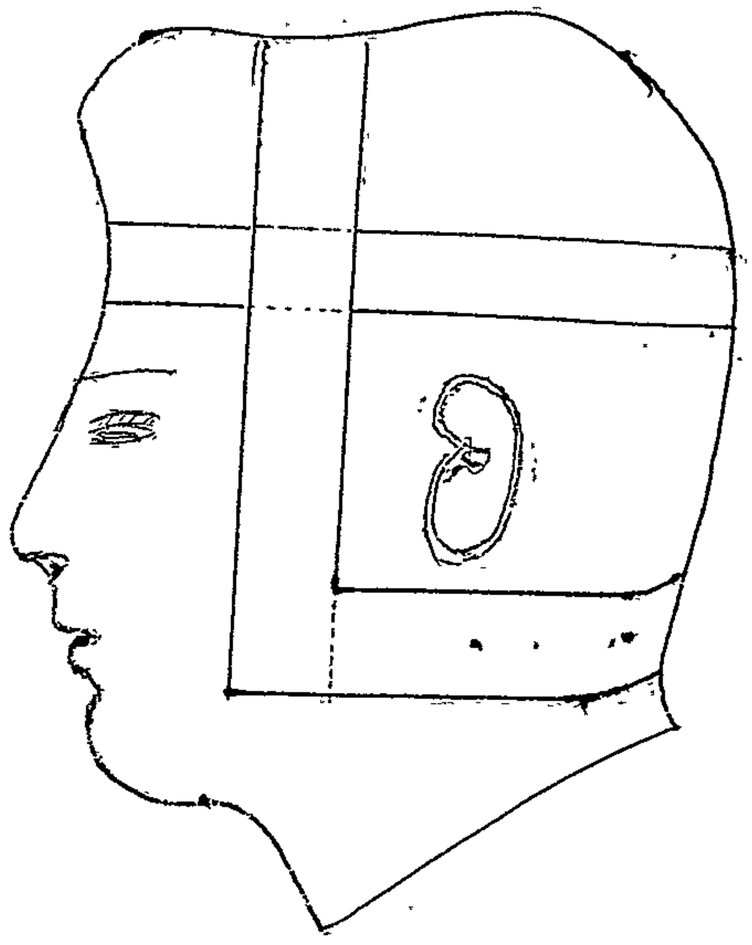


FIG. I

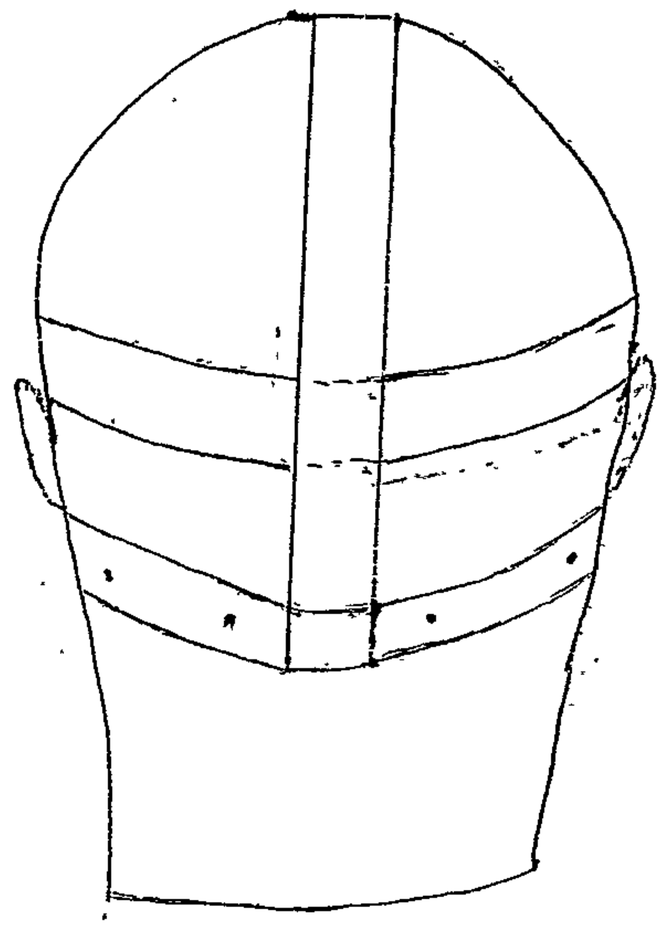


FIG. I

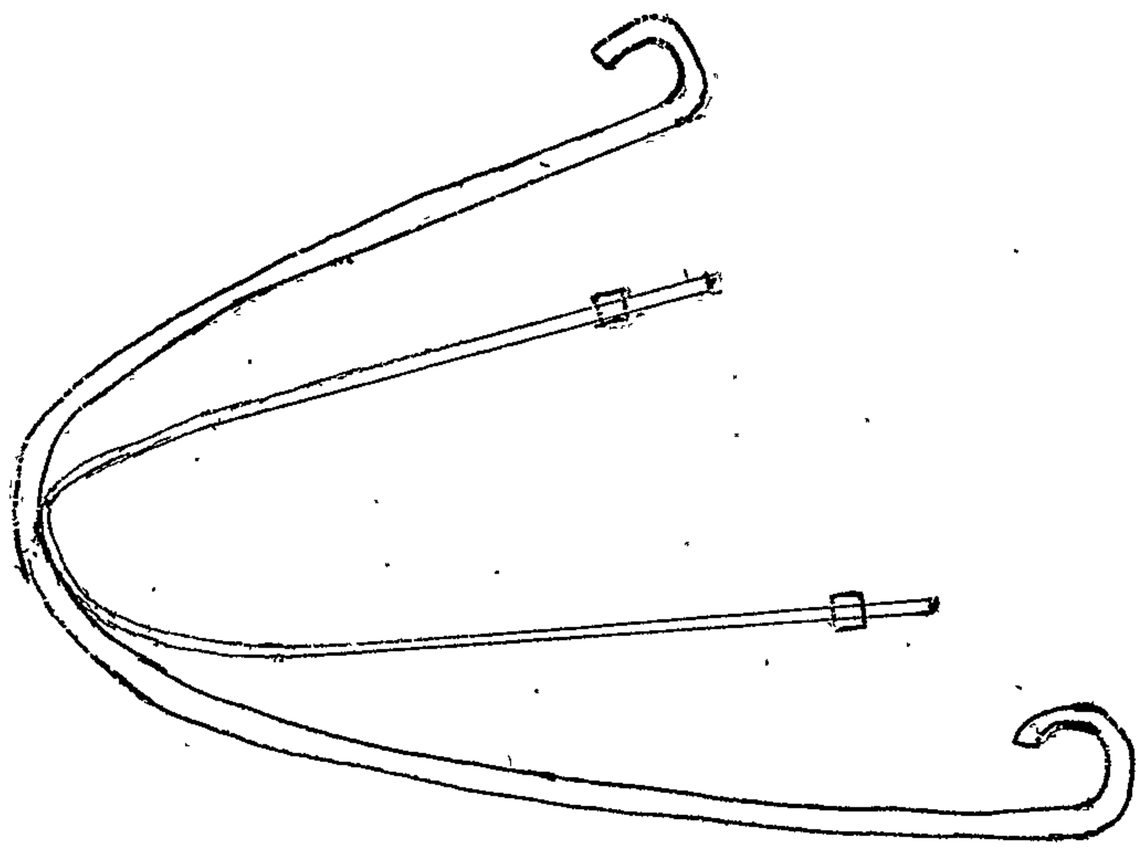


FIG. II

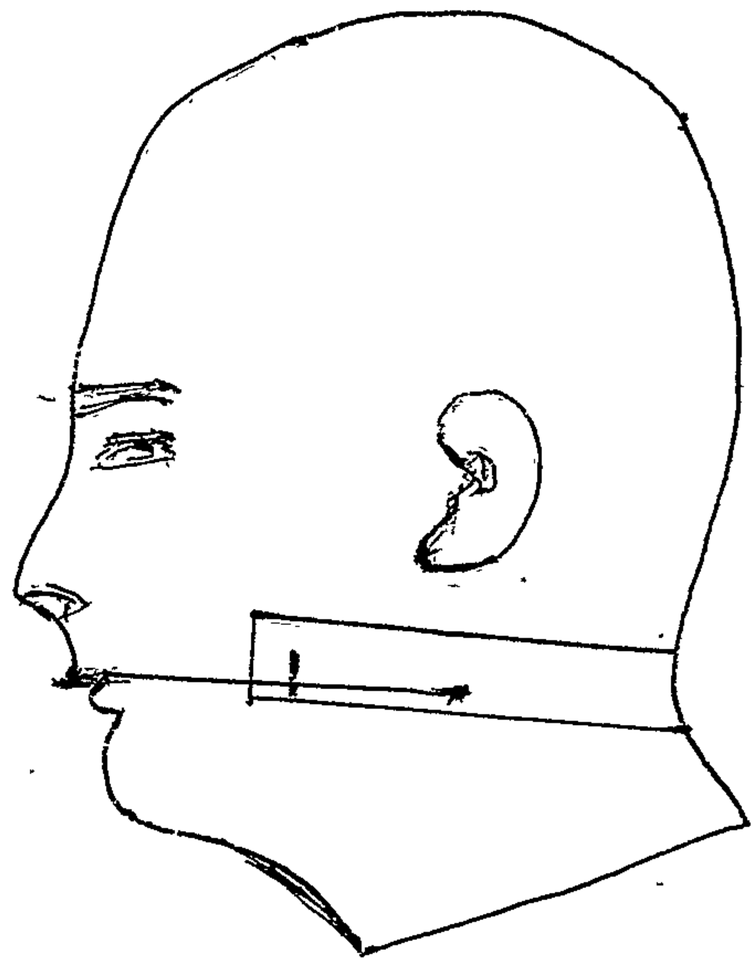


FIG. III

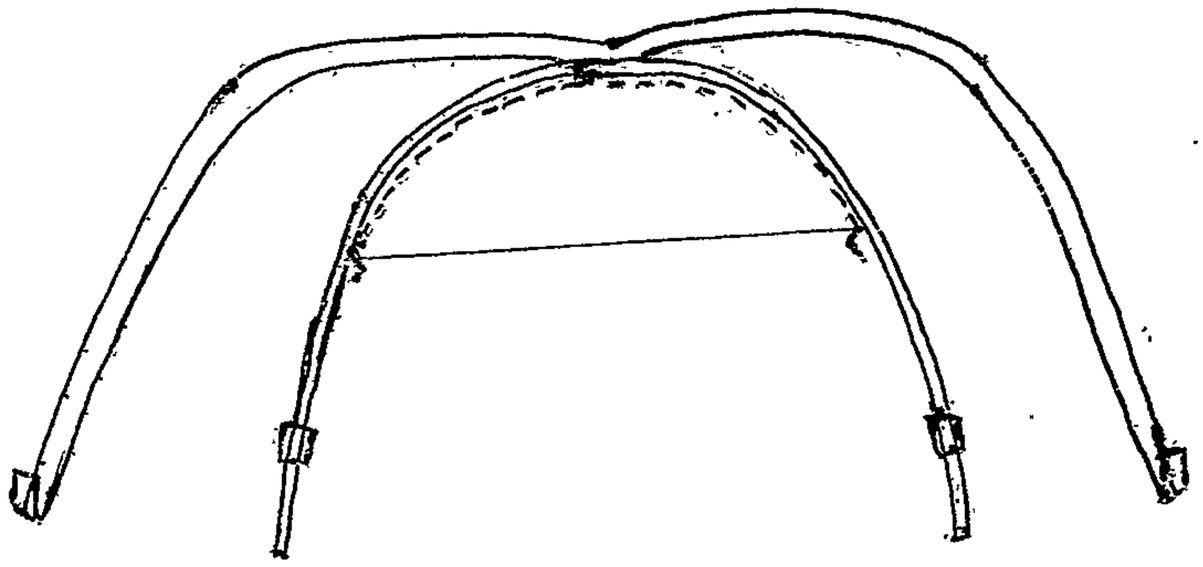


FIG. IV

the nape of the neck. (See fig.III).

The double bow arch is now ready to receive any alterations which may be necessary for it to carry out its specific task e.g. if the extra oral appliance is being issued to the patient with the aim of exerting distal pressure against the six year molar teeth, then the inner dental bow will need stops soldered to the arch just anteriorly to the molar tubes, so that the arch in the anterior region is standing away from the incisor teeth approximately 3 to 4 millimetres. There are several modifications to this extra oral appliance which are mentioned and favoured by a number of writers on this subject, e.g. if pressure is meant to bear on the anterior teeth, then the stops on the inner dental arch are so positioned that, when it is pressed against the molar tubes, the arch is almost pressing on the anterior teeth. Another means of achieving the same effect of pressure on the anterior teeth, as well as some distal force on the molar teeth, is to have small hooks soldered on the inner dental arch slightly distal to the canine teeth; elastic bands can then be stretched from these hooks to be attached to the corresponding hook on the other side of the arch, and consequently bring pressure on the anterior teeth. Care should be taken that the hooks are positioned distally enough, so that the rubber band is pulling in a distal direction and not just in a flat direction across the anterior teeth. (See Fig. IV) Other modifications of the extra oral appliance will be discussed later in this section.

Next to be discussed is the direction of force resulting from the extra oral, and how to vary this force in intensity and direction.

UNILATERAL FORCE.

The appliance previously described by Kloehn [47] results in force being distributed equally to each side of the maxillary arch. The condition of course, being, that the arms of the inner bow pass freely through the molar tubes and also without obstruction, and that the arms of the outer facial bow will be symmetrical when in position in the patient's mouth. However, happily or not, all malocclusions which might warrant treatment by the extra oral appliance do not show a similar condition on each side of the arch. In other words, it could be the situation which arises in Class II Division I sub-division cases where the treatment will involve distal movement on only one side of the arch; in other words, distal force has to be exerted by means of the head gear on to one six year molar tooth, while pressure on the other side of the arch is almost negligible.

Several articles have been written on this aspect of extra-oral force, that is, achieving some form of unilateral action. Some of the early articles by Closson [18] in 1950, Baldridge [3] in 1953, Block [7] in 1954 advocated a far different method of achieving this unilateral effect from more recent articles by Haack and Weinstein [31] in 1958 and Drenker [19] in 1959. The later day articles contradict the early articles on purely mathematical grounds and with numerous equations which are a little puzzling to a dental mind, but prove that their method must be the correct one as far as achieving this unilateral effect. However, it does seem a little perplexing when it is realized that these earlier authors, who have been proved so wrongmathematically, are still able to produce cases showing where their methods have achieved some unilateral force and corresponding uni-lateral response.

FIG. V

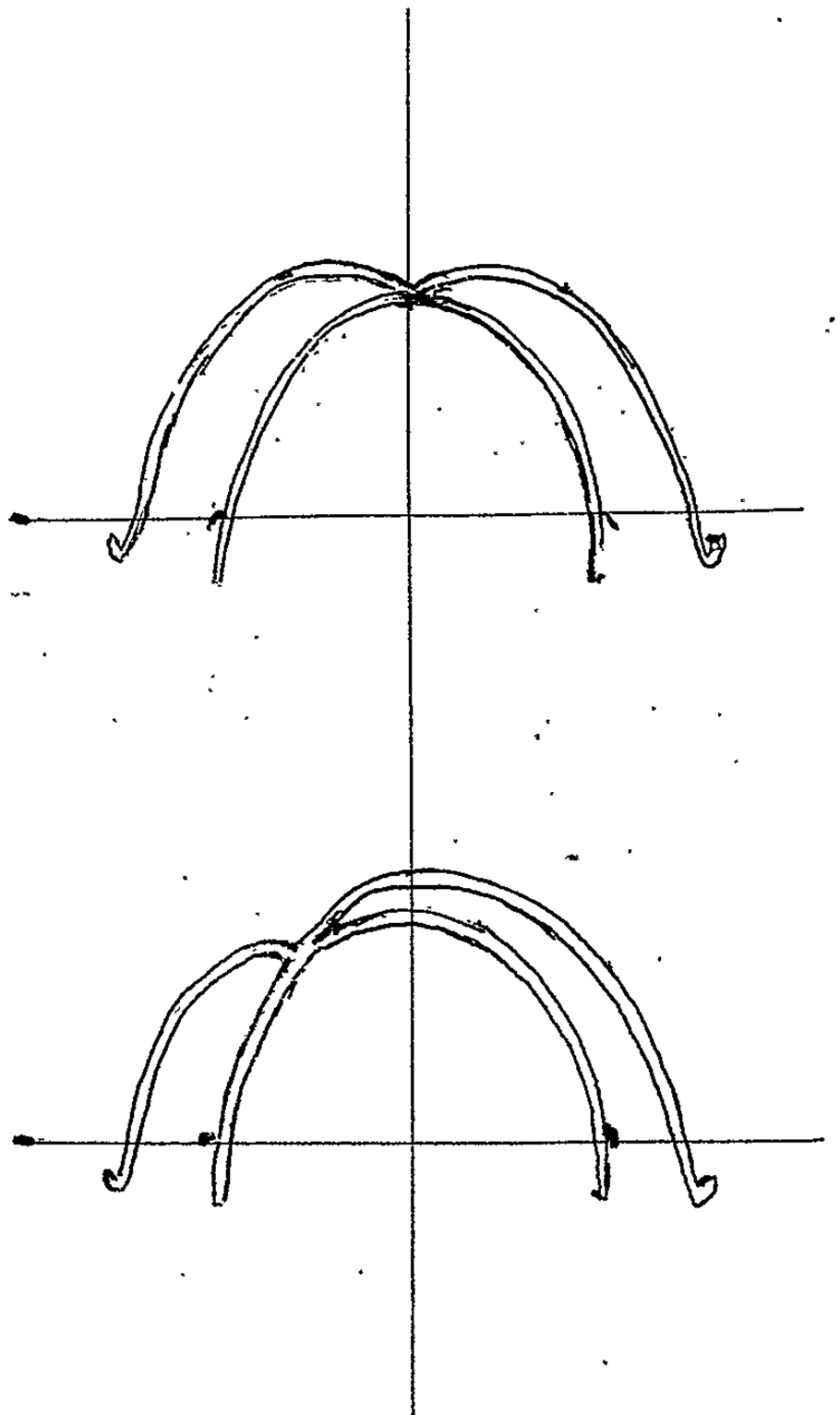


FIG. VI.

FIG. VII

Baldridge,[3] who was mentioned as having written one of the earlier articles in 1953, is seen again in 1961 in the Angle Orthodontist[37] in which he reviews his position as to the method used in achieving this extra-oral unilateral effect, and offers some reason why the earlier methods obtained successful end results by unwittingly using methods which are suggested by later writers Haack and Weinstein and Drenker.

Block,[7] in 1954, wrote an article in the Angle Ortho. on an analysis of mid-line and off-centre extra oral force. The extra-oral force is supplied by three appliances:-

1. The normal bi-lateral extra oral appliance (see fig. V)
2. The conventional unilateral appliance(see fig. VI)
3. After the design suggested by J. Williams Adams (see fig. VII)

Block used an experimental set up to illustrate his points and he found "force distribution was equal on both sides with the mid-line gear. The conventional off-centre design demonstrated a resultant in differentials, the greater resultant being produced on that side corresponding to the off-centre attachment on the face bow of the labial arch. The Adams type of off-centre appliance produced similar distribution in a relatively greater intensity than the conventional off-centre type."

Haack and Weinstein,[31] in their article in the Am.J.Ortho in 1958, discussed the mechanism involved when the fixed attachment on the face bow of the arch wire is off-set on one side, in the hope that such an attachment will distribute more force on the molar closest to the face bow-arch wire attachment. In other words, they are discussing extra oral appliance suggested by Block in 1954 in the hope of achieving unilateral effect.

In the analysis of the forces involved, Haack and Weinstein

showed that "forces induced by the elastic strap are equal and symmetrical with reference to the mid-line of the head, and also the reactive force on the molars would be equal." "In a statically determinate problem, the internal configuration of a rigid body does not affect the distribution of the external forces on the body. Hence, no matter where the rigid attachment of the face bow to arch wire is placed, as long as the applied forces on the cervical region are symmetrical with respect to the mid-sagittal plane, the reactionary force on both right and left molars will be equal".

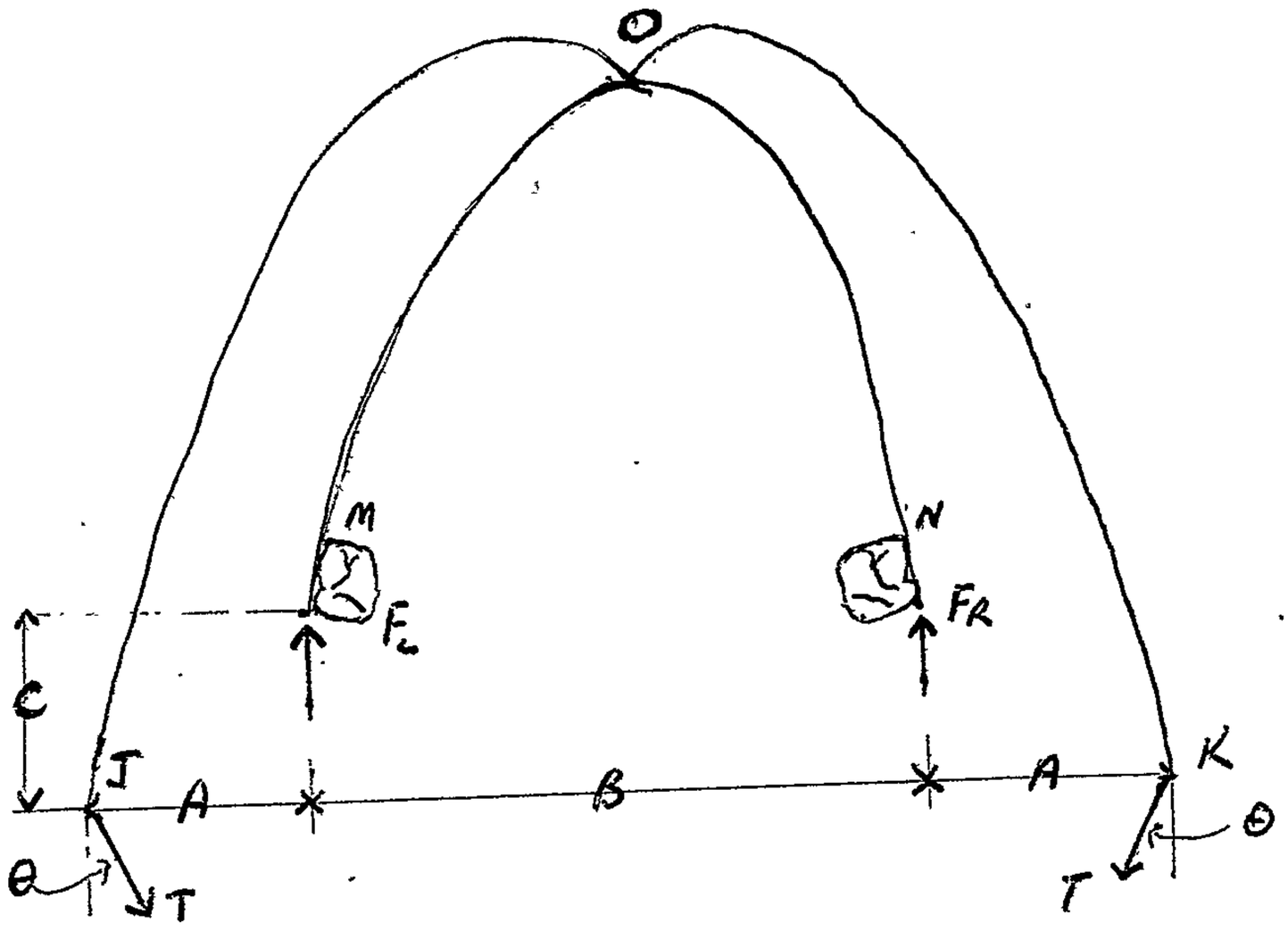
This statement is later supported in the results, tabulated further on by Baldridge in 1961 when tests of two different types of unilateral appliances were carried out.

Drenker, in the Angle Orthodontist in 1959, best explains the more modern approach to unilateral extra oral appliances "There exists a lack of understanding regarding the production of unilateral cervical traction with the Kloehn extra oral mechanism. The present method of off-setting the joint between the extra oral bows is not theoretically correct unless the joint is knife edged. Instead, the aim is to alter the position of the lines of action of the applied forces so that the line of action of the resultant lies closer to the molar against which greater force action is desired" (See Fig.VIII).

The arrows are vectors which signify the magnitude of directions of the applied force acting in the plane of the mechanism.

"The T vectors represent the pull of the cervical strap, and since the strap is continuous, the forces at J and K are equal in magnitude. The vectors F_l and F_r represent the reactive

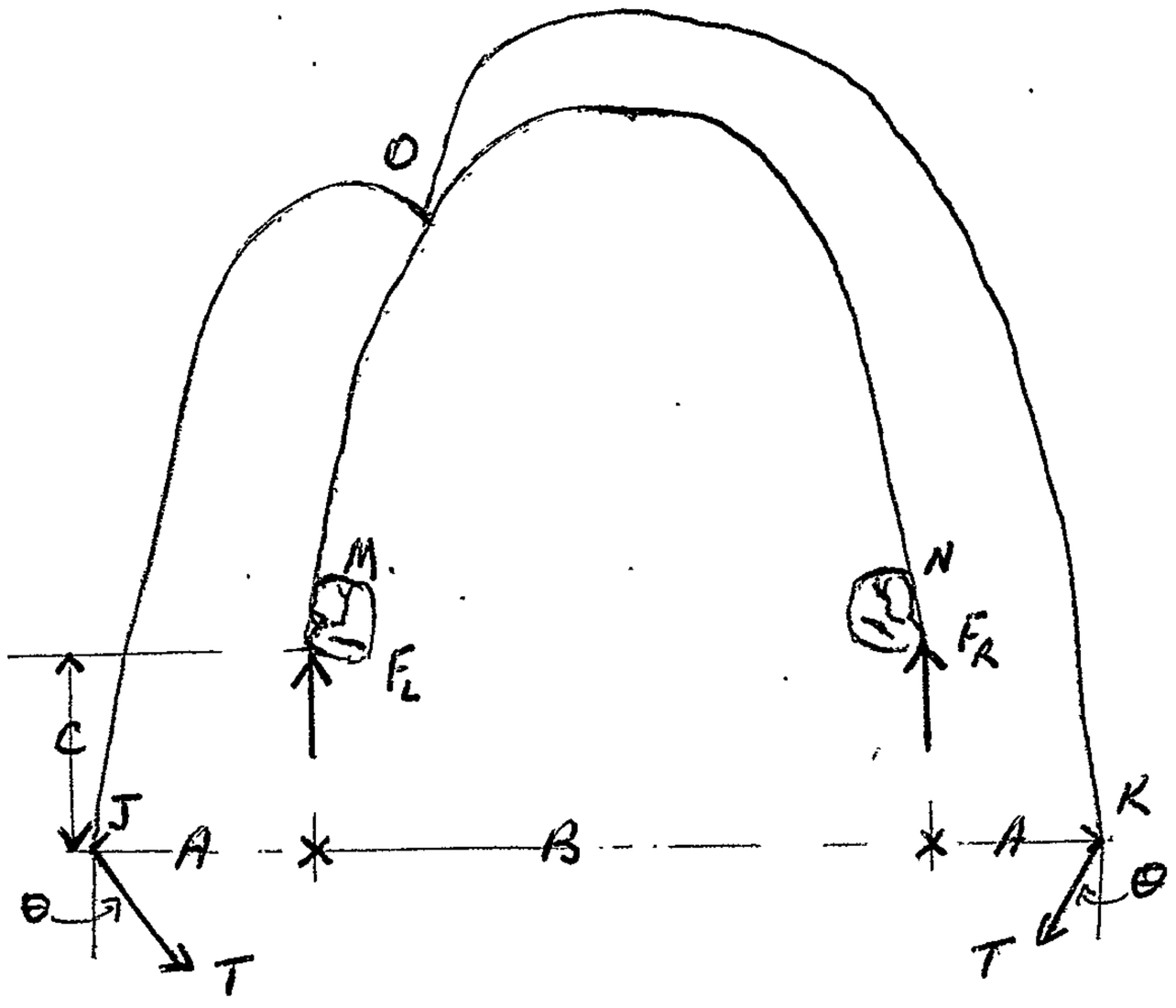
FIG. VIII



Plan view of a Kloehn extraoral mechanism. Points m and n enter buccal tubes. A cervical elastic strap is attached to points j and k.

FIG. IX

The joint at 0 between the oral and extraoral bows has been offset to the left from its central position shown in Fig. VIII.



forces exerted by the buccal tubes against the oral bow. Since the action and re-action are equal, the oral bow exerts F_l and F_r against the buccal tubes, and throught these, against the molars. Physical conditions which must be satisfied to produce static equilibrium of the appliace are:-

1. "The sum of the forces parrallel to F_l and F_r must be zero."

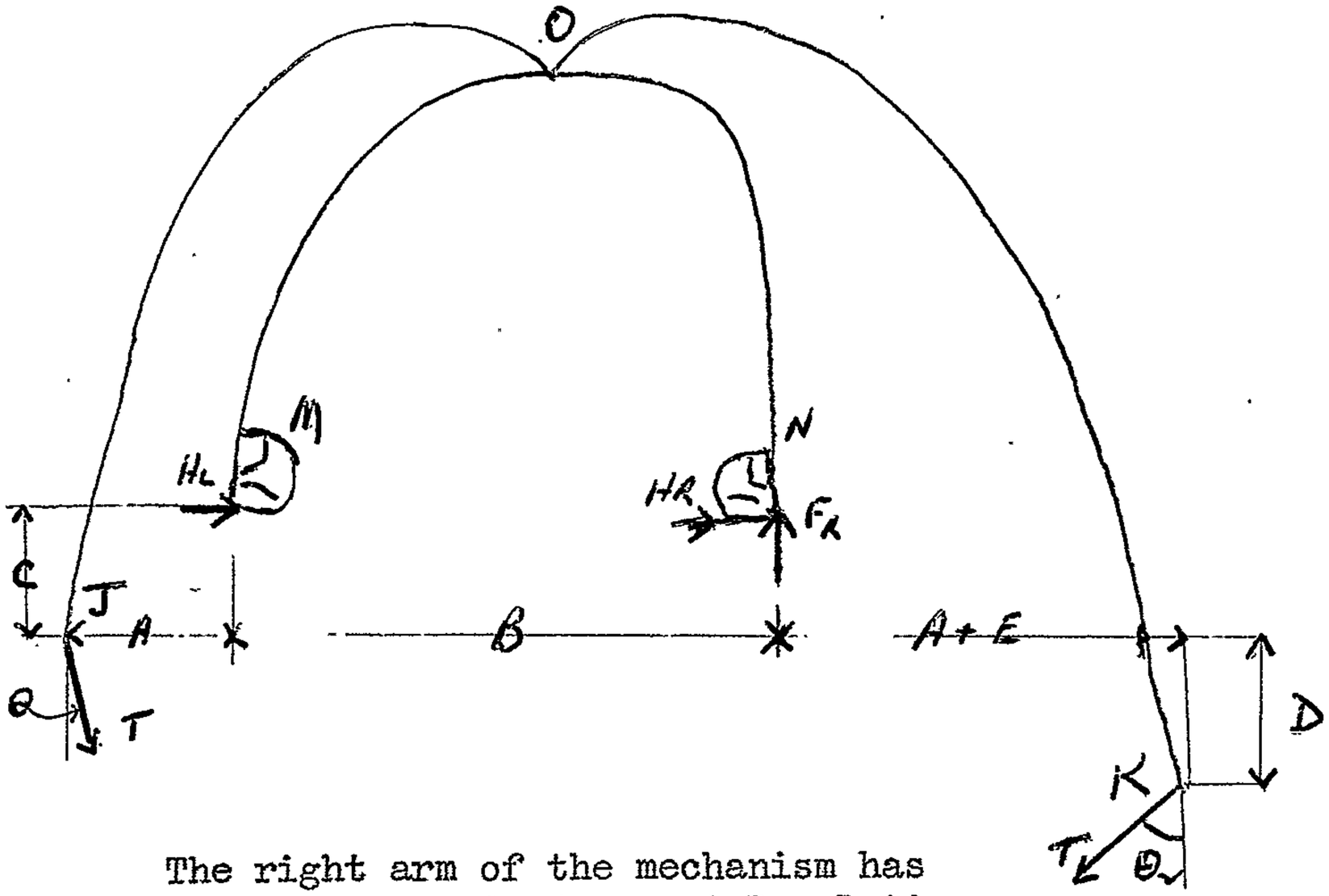
2. "The sum of the moments of the forces about any point in the plane of the forces must be zero."

Drenker[19] continues, "The location of the join at 0, on the other hand, does not enter into either condition. This joint is invariably soldered, welded or banded and it must be considered as being rigid. Since this joint is rigid, it does not represent a point where external forces are applied. In other words, the extra oral and oral bows comprise a single unit, and the location of the union between them has no significance as fas as external force action is concerned." "In any force system attention must be focused on the magnitude of the forces along their respective lines of action." (See fig. IX) This is in complete agreement with the conditions layed down by Haack and Weinstein.[31]

This (fig IX) illustrates one of the former extra oral mechanisms from which was claimed a unilateral effect. Here the appliance has been altered by off-setting the joint to the left. According to Drenker[19] "Inspection however, will reveal that this procedure has not altered any of the lines of action of directions, or magnitudes of the applied forces. Equilibrium equations would be exactly as before with the result that F_l and F_r must be equal."

Finally, Drenker[19] illustrates mathematically how to achieve unilateral force. (see fig.X). Basically it involves increasing A to A plus E and making the arm on that side longer by an amount represented by

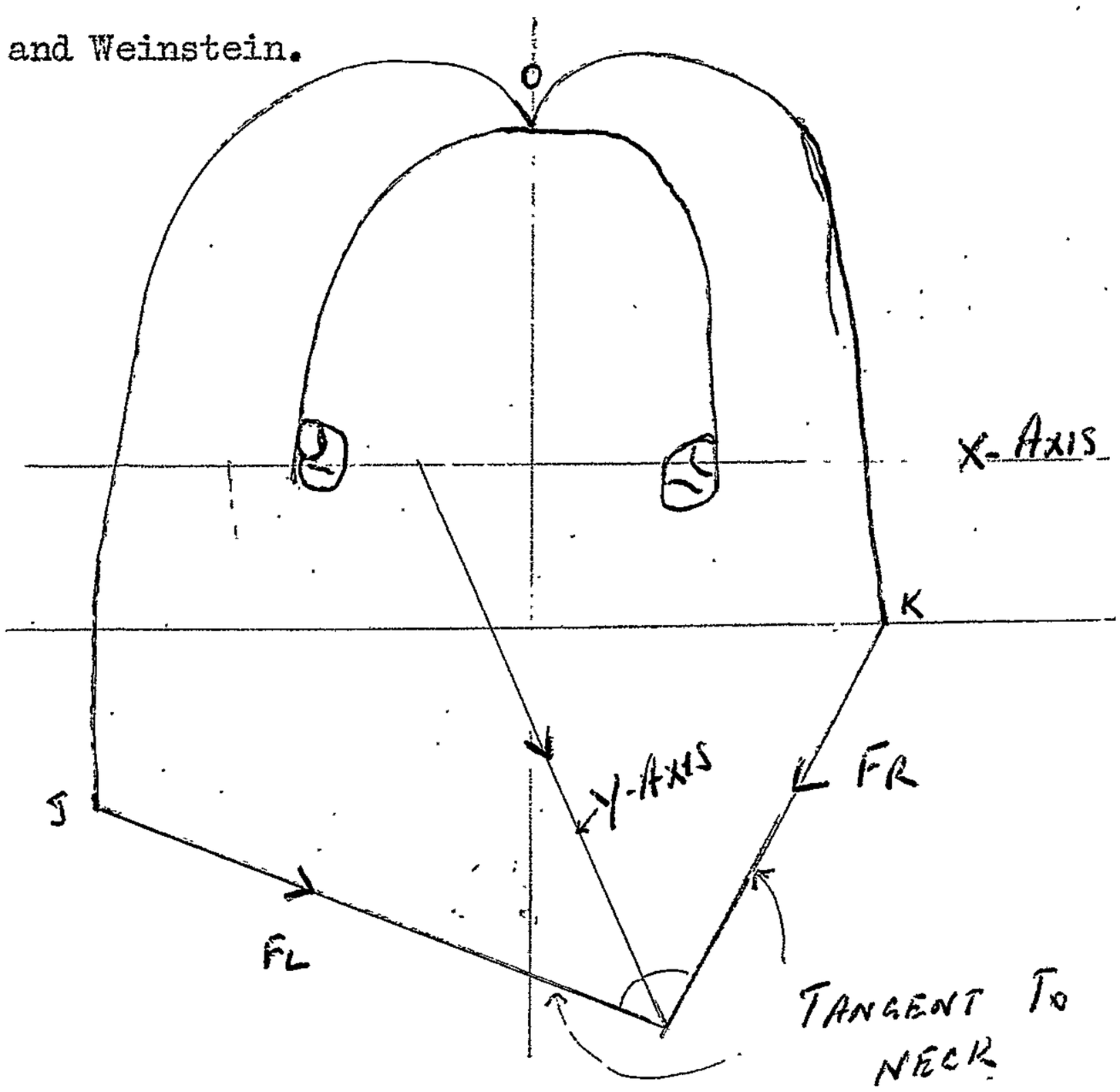
FIG X.



The right arm of the mechanism has been lengthened an amount D relative to the left arm. Point k is displaced to the right an amount E.

FIG. XI.

After Haack and Weinstein.



D. This appliance is similar to the one suggested by Haack and Weinstein[31] in their article in 1958 where they say, "The prime consideration then in the design of an appliance for eccentric cervical traction is one in which the geometry of the angle formed by the ends of the elastic strap, tangent to the neck, is such that the bisector of that angle passes closer to the more anterior molar than the other." "The optimum ratio of forces on the molars might be 2 to 1, for if the resultant force F crosses the X axis too close to one of the molars, it could reduce the force on the other molar to a point where there would be danger of inadvertently disengaging the arch wire from the tube."- Haack and Weinstein.[31] (See Fig. XI)

It is difficult to see how this disengaging would occur, if the inner arch has stops against the molar tubes. It could perhaps happen if the appliance was too flexible, but not with .045 mm wire. If there were no molar stops on the arch, then one arm could keep passing the molar tube on the greater force side until disengagement occurred from the opposite tube, but then stops are necessary to transmit the distal pressure to the molar tooth .

The only other way would be for the molar tooth to be moved so far distally on one side that it would enable the appliance to become displaced. That would be tolerated by most orthodontists.

It will be noted that these articles i.e. Haack and Weinstein[31] and Drenker[19], in the diagrams recommend that the arm on the side of the molar to be moved, should be further from the cheek than the arm on the other side. This fits in very well, both in the diagrams and mathematically, to help produce a greater force effect on that side. However, the problem that arises in this appliance in actual clinical use is when the patieht, on inserting the appliance and connecting the rubber

bands, unless the outer facial bow is made of extremely rigid material, will find it must be flexible enough to bend back against the cheek in exactly the same position as the shorter bow on the other side. This would automatically cancel out any effect of having the distance A increased to A plus E. Both articles recommend that the diameter of the wires can be increased for greater rigidity. The arch wire could be increased from .045" to .055" and the face bow increased to .075". Haack and Weinstein[31] say that .075" face bow is approximately five times as stiff as.050. However, it is still doubtful if, even with this increased rigidity on the part of the outer arm, whether it would minimise the error from the source when the patient lies on that side in bed.

It would seem that in constructing this unilateral extra-oral, and attempting to achieve the unilateral effect solely by means of having one arm wider from the molar teeth than the other, the operator is caught between two evils, first, if the outer bow is not rigid enough, the elastic bow and also the patient lying on it in bed will push it back in against the cheek in exactly the same position as the outer bow on the other side and secondly, if the outer bow is made rigid enough to even withstand the pressure of the head resting on it in bed, let alone an elastic band, then the problem must surely arise of the appliance being too hard to operate and insert by the patient.

Baldridge,[3] in 1961, describes the unilateral effects he achieved in 1953 as being probably due to the arms on the off-set side being wider from the mid-sagittal plane, than the arm on the other side. This it seems was a fortunate co-incidence. Baldridge[3], in 1961, tabulated some interesting results from measurements which were carried out on one particular patient when both the usual E arch and off-centre

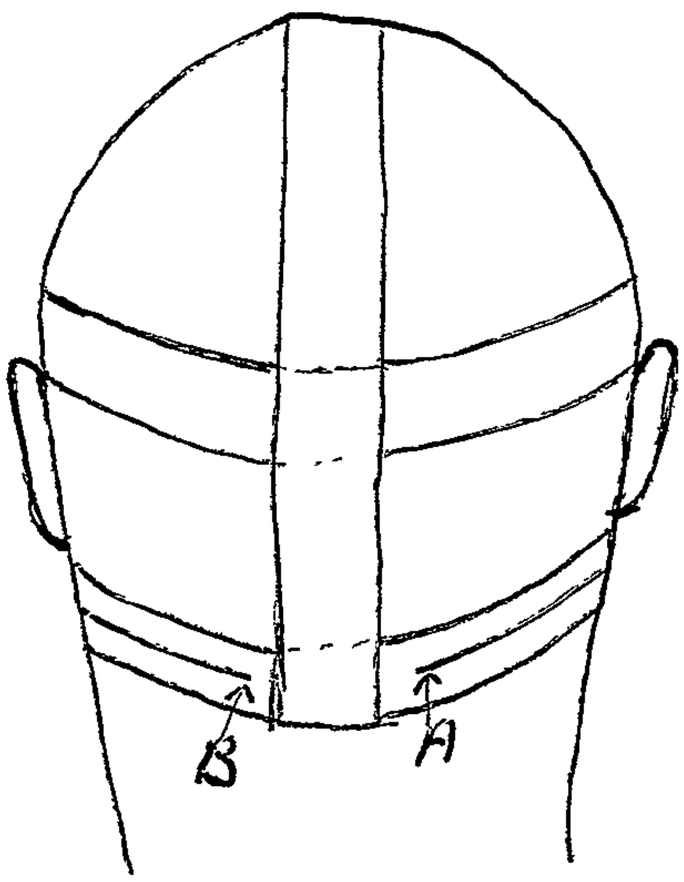
Pull on Cervical Band	.014 Spring Wire length 10 mms		.016 Spring Wire length 12 mms		.018 Spring Wire length 12 mms.	
Symmetrical Arch Bar	Right in mms	Left in mms	Right in mms	Left in mms	Right in mms	Left in mms
1 lb., Arms Even	7.0	7.0	11.0	11.0	11.0	11.0
1" longer on left side	6.5	5.8	11.0	10.3	11.1	10.0
2 lb., Arms Even	6.2	6.2	10.1	10.1	11.0	11.0
1" longer on left side	6.5	5.8	10.5	9.5	11.5	10.5
2 lb., Arm $\frac{3}{4}$" wider on left						
Arms even	7.2	5.5	10.5	9.6	11.0	10.2
1" longer on left	7.1	5.3	10.5	9.5	11.2	10.0
2 lb., Arch Bar $\frac{1}{2}$" off-centre			9.5	9.5	10.0	10.0

arch were used. His method was to place coil springs between stops on the .045 arch and the molar tubes, a cervical elastic was the source of traction, the compression in millimetres of the coil spring was the indication of how the force was being distributed. The .045 arch was thinned down and lubricated to prevent any friction on the molar tubes. See table - this table illustrates very clearly the various forces which can be directed against molar teeth on one side of an arch with uni-lateral appliances; as is seen, the former accepted unilateral appliance, the off-centre arch, does not have any difference between the forces acting on the molar teeth. Baldridge also found that, when one arm was bent laterally, it needed to be greater in diameter than .059 of an inch, rather .070 or .075, in order to help it maintain its lateral bend. All the findings in Baldridge's[3] report support the statement by Haack and Weinstein[31] and Drenker[19] on the appliance construction.

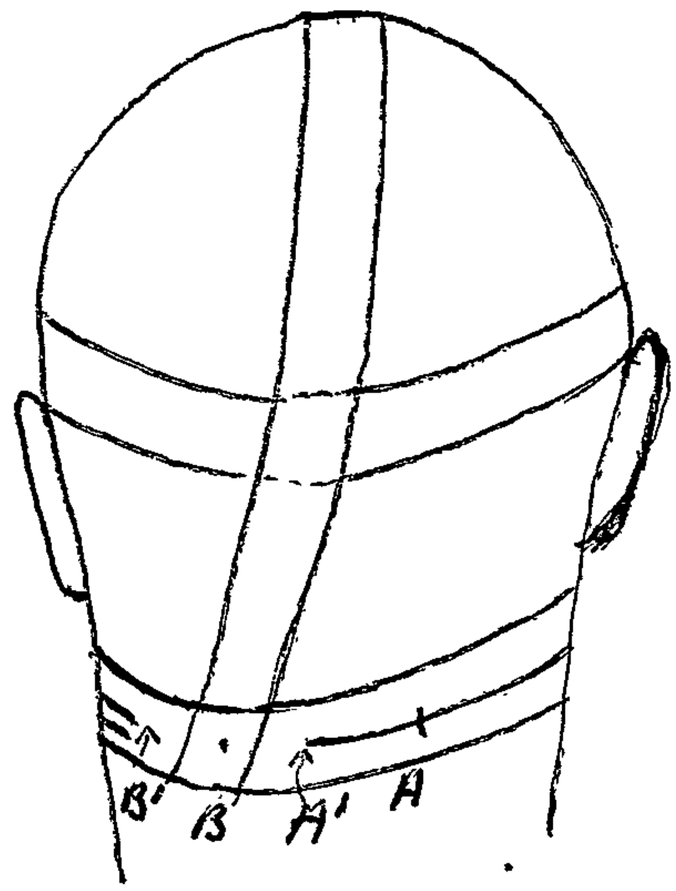
The actual making of a simple extra oral appliance, and secondly, what alterations are needed to the different members or member units of the appliance in order to change the application of the force exerted by the appliance has now been discussed. The standard extra-oral appliance is one in which half of the appliance, and this half includes both facial bow and the inner dental arch, is symmetrical with the other half. Also considered is an appliance in which the facial bow is first, longer on one side than the facial bow on the other, secondly, is wider from the mid-sagittal plane on one side than the other and finally, both longer and wider on one side than the other.

Block,[7B] recommends the use of double elastics on one side to achieve uni-lateral force. However, this seems unlikely to give a satisfactory result. (See fi. XII)

FIG. XII



SINGLE ELASTIC



DOUBLE ELASTIC AT

When double elastics are used on the left side attached to hooks at B, and at A on the right side, then because of the softness of the head-cap cloth, the hooks will move to new positions B' and A'. Clinically then, double elastics on one side approximate one and a half elastics on each side.

If the headcap was perfectly rigid, then agreaterforce would be experienced on the double elastic side. However, such a headcap would be impractical from the point of patient comfort and management.

Next to be considered is an extra oral appliance where the arch wire or the inner dental bow and the face bow are in a different plane. The standard extra oral appliance described earlier is one in which the two bow units should lie in the same horizontal plane, and the pressure is at right angles to the molars and maintains them in their existing axial inclinations. According to Kloehn[48] "if the face bow lies close to the lower border of the mandible and below the arch wire when hooked on the cervical strap, it causes a distal tipping of the maxillary molars. If the face bow lies above the arch wire it results in a distal root movement of the molars."

This manipulation of the face bow according to Kloehn[48] gives the extra-oral appliance its third variation in force control. This property of the extra-oral appliance, namely that it can be adjusted so that force can be distributed equally on each side of the arch, or if preferred, with greater distal force on one side than the other and finally so that distal crown tipping or root movement can be obtained, is one reason for its popularity, particularly in deciduous and mixed dentition cases.

So far the only force to be considered or to be examined

COMPONENTS OF FORCES USED TO EFFECT DISTAL MOVEMENT OF UPPER TEETH.

	Elastic Tension Applied ozs.	Useful Distal Driving Component.	UNDESIRABLE COMPONENTS OF FORCE. Mesial Lower Molar	Rotational Lower Root Ends	Upward Lower Molar	Downward Inter-Maxillary Hook	Rotational Upper Root Ends.
Intermaxillary Elastics	2.8	2.7	2.7	3.8	0.6	0.6	5.75
Mouth Closed	4.0	3.9	3.9	5.4	0.9	0.9	8.4
Intermaxillary Elastics Mouth Open	4.0	3.0	3.0	4.1	2.6	2.6	13.7
Headgear With Traction Bar	4.0	4.0	None	None	None	None	5.46

has been the distal driving force exerted by the appliance: however, it is now necessary to examine whatever might be the undesirable forces, or what might be called the side effects of the extra oral appliance; also, to compare the side effects produced by other appliances which achieve in some cases the same end result e.g. intermaxillary elastic traction for the reduction of protruding upper anteriors instead of by means of an extra oral appliance.

Bien,[4] in 1951, investigated this aspect of force control and has carried out and tabulated his results in regard to extra oral appliance and also to inter-maxillary elastics. His measurements of inter maxillary elastics were carried out with the mouth closed and the mouth opened. (see table).

Bien[4] concluedes "from the point of view of efficiency, it would appear that there is very little to choose between the inter maxillary elastics with the mouth closed and the head gear. However, when undesirable displacement forces are analysed, there appears to be an enormous difference in the efficiency." In discussing the deleterious forces acting on the upper molars with inter maxillary elastics, Bien[4] says there is "a downward displacement force transmitted through the upper appliance from the hook, and the rotational force at the root ends. There is no downward pressure with the head gear, unless the head gear is improperly designed."

Bien[4] concedes that the rotational force at the upper root ends is present with all appliances; however, he makes no mention of being able to vary the force effect by raising or lowering the face bow as claimed by Kloehn[48] and other authors. Also Bien,[4] in his analysis of the components of forces resulting from distal movement of upper teeth, only considers the extra-oral in its relation to a direct distal force on the molar teeth.

He does not consider the extra-oral appliance in its role of providing extra-oral anchorage to the upper arch, and such an extra-oral which hooks into the maxillary arch between the lateral and the canine teeth with the cervical strap, must produce some downward component of force in the inter-maxillary hook area.

Thus it can be seen that while in some cases the extra oral appliance, either the Kloehn type appliance, or the extra oral modified for anchorage purposes to an upper maxillary arch, may be the ideal mthod of obtaining force and pressure on maxillary posterior teeth, or providing anchorage to the maxillary arch, in all cases of its use, there should always be consideration given to what side effects the extra oral appliance will have on either the molar teeth or the anterior part of the maxillary arch.

FORCE TO BE APPLIED.

The next aspect on the mechanical side of extra oral appliances to be discussed will be the amount of force which is required for a certain treatment plan, and also the length of time that is required for this force to be applied to the teeth or maxillary arch.

Kloehn[48], in 1953, in the Angle Ortho, says "The amount of pressure from the elastics is determined by the patients reaction, pain being the indicator to decrease pressure. Patient tolerance in my office varies from three quarters to one and a half pounds. These elastics must be changed twice a week to maintain constant pressure."

In the same article Kloehn[48] stresses the importance of the appliance being worn seven nights a week and an attempt being made to have the force of the appliance in use for between 10 and 12 hours per night.

Closson[18], in 1950 in the Am.J. Ortho., is no more definite than Kloehn on the amount of pressure which should be used - "There is no set rule as to how much pressure should be applied from the elastics, what appears to work advantageously for one patient may not be correct for another. As a general rule, a light elastic with a rather long pull, is better than one which is heavy with a short pull. The force must be varied with the age of the patient and the tissue response." Closson[18] does not say though whether the younger the patient, the less the pressure, or vice versa, nor does he say that if no movement is seen after 4 to 6 months, for example, whether the pressure should be increased or decreased.

Later in the same journal Closson[18], discussing the effect of the use of the extra-oral appliances, says "Spacing between the molars and pre-molars is the result of excessive force from the elastics." If

distal movement of the molar teeth was the result wanted, then spacing between the molars and pre-molars would seem to indicate that the treatment is going through on a regular course with a desired result.
18
However, Closson feels that this is not correct, that the pressure should be light enough and the force intermittent and light enough on the molar teeth for the drag of the inter-septal fibres of the periodontium to bring the premolar teeth distally at the same time as the molar teeth, and not to cause a separation. Other writers use this spacing between the molar and premolar teeth as an indication of the success of their treatment.

Poulton,[60] in the Angle Ortho., in 1959, makes no mention of what pressure he uses with his appliance, but does stress that the patients were instructed to wear their appliances on a minimum of 12 hours a day.

[3] Baldridge in 1961, when doing clinical tests on the efficiency of different extra oral appliances, both mid-line appliances and extra-oral and unilateral appliance on the one patient, carried out the tests using pressures of on pound and two pounds. This would seem to indicate, together with Kloehn's experience, that the pressure will vary from three quarters of a pound to a maximum of two pounds. Although it was noted before that Closson[18] recommends a different pressure according to the age of the patient, it could be assumed that he intends that the younger the patient, then the less the pressure should be on the extra-oral appliance. In support of this conclusion, on behalf of Closson, the observations made by Oppenheim[58] as far back as 1930, when he attributed the success of his head gear therapy to the application of light intermittent force should be kept in mind.

APPLIANCE MODIFICATIONS AND ACCESSORIES.

One of the great advantages of the extra oral appliance is that it is an appliance therapy which can be adapted to several modifications, and with these modifications can be used under different sets of conditions. Most of the cases quoted by Kloehn[48] in his 1953 article, wore a platform during the day -"The bite-plane unlocked occlusion, stimulated vertical growth to decrease overbite, and permitted maximum mandibular growth." Graber [29] has also recommended the use of the platform in conjunction with the extra oral on cases presenting with a deep overbite problem. Nelson [56] in the Angle Ortho. in 1953, when faced with a similar problem, does handle it in a slightly different manner by banding the anterior teeth.

Several writers Nelson,[56] Kloehn,[48] Block [7] etc. give the extra-oral appliance two different, but definite, force actions during its use when the molar cusps are long and the fossaæ deep. These writers all recommend giving the outer face bow a definite downward tilt towards the lower border of the mandible which will bring about a distal tipping of the molar crown, and once the molar crown has shown this movement, the arms of the face bow are corrected as described earlier, so that the axial inclination of the molar teeth is then corrected. However, in spite of these seemingly cures for the deep overbite problem, care should be taken that the extra oral appliance for distal movement of six year molars is not used in cases which have a severe overbite, otherwise the operator may find himself in the position of Newcombe [57] who, in the Angle Ortho. 1958, admits that while, he once assumed that "extra-oral force alone, or with a bite plate was capable of correcting many class II division I malocclusions," his experience in treating these malocclusions in the

mixed dentition has been disappointing. This has led him to being more critical in selecting patients for extra-oral use or theraphy.

When the extra oral is being used for the treatment of a non extraction case of Class II, Division I, on the upper arch, as will be seen later in another section, it is necessary that the patient have a good in tact lower arch. Therefore, if there has been loss of deciduous molars or danger of losing existing arch length in the lower, then a lower lingual arch can be used in conjunction with the upper appliance. Closson [18] uses the lower lingual arch for another purpose - "It may be necessary to stabilise the mandibular anterior teeth with the lingual arch when the lingual incline planes of the maxillary anterior teeth begin to ride the mandibular anterior teeth as the maxillary arch is moved distally."

So far the greater part of this discussion has been to do with extra-oral appliances and their effect directly against six year molars. However, the extra oral appliance finds almost as much use in conjunction with band therapy as it does on its own. Nelson [56] uses the extra-oral appliance on the six year molars in conjunction with bands on the premolars or canines, which ever are necessary, and arch segments; he then has rubber elastics stretched from the molars to either the canines or premolars for distal movement of these more anterior teeth. However, these rubbers are only worn when the extra oral is in position; as a precaution, it would be best to have the rubbers extend from the ends of the extra oral as they protrude through the buccal tubes on the molar teeth, rather than have the rubbers extend from a fixture on the molar bands; this would ensure and prevent rubber bands being worn during the day without the use of the extra oral. If the extra oral is not used, there would be an eventual

loss of anchorage in space in the arch.

Closson,[18] in deciduous and mixed dentition cases, uses as anchor teeth the deciduous second molars - "The wedging action of the deciduous second molars when moved distally against the maxillary first permanent molars is most desirable; the axial position of the permanent first molar is not disturbed if the pressure is not excessive, and also there is no danger of causing decalification of the permanent molars." "Another reason for banding the deciduous second molars", Closson [18] says is that "quite often the incomplete root formation contra-indicates placing a direct force on the first molars at an early age." The usual indication when an extra oral can be placed on six year molar teeth, is the eruption progress of the upper lateral teeth which usually have completed their eruption about the time of the completion of root formation in the six year molar.

Poulton,[60] in 1959, is another writer who uses the extra or al appliance in conjunction with band therapy. -"the intra-oral appliance consists of bands with edgewise attachments placed on the upper first permanent molars and the four upper incisors. .021X .025 arch wire was used with hooks for attaching the head gear distal to the central incisors." Poulton uses the edgewise arch in order to have torque control over the upper incisors. The edgewise arch gives active lingual root torque in the anterior region, in order to move the anterior teeth with as little change in the axial inclination as possible. This lingual tipping of anterior crowns will be discussed further in another section.

Little mention is made in British Dental Journals about the extra oral appliance therapy so it is interesting to read Morris,[53] in the Dental Practitioner 1961, describing a technique of retracting upper buccal

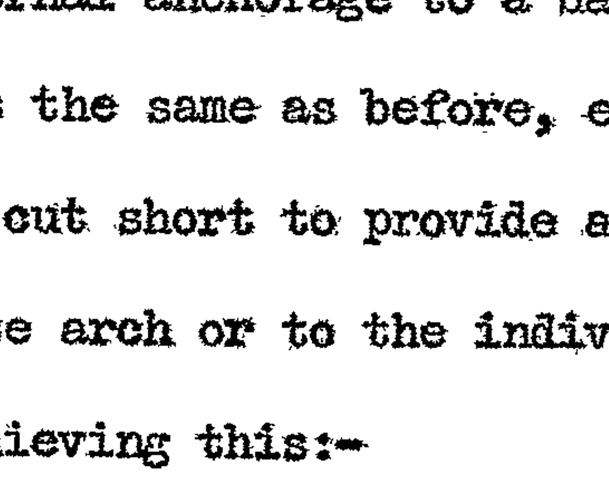
segments with the aid of removal appliances which are supported with an extra oral. The extra oral consists of :-

1. "a length of polythene tubing of one centimetre bore measured to the patients requirements.
2. two pieces of one millimetre stainless steel wire bent at both ends to hold the rubber band and for attachment to the appliance.
3. one elastic band no. 32."

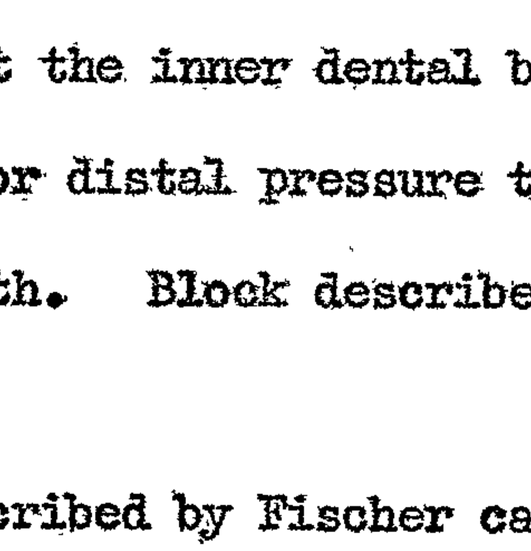
To receive the extra oral support the U bend is placed in the cross-over labial bow of the removable appliance just before this bow crosses over the mesial contact point onto the upper canine into the acrylic. This combination of extra-oral force with removable appliances is another example of its great variety of uses.

Block,[8] in the Angle Ortho. in 1962, devotes quite a deal of space to the use of the extra oral in a supporting role or as a source of external anchorage to a banded maxillary arch. The principle of the arch is the same as before, except that the inner dental bow is modified and/or cut short to provide anchorage or distal pressure to either the complete arch or to the individual teeth. Block describes two techniques for achieving this:-

1. "A sliding split tube as described by Fischer can be placed at any point on a round or edgewise arch and made to act against stops or brackets."



Fischer Split Tube
Fig. XIII



Lasher Fork
Fig. XIII

The split tube (see fig. XIII) is soldered to that part of the inner dental bow which lies ajacent to the arch wire. When this tube is applying pressure to stops on a arch, it moves or holds the complete arch wire, when applied to a bracket, it will move or support the individual tooth. Block's [8] second technique is "the substitution of a Lasher fork, in place of a split tube, which allows for ease of positioning on the arch wire in those instances of extremely limited inter-bracket space along the arch." (see fig. XIII).

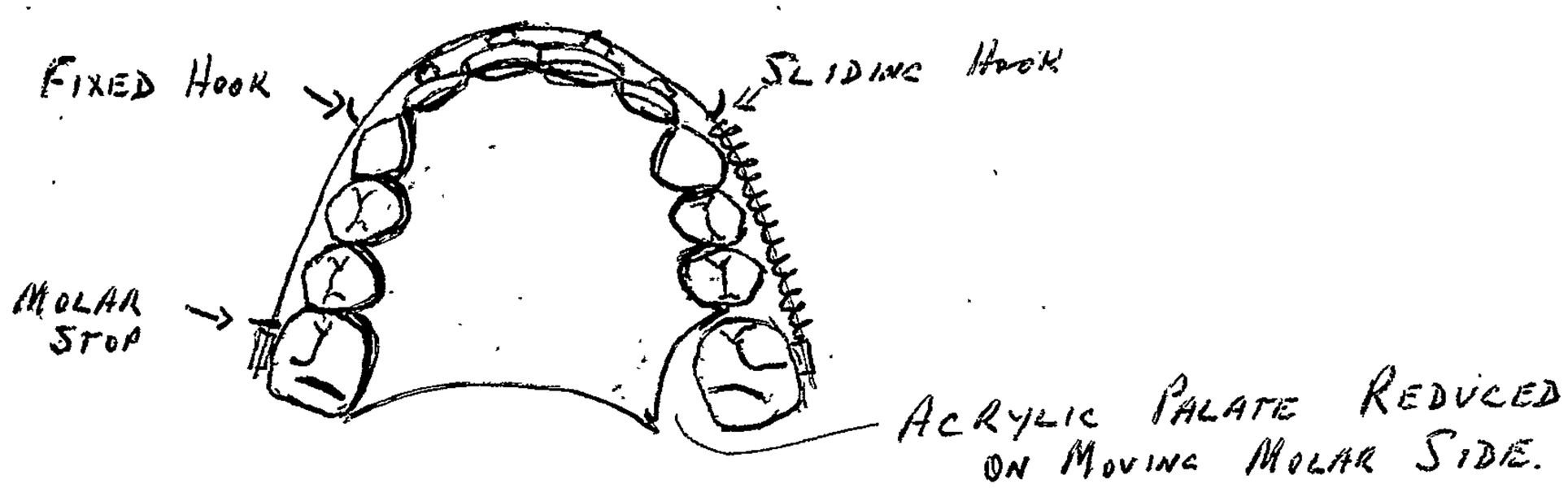
The Lasher fork can also be attached to the extra oral to fit between the two central teeth across the arch wire. This prevents too much play in the extra oral in an upwards and downwards motion when in place at night. While more space between teeth or brackets is needed for the use of the split tube appliance, it does seem that the split tube would give more positive and more direct pressure against individual teeth than would the Lasher fork arrangement. Another advantage of the extra oral in such a use, is the fact that it can be used to apply pressure to non corresponding teeth simultaneously, e.g. an upper left first premolar and an upper right second premolar.

Block [8] makes mention of many modifications to the extra oral appliance in this article. Some of these modifications have been suggested earlier and some of them do seem to be rather complicated for the localised effect they will achieve in the mouth. As mentioned earlier in those cases of rather long cusp formation and deep fossae on the six year molar, Block [8] suggests a high pulled head gear which will produce distal tipping of the molar crown. This technique has already been suggested previously by Kloehn [48] in 1953, Parker [59] in 1958.

To prevent upper bicuspids erupting in buccal cross bite,

FIG. XIV.

BLOCK UNI-LATERAL APPLIANCE.



Block [8] suggests a lingual bend in the E - arch in the bicuspid area; however, perhaps this bend or correction in the arch and subsequent pressure on the premolar teeth would make the appliance insertion more difficult for the patient, and could possibly lead to a distortion of the appliance. It is in achieving unilateral effect that Block's appliance technique appears cumbersome. It is a method incorporating the use of bands on the anterior teeth and an acrylic palate and coil spring. "The arch wire is stopped on the non-moving side, and the hook on that side is fixed, whereas that on the side to be moved is a moving type. The acrylic palate is reduced on the lingual of the molar to be moved." (see fig. XIV) This is quite an amount of appliance for the sake of unilateral movement, when compared with the appliance design suggested by Haack and Weinstein [31] and Drenker [19].

Some writers, e.g. Parker [59] in the Angle Ortho. 1958, - in order to reduce the flaring of anterior teeth, use the extra oral directly against these teeth. This is quite effective in results, but there is always the possibility of the patient being either careless or unreliable with appointments, in which case the extra oral pressing directly against the anterior teeth can cause a grooving effect on the enamel. This can be overcome, or could be prevented, by, instead of having direct contact of the extra oral with the enamel, elastic bands being used from hooks situated distally to the canine. This gives a cushioning effect of the extra oral with the necessary distal pressure on the anterior teeth.

It is felt that some of these modifications of the extra oral appliance may not be as quite as effective clinically as they are in theory, e.g. the achieving of distal tipping of the molar crown by bending the arch wire and the outer facial bow in different planes may be quite true but there is always the danger of the patient at home straightening the

appliance, fearing that he might have bent it out of position himself. However, the many modifications of the appliance listed here illustrate only too well the number and variety of situations in which the extra oral appliance can be used or adapted.

Finally the number and frequency of the patients visits will be determined by the intended action of the appliance and the co-operation of the patient. Naturally the visits of the patient using the extra oral appliance in a strictly preventive sense of maintaining six year molars in their erupted positions in the arch, will be less than the number of visits which would be required if the extra oral appliance was used in the modified form of a Lasher tube, having pressure on individual premolar teeth, where it could be expected that movement might be quicker, and consequently alterations to the appliance would be needed at more frequent intervals.

In conclusion, it can be seen that extra oral force can be applied to a dentition with the minimum of appliance construction, but at the same time there are mechanical principles to be followed and unwanted side effects to be avoided if the extra-oral therapy is to be a success.

RESULTS OF TREATMENT.

INTRODUCTION.

Since the aim of the extra-oral appliance and its use can be varied to meet different occlusions, or rather, the correction of different malocclusions, naturally, the results that have been achieved will vary in a corresponding fashion. Numerous articles have reported on the effect, good or otherwise, of the extra oral appliance, and these investigations have been centred on the events that happen to:-

1. teeth of both jaws, and not only 6 year molars.
2. the development of the alveolar bone in the maxilla and associated bone structures.
3. Development and growth of the mandible.

Unfortunately, the articles and findings in them do not support one particular result, but rather qppear quite contradictory on some occasions, and on others appear to be more interested in mathematical averages and precision in recording fine data, rather than having a broader, more clinical outlook.

Another rather disappointing feature of this review was to find that, although there is no shortage of literature available, each writer seemed to find it necessary to investigate extra oral force from an entirely new facet, and consequently, there were upwards of twenty angles and planes mentioned in all the articles reviewed. It would seem that perhaps, if more of the investigations had been duplicated by more writers, then a more definite conclusion could be drawn of the effect of the extra oral force on patients. If this was done, then surely with all writers using the same basis for their investigations, some answer may be given to the question "can extra oral force achieve distal

movement of maxillary molars ?"

With this question in mind, this section will review the results claimed by most of these writers. Firstly as regards posterior movement of maxillary molars' and increases in maxillary arch length.

Klein,[45] Poulton[60] and Fischer[22] all claim quite appreciable distal movement. According to Fischer[22] "In all of the cases, the maxillary arch was moved posteriorly, except the one in which the occipital force was applied in the intercanine area." Likewise Klein[45] (Angle 1957) found that "distal bodily movement was accomplished in the majority of cases."

Poulton[60] was even able to claim distal movement of unerupted teeth "posterior movement of upper teeth, the primary goal of treatment was well accomplished. The entire maxillary dentition, including both the erupted and unerupted teeth, was about 3 mm farther back than it would have been without treatment." Poulton is not as decisive as Klein and Fischer, but merely says that the maxillary dentition is 3 mm further back than it would have been without treatment - This reverts to the philosophy of many of the original users of the appliance e.g. Kloehn, Oppenheim, in that extra oral force is used merely to keep the maxillary molars stationary while rest of face and jaws grow forward. However, further on Poulton[60] supports Wests[73] findings of 4 mm distal movement of the upper deciduous molars. It is in this claim of distal movement that these writers must be questioned, in the light of results from others.

Mossman and Hackensack[54] conclude from their article, "Distal movement of maxillary molars is extremely rare, having been noted

in only two out of approximately fifty head cap cases, and at that, the distal movement was less than 1 mm." King [43] is even more conservative:- "A limited amount of posterior movement of the maxillary first molars occurred in some cases, but the amount was not significant. In fact, in each group (late mixed and adult dentitions) the mean revealed some forward growth of the maxillary first molar related to the pterygomaxillary fissure." King [43] also, in relating the position, before and after treatment, of the molar, in relation to pterygomaxillary fissure, found "measurements from the pterygomaxillary fissure to the maxillary first molar indicated that this tooth grew forward less than either nasion or pogonion, and we may assume that it was held back by the extra oral force." (Note that there was still forward movement of the molar in relation to the fissure.) Epstein,[21] in a report on 12 cases, found that molars were held back. Epstein's distal movement and correction of molar relationship was obtained by distal tipping of the molars.

Graber[28] seems to summarize the position when he says "There is evidence that bodily distal movement of maxillary first molars can be accomplished (not routinely) ---- It can be predicted if maxillary second molars are removed during the course of treatment" ---- "in most cases the maxillary first molar is merely restrained from coming forward in its normal path or tipped distally." In case this might infere that the extra oral was not achieving its purpose, Brodie et al[12] found little or no movement with Class II elastics. - "Class II cases treated with intermaxillary elastics - Under this treatment the posterior movement of the maxillary molars was negligible." Ricketts,[64] in a very comprehensive survey, found the following movements of molar teeth occurring under different conditions. Ricketts selected five groups

of patients for this study.

1. A Class I non-treated group of fifty patients (50)
2. A Class II non-treated group of fifty patients (50)
3. A Class II group of fifty treated solely by headgear.
4. A Class II group of fifty treated by intermaxillary elastics.
5. A third Class II group treated with full bands, elastic and head gear.

His results were:-

1. Class I controls showed 3.5 mm forward drift.
2. Class II controls showed 2.0 mm forward drift
3. Class II headgear cases - molar moved backward 1.3 mm
4. Class II elastic traction cases - molar moved forward 1.3 mm
5. Class II combination anchorage - molar moved forward 1.2 mm.

In this last group, extraction was often done and the upper molar was used as anchorage to retract upper incisors.

From all these accounts, the reader can certainly get a complete range of ideas as regards distal movement of molar teeth, ranging from a conclusion that:-

1. 3-4 mms distal movement is quite an acceptable aim.
2. Sometimes distal movement could be anticipated provided 2nd molars were extracted.
3. no distal movement as such should be expected, but rather an opportunity is given at specific times for the extra-oral appliance to maintain 6 year molars in a given position while rest of jaw and face develop.

This last conclusion is closest to that followed by Kloehn and others who could be called responsible for the return to favour of the extra-oral

appliance. Maybe these latter users of the appliance are expecting too much. After all, their measurements are not standardised, and to claim a distal movement may be jumping to conclusions- for example the task of trying to run with a train, only carrying such a load, that the runner gradually drops back in relation to the train, but not to the platform. Similarly, the upper molar drops backwards under the restraining influence of extra-oral force, in relation to the remainder of the jaw and face, but at the same time may show slight forward movement itself. Now if no distal movement is achieved, then how much mesial movement is obtained when no extra oral is acting, in comparison with a patient using the appliance?.

King[43] in his study of Class II Division I cases with head gear and edgewise arches in the late mixed and adult dentition, found "The maxillary first molar appeared to be held back as the face grew forward." Mossman and Hackensack[54] found that "Headcap treatment strongly retards the forward movement of the maxillary teeth, despite the manifestation of active dento-facial growth." As mentioned previously Graber[28] believes that maxillary first molar is in most cases restrained from coming forward in its normal path. Ricketts[64] in his study, showed that Class II untreated cases had a 2.0 mm mesial drift. However, his cases treated with headgear showed 1.3 mm of backward movement.

Poulton[60] found the following changes over a 12 month period in a group of untreated patients - "The mandible grew forward somewhat more than the maxilla or upper face, and that the dentition both upper and lower, moved forward as least as much as the lower jaw. In this group it was observed that the antero-posterior relationship within the dentition remained constant for both the erupted teeth and

the unerupted bicuspid and cuspid tooth buds. No significant changes in occlusion occurred. "The slight increase in mandibular prominence which was noted is consistent with the findings of Bjork[5] and Lande[49]."

As mentioned previously Foulton is in agreement with West[73], that with headgear therapy, the teeth, unerupted and erupted, were about 3 mm further back than they would have been. Actually, from Rickett's[64] calculations, he (Ricketts) has them 4.8 mm further back. These measurements are taken from the ptergyomaxillary fissure.

All these writers are reporting on investigations on patients using the headgear and achieving success and correction of the molar relationship, with one or two scattered cases where little or no improvement was obtained. Actually, the problem is one of whom or which group is coming to the right conclusions as regards their treatments and results. Basically, they are all working on very similar patients, with similar malocclusions; also, they are all achieving a corresponding uniformity in their results, clinically. It is in their conclusions drawn from the cases that this difference in opinion if found. After all, correction of molar relationship does not mean that the upper molar has moved distally. Nor is the pterygomaxillary fissure a static measuring point, since the spheno-occipital synchondroses remains active to some extent well past the upper age limit of any of these patients.

Those writers who maintain that the molars are restrained in forward growth, while the rest of the face or mandible develops and grows forward are certainly following the line stressed by Kloehn and Oppenheim, namely, the device is purely one for guiding and directing the developing dentition into a correct occlusion. On the contrary, those who claim a definite distal movement of 6 year molar teeth, should not

be too concerned if the patient has a lack of mandibular growth (a requirement stressed by the more conservative). Any such lack of growth would still be overcome in correcting the 6 year molar relationship, even though the profile would be distinctly backward diverging with lack of forward positioning of the pogonion. Such a task would not be envied by most orthodontists.

It would seem then, that until a more satisfactory evidence is forthcoming, that the maxillary teeth do show some forward movement, but not nearly as much as when a restraining appliance is used.

DISTAL TIPPING OF MOLARS.

Graber,[27,28] admits that maybe distal bodily movement of molars is possible but only should be anticipated in special conditions, e.g. when extraction of second molars is done. "There is evidence that bodily distal movement of maxillary first molars can be accomplished (not routinely) ——". "It can be predicted if maxillary second molars are removed during the course of treatment"——. "In most cases the maxillary first molar is merely restrained from coming forward in its normal path or tipped distally." - Graber[28]

Epstein[21] found that the molars are moved back in relation to the maxilla and lower molars by tipping. It is this tipping of molar teeth with extra oral which will be discussed now. As before, some writers found no problem in this matter at all, for others it was certainly present and they have mentioned ways of overcoming any excess distal tipping.

According to Klein,[45] in an article making observations on 24 clinically successful cases, he found, "The degree and direction of tipping can be controlled to a great extent by the manipulation of the appliance." This manipulation of the appliance no doubt adheres to the advice given by Kloehn,(as mentioned in the section on Mechanics) that is, that giving the outer face bow arm a definite downward tip toward the mandible can produce distal tipping of the molar crown. Conversely, a high pull headgear will have the effect of moving the molars bodily distally.

King[43] in his report had little or no tipping, but he "felt that the tipping was controlled largely by a full or partial appliance that was in place during part or all of the time each case was under treatment."

Epstein,[21] in a report on twelve cases treated with the headcap, attributes a great deal to distal tipping of the molars in the correction of molar relationship when using the headgear appliance. Graber[27] found the molar teeth to have this tendency towards distal tipping under cervical traction, however, this was lessened by permitting the arch wire to maintain positive pressure on the maxillary incisor segment. Graber[28] also claims that "excess tipping can be reduced by banding deciduous 2nd molars, or waiting for 12 year molars to erupt."

Newcombe[57] found varying degrees of tooth tipping; the tipping was measured by superimposing cephalometric x-rays made prior to treatment on those, made at the end of treatment. "The posterior tooth tipping combines with the bite plate to force a downward and backward rotation of the mandible, thus reducing the overbite anteriorly." While Newcombe can claim that the anterior overbite can be reduced by this distal tipping effect, as will be seen later, the downward and backward rotation of the mandible can be detrimental to the development of a normal profile and forward positioning of the pogonion point.

The distal tipping of the molars, while it may cause a correction of the molar relationship, has also to be considered with regard to the second molar, which, on most of the patients, has not erupted. Also, can the molar, tipped distally, be reckoned as a stable result, or will further development and eruptive force distal to it cause it to relapse, with the crown moving mesially again into an upright position, rather than the roots moving distally to upright the molar crown ? Certainly if the cusps on the upper molar are long and the corresponding fossa on the lower molar is deep, then a definite locking can be visualised. This aspect of distal tipping will be considered furtheron in relation to the effect on the second molar eruption.

ANTERIOR TEETH TIPPING.

Not many of the articles reviewed showed much concern for the tipping effect on the anterior teeth; although most writers certainly investigated in fine detail the effect of the extra oral on the alveolar bone, few considered one of the sometimes unfavourable results on the anterior teeth, namely lingual tipping. This will or is likely to occur where the headgear is being used to reduce an anterior overjet. The extra oral appliance either rests directly against the labial surfaces of these teeth, or else an elastic is stretched from canine to canine to achieve a distal driving force.

As mentioned in a previous section, some of the articles avoided this by banding the anterior teeth and using edgewise arches for root control. However, not all of the cases had this refinement, most being a simple headgear appliance.

Ricketts[64], in his investigation which was detailed earlier, carried out measurements on his controls and treated cases, these measurements being to the upper incisor, not the labial trough above its apex.

Class I controls showed an increase of 1.2^{0} in labial inclination.
Class II controls showed an increase of 0.7^{0} in labial inclination.
Headgear sample showed a reduction of 3.4^{0} in labial inclination.
Elastic sample showed a reduction of 1.8^{0} in labial inclination.
Combination anchorage showed a reduction of 4.0^{0} in labial inclination.

Since Ricketts makes no specific mention of attempting or achieving bodily distal movement, it must be assumed that the reductions occur in the form of a lingual tipping. Ricketts also found that the "upper incisor showed similar characteristics when measured in mms to the

A Po plane."

Graber,[27,28] in his two investigations in 1954, 1955, found that "in severe basal dysplasias, it was necessary to incline the maxillary incisor excessively to the lingual in order to reduce the incisal over jet." - Graber.[27] Also his findings from a more precise study of treatment effects in different age groups, showed that in the deciduous group "Correction of the overjet meant excessive lingual tipping of the maxillary incisors."----"The anterior muco-labial concavity decreased quite considerably in most cases. Overbite correction was least satisfactory." In the mixed group a similar finding was recorded, namely the "overjet correction again produced excessive lingual tipping."- Graber.[28]

Urban[71] raises the problem of whether, once the overjet is corrected by a substantial reduction in the upper incisor angle, and beyond its normal range, these anterior teeth will show a tendency with time and growth to revert toward their pretreatment axial positions.- "In view of studies of the behaviour of lower incisors after treatment, it seems reasonable to expect that this may happen."

However, Urban sees no worry here, as this slight relapse merely makes room for more favourable forward growth of the mandibular denture; on the contrary, Urban feels that should this relapse or repositioning to some extent of the upper incisors fail to occur, they may exert an unfavourable influence on the mandibular path, in which case he feels that "it would seem prudent to stop the treatment (i.e. of reducing overjet) somewhat short of complete closure of space, especially in young patients whose growth potential is great." There will always be the worry of upper incisors reverting to their former axial inclinations

in those cases where lip and tongue habits are the predisposing factors in the overjet problem. However, it seems that Urban feels that cases other than these can show a return to their former positions - a disquietening factor to be considered in any prognosis of Class II, Division I malocclusions.

Perhaps, Graber[28] may have once again summed up the 'middle of the road' feeling best when he says in 1955 "lingual tipping is of constant concern in the maxillary incisor region" and later on "we believe that between lingual tipping of the maxillary incisors and labial tipping of the mandible incisors, the former is the lesser evil."

As mentioned previously, some of the articles stressed the use of edgewise arch segments on banded anterior teeth for root control of the anterior teeth. However, it has been difficult to find any mention that either firstly, the reduction of overjet was more or less satisfactory than with a simple headgear attachment, and secondly, whether more or less time was involved in achieving corresponding results.

In any case, where the anterior teeth are subjected to pressure from the extra-oral appliance, then these teeth need to be kept under constant observation in order to avoid an end result where any overjet has been corrected by excessive lingual tipping with its rather unsatisfactory appearance. Admittedly, upper anteriors tipped lingually may be the lesser evil when contrasted to labial tipping of the lower incisors, but it does seem surprising that Graber appears to be condoning one fault by calling it a lesser evil. "Two wrongs do not make a right," is an old saying which can still be applied to lingual tipping of the upper anteriors and labial tipping of lower anterior teeth, when means are considered for treating a severe anterior overjet.

With this in mind it appears that the use of the extra-oral alone to reduce an anterior overjet should first be determined by the degree of flaring of the untreated incisor teeth. If the upper incisor angle is close to the normal range, then the extra oral appliance would not be the ideal method of treating the overjet.

OCCLUSAL PLANE TIPPING.

The next point to be considered is the occlusal plane and the tipping effect upon it of the extra oral appliance. Opinions seem to vary concerning the occlusal plane, whether the treatment is undertaken by use of the headgear appliance or intermaxillary elastics are employed.

The method of recording the occlusal plane changes differ considerably. In the Downs analysis, the occlusal plane is measured as an angle made between it and the Frankfurt Horizontal Plane. This is the standard as used by most of the writers. However, Ricketts[64] measures the angle made by the occlusal plane with the mandibular plane, so that while one writer mentions an increase in the occlusal plane angle, another may talk of a decrease in the occlusal plane, both discussing a similar result. It is in cases such as this that it is felt more could have been achieved and defined had the investigations had a more common basis for their conclusions.

According to King[43] "Changes in both the occlusal plane and the mandibular plane generally were small. The changes were smaller than those reported by Tovstein[70] on cases that had been treated with Class II elastics. This would tend to confirm the conclusion that Class II elastics disturb the occlusal plane." Likewise, Brodie[12] et al in the study of cases treated with Class II elastics, found a tipping of the occlusal plane. From these two statements it could be argued that the extra oral has little effect on the occlusal plane, particularly in relation to the effect of intermaxillary elastics. However, Poulton,[60] Buchner,[16] and Ricketts[64] found opposite results in their articles.

Poulton,[60] in his report compares changes in a group of Class II patients (29) treated with occipital headgear, with changes in

a similar but untreated group at the end of a twelve month period - "While there was no change in the untreated group, a mean downward tip of 2.8° was noted in the treatment group." Poulton's results showed "that with an increase in occlusal plane tipping, a decrease in forward pogonion movement occurred."

Likewise, Ricketts[64] found that the occlusal plane angle to the mandibular plane showed a tendency to decrease with growth, i.e. to lower in the posterior region, in the Class I and II control groups. In the control groups the lower molar drifted forward 0.1 mm and erupted upward 1.5 mm.

In the headgear sample "The lower molar was prevented from erupting to that degree observed in the controls, i.e. only 0.8 mm eruption. Likewise, the occlusal plane further decreased with treatment more than seen in the controls."

"In the intra oral anchorage cases, the lower molar moved forward 1.6 mm and upward 3.3 mm; the occlusal plane tilted 3.4°."

In the combination anchorage cases, Ricketts found that the lower molar moved forward 1.1 mm and the occlusal plane tilted 2.4°.

As a matter of interest regarding the effect of different techniques, Stoner[67] et al (according to Poulton[60]) 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 II elastics and a 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."

So it appears that excess tipping of the occlusal plane

can result in a less satisfactory improvement in the profile; this also was noted by Newcombe[57] in his analysis of excess distal tipping of the molars.

Buchner,[16] however, feels that the changes in the plane itself may be difficult to record -"the method used in determining the occlusal plane permits sufficient variation in its registration so that observations concerning changes in the plane may have a high degree of inaccuracy. From the data recorded however, it would seem as though extra oral force consistently caused a greater tipping of the occlusal plane than did intermaxillary elastics."

If this is so, it would certainly account for the great variation in results and conclusions in the different articles. It must be remembered that King[43] in his treatments had full or partial edgewise arches in operation. Also, it was King[43] who experienced very little tipping of the molar crowns, so that his results as regards occlusal plane tipping would not necessarily be duplicated when using the simple headgear appliance.

OVERBITE CONSIDERATIONS.

Several other smaller points have been observed as regards the behaviour of the molars and anterior teeth under the influence of the extra-oral appliance. As mentioned previously, Newcombe[57] found that distal tipping of the molar crowns produced a backward and downward rotation of the mandible, but at the same time a decrease in anterior overbite. Admittedly, Newcombe incorporated a bite plate with the extra-oral.

However, Graber,[28] from a study of 100 cases of headgear treatment found "that extra oral anchorage alone was inadequate for the vertical discrepancies in cases where overbite was excessive. Even with bite plate assistance, residual overbite remained after basal adjustment ond overjet correction ---- overbite correction was more favourable where there was no appreciable change in the inclination of the occlusal plane and where growth increments were favourable."*

A conclusion that could be drawn from these last few articles and quotations is that the anterior overbite correction is more favourable where there is no change in the occlusal plane inclination. However, as mentioned previously, the headgear appliance does cause both a tipping of the molar teeth and a tipping of the occlusal plane. Consequently, the use of the headgear would definitely seem contra-indicated where an overbite problem existed.

One of the final points to be discussed is what change occurs in the downward movement of the 6 year molars? Newcombe[57] by superimposing tracings, found "remarkable elongation of the first molars, if a bite plane had been used."

Conversely, Klein[45] in his observations on a sample of 24 clinically successful cases found that "downward movement and elongation

was not observed to a degree where it would be considered detrimental."

Mentioned earlier, were Ricketts[64] findings in relation to the occlusal plane, where he found that the headgear prevented lower molar eruption from being the same as in his controls - This certainly supports Newcombe's claim of elongation. However, judging from Ricketts' results with intermaxillary elastics, the elongation of the upper molar with the headgear is no where near as prominent as the increased upwards eruption of the lower molar when elastic traction is used. - virtually - 0.7 mms elongation of the upper molar as against 1.8 mms upward eruption of the lower molars.

Having considered the effects of headgear therapy on the 6 year molar teeth, it is now time to see what effect if any, is made upon other teeth, more specifically, second and third molars. This, indeed, is one aspect of extra oral force which seems to need a further and more defined investigation. Few of the articles even consider what will happen to the eruption of the remaining molar teeth, even though they have claimed upwards of 3 to 4 mm distal movement of the first molar teeth. Growth is a most important ally in any orthodontic treatment and more particularly in headgear therapy, but growth alone cannot be expected to unravel all impactions which may occur, and there is enough evidence to claim that this can happen, whether routinely or spasmodically.

EFFECT ON MOLAR ERUPTION.

Gregorak,[30] in 1962, made a comprehensive study of the result of headgear therapy on molar eruption. Prior to this, Closson[18] in 1950 in his article, made a rather general statement that "when using the headcap in the mixed dentition, the question often arises as to what happens to the maxillary second molars. The eruption time may sometimes be retarded; however, they do not become impacted as a general rule".

In between these two dates, Graber[28] in 1955 in reply to the query is second molar eruption altered or interfere with ? says "In general, the answer can be no." "It is possible ---- by excessive distal tipping of first molars, but with removal of the distal force, the first molars usually upright themselves, permitting eruption of the maxillary second molars." However, in this article, Graber admits that he has cases of impaired eruption, but, as mentioned before, these cases are then entrusted to growth and development, which if good can rescue the impaired eruption of the second molars. If growth is not sufficient, then some additional and alternative treatment will have to be found.

Graber also has mentioned that the distal tipping may impact the second molars, but this impaction is removed when the 6 year molars upright themselves. This is difficult to comprehend. If the distally tipped molar crown is uprighted by distal movement of the roots, then the second molar must surely be still impacted or else moved in another direction itself. If the roots of the 6 year molar remain stationary, and the crown tips mesially again to upright itself then this must cause a relapse of the 6 year molar position and the occlusion. As explained and shown by Gregerok,[30] the second molar need not be driven only distally, but also bucally and vertically.

Kloehn, in a discussion on an article by Block[8] in Angle Ortho. 1962, commenting on adverse results of the headgear appliance, says "the impaction of second molars has not been a problem in our hands, perhaps because we did not tip the first molars excessively and always try to correct the axial inclination before completion of treatment." This still does not explain what happens to second and third molars in their eruption, since, with this distal movement, the 6 year molars must be encroaching on the space provided for the second and third molars.

Graber[29] later in 1956 appears to be slightly more convinced that the eruption patterns are altered. His views are best expressed by himself in discussing Class II therapy.- "In the maxillary arch, only so much room exists in the alveolar trough for distal movement of teeth. After this has been gained, further movement is at the expense of impacting second and third molars, or causing them to erupt buccally. There is not one whit of evidence that orthodontic appliances stimulate bony apposition on the tuberosity in advance of tooth movement. There are several qualifying elements affecting the success of distal movement in the maxilla. These are the amount of distal movement needed, the available alveolar trough space, the presence of absence of third molars, the differential size of deciduous molars and their successors (the premolars), growth increments during treatment, and the length and intensity of intermaxillary force. Class II therapy, then, does not mean simple reciprocal force - maxilla against mandible. It does mean, first, removing all interferences that might restrict complete accomplishment of mandibular pattern growth (excessive overbite, for example). Second, it means restriction of the forward component of maxillary or maxillary alveolar process growth to reduce the basal dysplasia and allow unimpeded mandibular pattern growth.

Third, it means taking up the alveolar trough slack. How much of each elementisneeded depends on mandibular growth increments, on treatment timing, and on the length of treatment. If growth increments are small during therapy, more recourse must be had to distal movement of the maxillary denture either by taking up available space or by creating space, but most certainly not by dragging the mandibular denture forward with elastics. This may mean extraction of the maxillary first premolars, second premolars, or second molars. The last alternative offers a most attractive possibility."

Gregorek[30] studied 4 groups of children in his report:-

1. Children 7-15 years under active orthodontic treatment.
2. Children 7-15 years with untreated Class II Division I malocclusions
3. Patients whose Class II Division I treatment with cervical headgear therapy had been completed, age ranging from 13-18 years.
4. Second control group (cephalometric tracings) was obtained from R.M. Ricketts. This group covered a greater period of eruption from 17-38 months. Age range was 7-15 years.

Gregorak examined the path of eruption in three planes:-

1. in a horizontal plane; i.e. forward and backward in a proximo-distal line.
2. in a vertical plane - upward and downward in the line of their own long axis.
3. in a horizontal plane - i.e. in outward or inward in a buccolingual line.
i. Antero-posterior change was related to "the pterygomaxillary fissure, a point suggested by Broadbent[11] and Brodie[13] as being the most suitable in the entire head skeleton, at least in an anterio-posterior dimension." - Gregorak.[30]

ii. Vertical Movement. "The distance of each of the molars below the Frankfurt Horizontal plane was taken from the lowest point of the crown of the tooth along a line perpendicular to the Frankfurt Plane."

iii. Buccolingual Movement: "Measurements were made directly on the occlusal film between the most lingual contour of the molars."

From observations of the two control groups Gregorak[30] says: "In general, the first molars, once in occlusion, continue in a downward and forward path. The second molars erupt downward and forward, with a strong tendency to move buccally." This pattern of eruption according to Gregorak "confirms the findings of Broadbent[11] and Brodie[13]." —— "The most significant changes were noted in the group of children under active treatment."

Gregorak[30] compares the situation with having three marbles in a straight line with the last marble against a rigid object. When pressure is applied to the marbles, the middle marble goes either left or right, up or down. Gregorak found "that the majority of second molars had moved posteriorly and buccally, with a significant number (22%) either prevented from erupting downward or actually moving closer to the Frankfurt Plane. The third molars, moved posteriorly, and, at the same time, either buccally or lingually." These findings, together with Grabers[29] comments on molar eruption and evelopment of the maxilla , seem to be convincing enough for there to be some concern shown for the fate of the remaining molars in the arch.

Gregorak[30] next considers what happens to this altered eruption pattern once the distal pressure was removed. He found "the path of eruption returned to a downward and forward direction of the first molar,

75% had moved forward while 67% of the second molars had moved forward."

Although this seems that once treatment is complete, the path of eruption returns to normal, in a comparison of the post-treatment group with Ricketts control group, there had been a significant alteration that should be "credited to the influence of orthodontic treatment." In other words, it was caused by the headgear appliance.

Gregorak continues, "The prognosis of third molar behaviour is uncertain with regard to ultimate position, but indications point to a greater incidence of impaction in treated cases." Gregorak makes this statement in the light of Hellman's[35] findings "that in females, the third molars erupt after the growth of the maxilla is entirely finished, whereas in males, this growth continues beyond the time of eruption of the third molars."

Therefore, it would seem that the headgear appliance can cause some changes in the eruption of the second and third molars - another factor to be considered before using the headgear in treatment.

EFFECT ON MAXILLA.

The problem now to be discussed is whether the extra-oral appliance can alter or influence the growth and development of the maxilla ? The investigations in this regard were carried out with emphasis on what happens to the Palatal Plane; this plane (ANS-PNS) was recorded sometimes as an angle with S-N. The majority of the writers who commented on this point noticed changes in the plane after occipital or cervical traction.

Klein[45] had the more noticeable or prominent results - "The palatal plane tipped downward suggesting alteration of the basic maxilla." "Previous growth studies have also suggested that the palatal plane drops directly parallel to SN during growth. In the average 18 month treatment with cervical gear, the average palatal plane tipped downward almost 2 degrees and in some cases as high as 4 degrees."

In only four of Klein's cases did the plane remain constant. Also, in no case was there a decrease of the angle nor a greater dropping posteriorly rather than anteriorly.

Poulton[60] in his findings, recorded a tipping downward of the palatal plane. Blueher [9] also had a similar finding,-"the palatal plane increased in the majority of both boys and girls. If the possibility of error in tracing could be discounted, this increase would be indicative of a tendency for the neckband appliance to change the palatal plane in a natural direction."

Ricketts[64] confirms the findings of the above articles in his treated cases and also Brodie's[15] findings as regards normal growth movement of the palatal plane- "Brodie's findings also emphasised that the palatal plane (S-N, ANS-ANS) tended to remain constant but, if anything,

lowered slightly in the anterior area." - Ricketts.[64] This was corroborated by Ricketts' findings in the untreated control group as reported in the same article. "In the treated cases this was accentuated. The downward tipping average 1.6° in the headgear cases and 1.3° in the combination anchorage cases." - Ricketts.[64]

Newcombe,[57] in his results, found varying degrees of posterior teeth tipping, which he feels may affect the palatal plane. This is slightly indecisive information and conclusion.

In comparision with the headgear results, Silverstein,[66] using edgewise arches and intermaxillary elastics, found that the maxillary base S-N-ANS was altered. "The treated males and females were 4° less acute than the untreated cases ——— the changes after treatment were less than the differences that existed before treatment was started."

In spite of all these results, Graber[28] remains unconvinced. "There is no evidence that maxillary growth, per SE, is affected." Perhaps Graber feels that the headgear is notchanging maxillary growth, but merely accentuating a normal pattern as reported by Brodie.[15]

Maybe Poulton[60] puts everything in its right perspective when, after reporting an inhibition of forward growth of the maxillary body of 0.6 mms and also a downward tipping of the palatal plane, he says: "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."

Therefore, if asked to precast, it could be expected that the palatal plane is altered to a slight extent, nevertheless, the changes are not of such magnitude to warrant discarding extra-oral therapy.

MAXILLARY ALVEOLAR GROWTH.

Maxillary alveolar growth is an entirely different matter, and in this regard the extra-oral appliance perhaps finds its best results. None of the articles reports failure to achieve some change in this respect. The only point to be discussed is what variation exists in the results. Changes were recorded in the anterior alveolar growth by measuring the angle SNA, the distance SA and the distance of pt A from the facial plane.

Before contrasting the results, it might be best if the normal growth patterns of these measurements were mentioned. Lande,[49] as reported by Klein,[45] in his studies on change in the profile revealed that "subspinale, or point A, descends almost directly downward from the Nasion where the SN plane is employed for orientation with the Nasion registered."

According to Ricketts[64] "for profile study, Point A was taken directly to the facial plane as a measure of facial contour. This figure averaged 4.7 mm in 1,000 clinical cases, although Downs' normals revealed a mean of 0 mm. In our cross sectional study of 1,000 cases, decreases of approximately 1 mm for every 4 years age difference were noted. Youngsters 3-6 years averaged + 5.5 mm (i.e. A anterior to N Po plane) and cases decreased until at 15-18 years, the average was + 2.5 mm. A similar finding was observed in the present sample of untreated cases.

Ricketts[64] also points out that SNA has come to be employed as a reference line in treatment planning, etc. by Steiner. Landes[49] and Brodie's[15] early investigations both showed a remarkable constancy. According to Ricketts, his own sample showed only a 0.5°

increase in SNA over 30 months.

Blueher[9] found that, in general, the angle SNA was reduced. Hanes,[32] in evaluating angular and linear measurements from before and after head films of 32 cases treated with cervical anchorage and on 38 cases treated with intermaxillary elastics in addition to cervical anchorage, claimed changes in Pt A moving distally were responsible for any improvement in either type of treatment.

King[43] obtained a "posteriorly directed change in the position of Pt A related to the Nasion." Klein[45] observed that "under cervical traction, Pt A witnessed a posterior movement of more than one degree. Almost one quarter of the cases (24 cases) were found in the 3-4 degree range, which is of great significance."

Ricketts[64] gave results in both linear and angular measurements. Firstly, the distance of Pt A to the facial plane.

Headgear cases were reduced from 5.8 mm to 2.7 mm - a reduction of 3.1 mm.

Retrognathic cases (in headgear) reduced from 8 mm to 4.0 mm - a reduction of 4.0 mm.

Elastic cases reduced from 4 mm to 2.8 mm - a reduction of 1.2 mm.

Elastic and Headgear reduced from 5.1 mm to 1.3 mm a reduction of 3.8 mm.

64.

Ricketts[64] has similar results for the SNA angle, obtaining the following reductions:-

Headgear alone - a reduction of 2.7^{o}.

Elastics - a reduction of 0.9^{o}.

Combination - a reduction of 3.1^{o}.

Of all the articles reviewed, Blueher[9] in 1959, was the only one not to have achieved a reduction in all instances:-

"The SA distance was reduced in the majority of cases. This reduction occurred more often in the female than in the male. In the boys, A moved forward as often as backward. The millimetre change in forward movement was greater than that which occurred in backward movement." Blueher also sounds a caution as to recording the changes in pts A and B. "The difference between angular or linear measurements of points A and B respectively indicate a masking of true events in the recording of angles. It should be remembered that SNA, SNB NAPo are influenced by growth activity at points other than A and B."

However, lest this last observation of Blueher makes it appear that the results are not all that they should be in regard to reduction of SNA, perhaps Graber's[28] comment on the effect of headgear therapy on the maxilla, will restore the confidence in the appliance in in this regard:- "That maxillary alveolar growth can be influenced is another matter, for the routine change in anteroposterior apical base relationship in our studies is one of the more significant observations." Hence, it does seem that the use of the headgear to change maxillary alveolar growth is a fit and proper usage of extra-oral force.

EFFECT ON MANDIBLE.

Before reviewing the next section of results of extra-oral force, it may be best to mention that one of the advantages in treatment (another section in this review) is that the extra oral force can be used solely against the upper arch, the lower arch and mandible being left untouched; this is in contrast to intermaxillary elastic traction, where both upper and lower dentitions are subjected to pressure, with the possibility in certain instances of a loss of anchorage in the lower arch.

However, as will now be seen, the mandible, the lower alveolar bone, and the lower teeth can all be affected by the headgear. Firstly, the effect on the mandible will be considered.

Most writers agree that the correction of a Class II malocclusion depends to a great extent on mandibular growth e.g. Newcombe[57] - "Orthodontic correction is largely made possible by satisfactory developmental growth, i.e. forward migration of the mandibular teeth. Without the later to aid in treatment, correction of a ClassII molar relationship would indeed require an incredible amount of maxillary teeth movement."

Employing a cephalometric investigation method, Hedges[33] showed that in Class II treatment, mandibular growth provided most of the change in molar relationship.

Brodie et al [12] reported:- "In a cephalometric appraisal of orthodontic results, observed that growth and development accounts for much of the change that occurs and that tooth movement was not as great as it would seem on clinical examination. The Class II cases in this study were treated with intermaxillary elastic. Under this treatment

(Class II elastics) the mandibular molars came forwards." They noted that best results were obtained when growth was most effective. Other examples of this dependence on mandibular growth can readily be seen in the literature.

Consequently any appliance that might impede this growth of the mandible, or rather its positioning, since Graber[28] believes that no orthodontic appliance can make the mandible grow any more than it is going to, according to morphogenetic pattern, then such an appliance should be given keen consideration before use in the correction of Class II Division I malocclusions.

Once again, before analysing the results of headgear treatment on the mandbile, it may be best to summorize briefly what occurs in normal development. Poulton[60] noted that, over a 12 month period in a group of untreated patients, "the mandible grew forward somewhat more than the maxilla or upper face", and that this slight increase in mandibular prominence is consistent with the findings of Bjork[5] and Lande[49].

Brodie et al[12], in a cephalometric appraisal of orthodontic results, observed that growth and development accounts for much of the change that occurs; Mossman and Hackensack[54] found that "mandibular teeth are carried forward into Class I relationship during headcap treatment as the mandible grows forward and downward."

Silverstein[66], in 1954, in his analysis of age changes in untreated cases, says that "in general, changes in facial proportions, as measured by the various angles become progressively greater from Nasion downwards. The upper face (SNA, SN-ANS) showed very little change in angulation from 8-20 years. The lower face in general, showed greater changes. SNB and the relation of AB to the facial plane showed slight

angular changes similar to the upper face." This increasing prominence of the chin, which Lande[49] found generally occurred beyond 7 years with normal development, has been contrasted in numerous ways in the articles reviewed.

CHANGES RELATING TO POGONION AND GNATHION.

Basically, the parts of the mandible measured in angular form were the pogonion (Po) and the (Gn). The investigations have been made as regards the following angles:-

1. S - N - Po
2. Y - Axis
3. N - A - Po
4. S - N - Gn
5. N - S - Gn

One conclusion which seems inescapable is that the forward positioning of the mandible is altered by headgear therapy. This is evidenced by the results obtained by various writers with reference to some of the angles mentioned above.

Poulton,[60] in discussing some of his findings, says "with an increase in occlusal plane tipping, a decrease in forward pogonion movement occurred." Also relating to the pogonion, King[43] observed in a study of Class II, Division I malocclusions in the late mixed and adult dentitions, (appliance being a neck strap and full or partial edgewise arches), "the forward growth of the Pogonion was disappointing."

Ricketts,[64] in discussing the facial angle (S-N-Po) found that "improvements in the facial angle appeared to be slighly inhibited by the cervical headgear, but improved with high pull headgear and conservative anchorage in the lower arch; without treatment the facial angle improved .35° per year over 30 months period.

With headgear the facial angle improved .20° per year over 30 month period.

With intra oral anchorage the facial angle improved .2°- .3° per

year over 30 months period.

With intra oral and headgear the facial angle improved .5° per year over 30 months period.

In reference to lower face height, Poulton[60] again concludes "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 retrusion profile common in Class II malocclusion." Poulton[60] in the same article re-affirms Graber's attitude to mandibular growth etc. when he (Poulton) says "the inhibition of forward chin movement was not due to any lessening in growth of the mandible, 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.

As regards the bite opeing effect of the appliance, which is mentioned on several occasions, there seems to be some contradiction in the results. As mentioned earlier, and also in another section (contra-indications - its use), cases with closed bite are not suitable for head-gear therapy. Yet at the same time, some results indicate that extra-oral force is a bite opening appliance. e.g. Newcombe[57] "found that posterior tooth tipping, combined with the bite plate to force a downward and backward rotation of the mandible, thus reducing the overbite anteriorly."

Also Klein,[45] "In some instances, bite opening and rotation of the mandible appeared far greater than would be expected in normal behaviour during the time period studied. It might be speculated that the headgear affected behaviour of the mandible, not so much by influencing its growth, but by increasing the angulation of the mandibular plane/

Blueher,[9] found that "N S Gn increased in the majority of cases, indicating the bite opening propensities of the appliance." However, Poulton,[60] in discussing posterior tooth movement, says "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."

None of the articles measures any changes in overbite by measuring in mms the level of the upper incisal edge against the lower labial surface of the anterior teeth, but rather they claim a bite opening effect as a result of rotation of the mandible and distal positioning of the pogonion. This would be so, if there were no upper incisor extrusion, no tipping of the occlusal plane and even no tipping of the palatal plane, all three of which tend towards increasing or maintaining any overbite.

Also, bite opening achieved in this manner does not help in the development of the facial profile, so it is difficult to see any merit in the use of the extra-oral appliance where one of the main objects is to reduce anterior overbite.

There was no increase noted in the length of the Y axis as a result of the head gear therapy. According to Ricketts[64] "A comparison of 100 non-treated control cases over a 3 year period with treated cases, revealed no difference in the quantity of mandibular growth as measured on the Y axis. However, better orthopedic developmental behaviour of the mandible was observed with high pull headgear and vigorous elastics, than with simple intermaxillary elastics due to less rotation. Growth of the mandible was no better than normal tendencies seen in the untreated, on the average." Also later on Ricketts[64] found

that "cervical anchorage and intermaxillary elastics tend to open the X-Y axis or lengthen the face much faster than usually observed with normal growth. However, this is thought to be due to bite opening, since differences in the lenght of the Y axis were not observed."

A similar measuring angle is N S Gn, which Blueher[9] found increased in the majority of cases, in contrast to Lande[49], whose measurements showed that N S Gn in normal development evidenced very little change from 7-17 years; also, Brodie[15] according to Blueher[9] found the same angle quite stable from 8-17 years. Likewise, the mandibular plane angle was usually increased with headgear therapy; Ricketts[64] and King[43] as reported by Blueher[9], found that generally the increase occurred in both sexes. However, Blueher[9] found the angle tended to remain the same in boys but increase in girls - This he attributes to greater growth trends in the male.

Overall, then, there is no doubt that the headgear will cause less forward positioning and/less prominence of the pogonion, with similar consequences on the facial profile. However, the rotation of the mandible and opening of the Y axis will have its effect of bite opening clouded by the extrusion of upper incisors, and tipping of the palatal and occlusal planes.

It will be remembered that one of the most significant result s of headgear therapy, was the consistent reduction of Pt A (subspinale) in the maxilla. Since, it is now established that the headgear appliance causes a rotation and more distal positioning of the pogonion than would be expected with normal growth, the next problem is what effect is there upon Pt B the supra-mentale.

EFFECT ON SUPRA-MENTALE - Pt B.

Generally, it is admitted that Pt B moves distally in cases that have no lower appliance, but only an extra-oral appliance on the upper arch. Hanes[32] found that, in an analysis of cases treated with a cervical appliance alone and 38 cases with inter-maxillary elastics as well as cervical traction, "Pt B also moved distally in both types of treatment, but to a larger degree in those cases treated with cervical anchorage alone; except in individual cases, the forward movement of the mandible was not responsible for improvement in A-B distance." "PointB moved farther distally in the group handled with cervical anchorage alone. The use of Class II elastics tends to nullify this undesirable change in Point B."

Blueher[9] found that the angle S N B behaved similarly in both sexes - "It tended to stay the same or decrease as often as it increased." Blueher also had similar results for the S B Distance.

In contrast to these results under headgear treatment, Lande,[49] in his studies on face and jaw development, found no significant change in Pt.B from 7-12 years, but a mean forward movement of 2.2 mms from 12-18 years. Also, for interest, in addition to Hane's[32] claim that elastics tend to nullify the distal movement of Pt.B, Silverstein[66] in his treatments with edgewise arches and elastics claimed that Pt.B was not affected, and Stone et al.[67] in an analysis of Tweed's cases found a mean forward movement of .08 mm.

In summary then, it can be said that the Pt.B will be farther distally as a result of extra-oral appliance on the upper arch, but not to such an extent as might be detremental to a result, nor with such certainty as to be expected in every case.

EFFECT ON LOWER TEETH.

Finally, what effect is made upon the lower teeth ? The teeth most likely to be affected are the lower molars and the lower anteriors.

As a result of the elongation given to the upper molars, then there is a corresponding effect with the lower opposing teeth. Ricketts[64] found that in his headgear cases, the lower molar showed only 0.8 mms eruption, in contrast to the control cases which showed an upwards eruption of 1.5 mm. None of the other articles makes any mention of this aspect of headgear treatment.

Similarly, only Urban[71] mentions that overjet reduction which results in the upper anteriors contacting the lower anteriors before all growth is finished in the mandible may have a detrimental effect on the lower arch. This seems an unreasonable worry, since once the overjet was reduced surely the case would be freed from the headgear therapy, and kept under observation to enable both arches to develop and grow forwards together.

As is seen from this section reviewing results of treatment, the effects of exta-oral force are seen over a wide area; they are not only confined to the upper six year molars and anterior teeth; Therefore it is most important that all these points are considered when planning treatment with extra-oral force.

It was disappointing to find that in none of the articles reviewed was there any investigation into results with uni-lateral appliances. It is considered that uni-lateral mesial movement of an upper molar is seen often enough for this appliance to find more fegular use and it is important that in correcting molar relationship on one side, the already satisfactory occlusion on the other side is not disturbed.

AIMS OF TREATMENT.

Before using the headgear appliance it is essential that the dentist has a sure knowledge of just what can be expected of the appliance, and also of what can be expected to happen to the patient. In this section, the various aims as mentioned by the writers will be considered.

There does not seem to be much doubt that the extra-oral is an appliance which is used to best advantage in borderline cases which show a slight mesial movement of the maxillary arch together with an intact lower arch. Such a case can be commenced as soon as the maxillary molars can be banded e.g. Kloehn[46] "Alveolar growth and eruption of teeth can be guided at an early age resulting in better fixed balance and a more stable denture. Simple appliances using light forces in conjunction with occipital anchorage applied over a short period of time will prevent severe malocclusions and a long period of treatment. The headcap is a most important adjunct of this treatment."

Oppenheim[58] was convinced that light intermittent force is the best, not only for moving teeth distally, but also for moving them with the least damage to the roots and investing tissues.

From reading the literature, two views on treatment aims and method become apparent in relation to Class II Division I malocclusions. In one, the treatment is directed principally against the maxillary arch. Conversely, in the other, treatment is directed upon the mandibular arch in order to produce growth and change of the rate of growth at the condyle.

Holdaway[38], in his treatment aims, plans for a forward positioning of the mandible. He is not in agreement with "present day treatment philosophy which aims at accepting the existing relationships of

maxillary and mandibular apical bases and securing the best compromise of teeth possible within that limitation." Holdaway[38] bases this "present day treatment philosophy on Brodie's[12] findings of an apparent inability to alter anything beyond the alveolar process." Holdaway[38] acknowledges that this "other attitude" may be acceptable when applied to cases beyond any period of active growth, but for the growing child he reasons that strong Class II elastics can result in growth occurring, with the head of the condyle held somewhat forward and riding down on the eminentia articularis - "It seems perfectly logical, therefore, that the use of intermaxillary force can alter the rate and direction of deposition of new bone in such an area."

Later on in the same article, Holdaway[38] does concede that growth and downward positioning of the gonial angle, with the result of a swinging further forwards of the chin point Po to give mandibular prominence, will occur naturally in some mechanically locked dentitions when a bite plate is inserted.

This concession is really only a restatement of Bjork's[5] (1947) findings in a longitudinal cephalometric study on Swedish males at twelve and twenty years of age, when he (Bjork) observed that the prognathism of both jaws increased with age, with the increase in the mandible being greater than that in the maxilla.

Similarly, Bowyer,[14] in a discussion on the merits of a guide plane in association with a labio-lingual devise, maintains that the mandible can be positioned forwards and intra-chondral ossification can take place on the posterior surface of the condyle. Bowyer basis his opinion on the results of tests carried out by Baume on monkeys.

In distinct contrast to Holdaway, several writers e.g.

Kanter,[41] Silverstein,[66] Urban,[71] feel that Class II elastic treatment does not give such favourable results :- Silverstein[66] found that "the forward movement of mandibular growth was inhibited rather than improved by Class II treatment."

Also Urban,[71] feels that "In Class II treatment, the effect of intermaxillary elastic traction on the lower denture and facial profile may be unfavourable, except in cases which involve distal position of the teeth on base bone."

Kanter[41] in his article concludes "it is now becoming generally accepted that a relatively small percentage of ClassII malocclusions can be corrected by a mesial movement of the mandibular dental arch, a repositioning of the mandible or a combination of both."

In contrast to this concentration on the mandible, there is the other school of thought which feels that the mandible and mandibular arch are best left alone and treatment centred on the upper arch.

Graber,[29] (1956) says with regard to Class II therapy, "my philosophy demands the minimum of intermaxillary force. Exceptions are those Class II cases, with not too severe overbite and overjet problems, in which arch length is difficult in the lower arch particularly, and recourse is made to extraction..... A large portion of Class II cases show essentially normal mandibular arches, if examined unrelated to the maxillary arch .... I cannot bring myself to disturb tooth-to-basal bone relationships in these cases, except as a last resort. Thus extra-oral appliances and bite-plates make up a large part of my armamentarium for Class II Division I malocclusions. Intermaxillary elastics are used part time in some cases, but no more than half-time, and usually the damgge to the

integrity of the mandibular dental arch is minimal."

In contrast to Bowyer,[14] Graber,[28] 1955 believes that no orthodontic appliance can make the mandible grow any more than it is going to, according to morphogenetic pattern.

Also, Moore[52] (1959) in discussing the effect upon growth of orthodontic treatment admits that a distal or posterior force applied to the maxilla may cause distal movement of the maxillary teeth. "Also, such a force alters the horizontal growth pattern of the maxilla itself... We must remember that this force is being applied against a suture where its effect is being transmitted to other cranial and facial growth sites. A similar force upon the mandible is upon a free floating bone; therefore in my opinion it is not capable of inhibiting mandibular growth, or, if in a reverse direction, accelerating its growth."

Kloehn[47] also, in 1953, disputes the growth potential of elastic traction - "Intra-oral anchorage does not increase mandibular growth beyond its regular intended growth rate, nor could the pattern be changed."

Once again then, it seems, the controlling factor is growth. If favourable, then in the selected cases, a satisfactory result will be obtained. If not, then all the extra-oral force in the world will not establish a proper permanent occlusion; Kloehn[47] readily admits that "growth is our greatest ally in gaining successful results." Newcombe[57] and many others have stated their reliance upon growth, which the studies of Lande,[49] Bjork[5] and Hellman[35] and others have shown to tending always towards a faster and longer rate of growth of the mandible than the maxilla, with a corresponding favourable improvement in the profile. Newcombe[57] - "Orthodontic correction is largely made possible by satisfactory

developmental growth..... without the latter to aid in treatment, correction of a Class II molar relationship would indeed require an incredible amount of maxillary tooth movement."

Therefore it would seem that the aim of treatment with extra-oral force should be consistent with the knowledge of the effects of the appliance and an awareness of its limitations. Also, the stage of development of the patient must always be one of the main criteria for the use of the extra-oral appliance. With these general principles as to the effectiveness of extra-oral force and its reliance on growth for the most satisfactory results, it would be opportune to discuss specific indications for its use and the resulting advantages.

INDICATIONS AND ADVANTAGES WITH EXTRA-ORAL FORCE.

The indication for its use will be found it three ways.

1. Case analysis.
2. An estimate of the co-operation from the patient.
3. Ability of the appliance and the operator to control tooth movement.

If the case analysis, according to Hanes,[52] shows that maxilla is at fault, then the probable choice is an extra-oral appliance. However, Ketterhagen[42] and others recommend commencing severe Class II cases which induce a gross discrepancy in the bony facial pattern as soon as the first molars erupt. In these cases, it is acknowledged that a second period of full appliance therapy is equally necessary for correction.

Possibly one of the best indications for deciding on extra-oral force, is for the lower arch or model to be examined on its own. Graber[29] says that a large portion of Class II cases have a normal mandibular arch, the malocclusion being seen only after the models are articulated. The advantages of treating such a Class II Division I malocclusion with extra-oral force are best listed by Henry[36] (1961).

"1. Distal movement of the upper molars may be accomplished without depending on the lower arch for anchorage."

2. Anterior growth of the maxilla can be controlled to a certain degree during the active growth period of the child.
3. Early treatment of Class II cases is made possible. In certain cases, treatment can be completed in the mixed dentition.
4. Simplification of appliance therapy.
5. The number of extraction cases is reduced because anchorage for distal movement of the upper arch is removed from the lower

arch to the stable extra-oral region.

As regards the first advantage, it must be remembered that the lower arch should show normal development and that there should not be loss of arch length from premature loss of deciduous teeth, anywhere in the arch. The distal movement is achieved by the intermittent pressure from the headgear appliance. According to Closson,[18] "it was Oppenheim's contention that once the osteoblasts and osterclasts were stimulated to activity, they would continue working for approximately four days after the stimulus was removed. Therefore, in using the headcap it is not necessary to be concerned about the absence of stimulation during the daytime in the majority of cases." This physiological tooth movement is also supported by Block[8] (1962).

As has been shown and discussed in another section, the anterior growth of the maxilla and alveolar process can be altered to a considerable degree by extra-oral force; so that the second advantage claimed by Henry[36] is undisputed.

COMMENCING TIME FOR TREATMENT.

In considering the third advantage of being able to commence treatment early, there are several points of view extolled with regard to this aspect of extra-oral force. Some writers prefer to commence treatment early, in the deciduous dentition e.g. Kloehn[46] and Closson[18](1950). By early treatment, according to Closson,[18] is meant patients 4-6 years of age. This early treatment "gives us an opportunity to check pernicious habits that are more difficult to break later on. The improvement in facial harmony, the opportunity for the denture to develop to its maximum inherent growth pattern, and the elimination of an inferiority complex more than justify early treatment of patients with extreme Class II malocclusions." .. Closson.[18]

The majority of articles expressed a preference for treatment in the mixed dentition. Perhaps this period may be written about more than early deciduous treatment for reasons other than the suitability of the extra-oral appliance to help the malocclusions. It would be more than likely that the great majority of patients being seen by the orthodontist would be seen first in the mixed dentition stages; it is conceivable that these same orthodontists might have wished to start treatment earlier, but the patients were never presented until the mixed dentitions stage. Also, although it is not mentioned, the clinical task of banding deciduous molars in a 4 year old patient, may not be a very rewarding procedure.

Even in treatment in the mixed dentition, there is some variation in what is the most opportune time to commence treatment. Several writers lay great emphasis on treatment being commenced to coincide with the 'pubertal growth spurt.' e.g. Lucchese[50] 1960 -

"co-ordintation of the orthodontic procedures with the pubertal growth provided a significantly greater chance for success. The most favourable results of orthodontic appliances exerting extra-oral force have been obtained in girls from 10-12 years and in boys from 12-17 years."

Parker[59](1958) considers that the last great growth spurt in the human "co-incides roughly with the loss of the last deciduous teeth and eruption of the permanent teeth." Parker[59] feels that if treatment is delayed past this age, then the "golden opportunity is long passed." Similarly Mossman and Hackensack[54] like to commence headgear therapy "just prior to the accelerated growth period which frequently occurs in girls around 10 and in boys around 11 years of age."

Ketterhagen[42] (1957) sounds a warning on leaving appliance therapy too late. He uses as a guide the following principle - "No case, in which the cuspids and bicuspids have already erupted, is to be treated with headcap only, if the purpose of treatment is to complete the case with no additional appliance."

McIver[51] has a definite preference for late mixed dentition treatment. In girls, "this means starting treatment at age 10 or 11, regardless of whether or not all deciduous teeth have been lost. In boys, treatment can often be delayed one or two years or until all deciduous teeth are lost." McIver feels that early mixed dentition treatment will necessitate two periods of treatment and four or five years of care.

Poulton[60] recommends treatment in the late mixed dentition, likewise Graber,[29] Block[8] in 1962 reports Fischer[23] in his text book as finding a "lower incidence of root resorption prevalent in younger patients, and advises treating in the mixed dentition before the roots of the permanent teeth are fully formed." Block[8], in the same article, issues

a warning against too rapid distal crown tipping of maxillary and mandibular molars which causes increased arch length between deciduous canine and permanent first molar crowns which can "eliminate proximal contact for erupting bicuspids. When this is evidence, there is often observed undesirable rotation of newly erupted bicuspids. This seems to be particularly apparent when the deciduous second molar is exfoliated prior to first bicuspid eruption." From this it could be assumed that Block prefers treatment when the deciduous teeth are present to prevent this possible lack of proximal contact for the bicuspids. Likewise Block[8] recommends having the deciduous canines present when retracting upper anteriors to prevent impaction of upper permanent canines.

In contrast to all these suggestions concerning mixed dentition treatment, Fletcher[24] in Dental Practitioner, states "the arrival of the full dentition provides the orthodontist with firmer and more extensive anchorage against which multiple tooth movements can be carried out, at the same time reducing the risk of inadvertent movement of the wrong teeth by reciprocal action." Higley[37] comments on this that "there is no doubt that the permanent dentition will provide better tooth anchorage, but at this age it also may be more difficult to move those teeth that need to be moved." ..... "Anchorage is adequate, and from this standpoint, it becomes a relatively insigificant consideration when it is derived from an extra-oral source."

However, this discussion as to whether it is easier to move teeth at a certain age does seem to be losing sight of the principle advantage of extra-oral force, that is, it guides the developing dentition into a better occlusion.

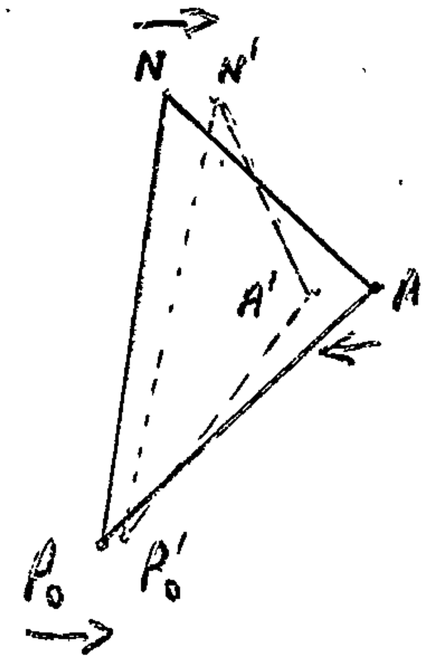
Perhaps King[44] in 1960 has made the most comprehensive

study on the differences in results obtained from treatment to different age groups. His results indicated generally "a greater amount of growth and favourable change occurred per unit of time in the youngest age groups .. In the severe cases, it seems that treatment should be timed to start earlier."

"The changes that occurred at subspinale (pt A) and pogonion confirmed the recommendations of Kloehn[46] regarding the desirability of starting treatment early. The slowing of growth with advancing age decreased the possibility for reducing the prominence of point A as well as obtaining favourable growth response indicated by pogonion. Furthermore the decreasing quantity of change that occurred as age advanced emphasizes the fallacy of depending upon the so-called pubertal growth spurt to provide sufficient growth for a desirable improvement in the more severe problems."

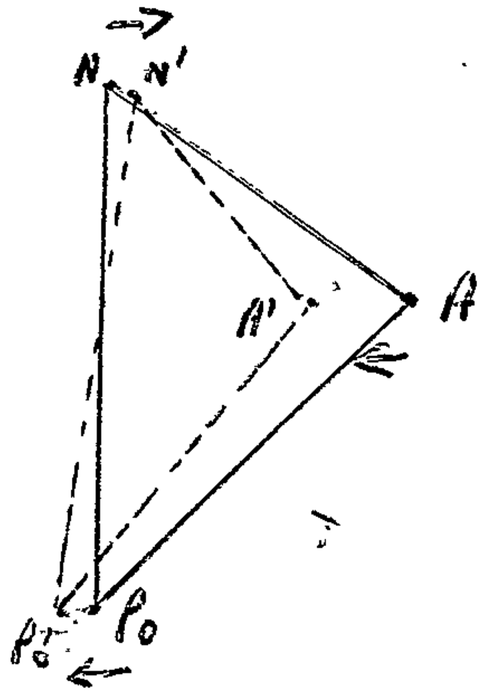
King's analysis of changes for a nine year old or thirteen year old groups after treatment are quite interesting as regards the nassion, subspinale and pogonion.

NINE YEAR OLD GROUP.



N Grew Forward.
A Was Reduced.
Po Grew Slightly Forward.

THIRTEEN YEAR OLD GROUP.



N Grew Forward Less.
A Was Reduced Same.
Po Dropped Back.

These results of King's certainly seem to indicate that treatment can be started as soon as convenient and that to wait for one final great growth spurt is erroneous. In other words growth, which occurs in 'spurts', is occurring throughout the patients development and treatment should be aimed at taking advantage of these growth increments where and when they occur.

Brader[10], in discussing King's[44] results brings the reminder that early treatment does not necessarily mean a better degree of improvement over later treatment; however, he concedes that treatment time may be reduced. Brader[10] also expresses misgivings about the risk in too early treatment of borderline cases of "prejudging the child with respect to eventual facial outline, the severity of the problem and perhaps even the amount of arch length deficiency. It is conceivable that after additional growth, the treatment plan may require a change." Brader seems a little contradictory when he talks of prejudging "borderline cases" with respect to the "severity of the problem". Also, it is hoped that all orthodontic treatment with a growing child, and most particularly headgear therapy, is always open to change in treatment plan in response to growth changes.

Finally, it might be recalled the Oppenheim who did much to revive the use of extra oral force, began to appreciate the potential of headgear appliances after seeing the improvement in an actress' occlusion- surely this was treatment in the adult dentition, well past the 'last great growth spurt."

Therefore, it does seem that if extra-oral force is being used to help guide the dentition into better occlusion by restraining maxillary growth while mandibular growth proceeds on its normal path,

then this guiding influence will be better appreciated with early treatment. Also, extra-oral force can be used in later stages of development to move teeth distally provided all other necessary treatment procedures are carried out - e.g. maybe there will be the need of second molar extraction.

The next advantage as listed by Henry[36] is the simplification of appliance therapy. Parker[59] (1958) feels that in cases of mild discrepancy, the total thickness of band material in sometimes 28 interproximal spaces, can be a major consideration. Nelson[55] (1952) in weighing the advantages and disadvantages of full banding against those of the simple two molar band technique, in which no force whatever is active except when the headcap is worn, concludes that "for the health and comfort of the mouth, there is little doubt that two bands are better than many. For less damage to investing tissues, intermittent force, if light, has been shown best." Block[8] (1962) says the "extra-oral force, when properly employed, can approach a physiological degree of tissue tolerance."

Finally, Henry[36] says that the number of extraction cases is reduced because anchorage is removed from the lower arch to the stable extra-oral region. This is also stressed by other writers - e.g. Kloehn[47] "growing alveolar bone is in continuous state of flux, and teeth in this type of bone will not provide much anchorage." Likewise, Graber,[29] in discussing extraction in the lower arch, says "my constant concern in these cases, or in any Class II case with extraction in the lower arch, is relapsing overbite. Thus, I am quite willing to accept a moderate irregularity in the mandibular anterior segment in preference to regularity at the time the appliances are removed, but a regularity

gained at the expense of tooth material with its greater attendent future functional and periodontal implications."

This aspect of extra-oral force is one of big advantage of headgear therapy and will only be realized provided the treatment is applied to the proper range of malocclusions, which, in itself, entails a correct case analysis of the malocclusion presented. This reverts back to the commencement of this section on indications for the use of extra-oral force, when it was said that these indications will be determined by :-

1. Case analysis.
2. Patient co-operation.
3. Ability of appliance and operator to control tooth movement.

These last two considerations will now be discussed with emphasis on the contra-indications and disadvantages of extra-oral force.

LIMITATIONS AND CONTRA-INDICATIONS.

The limitations and contra-indication of extra-oral force can be listed from examining the results obtained from headgear therapy, where any indesirable result could be listed as a limitation or contra-indication for its use.

There seems to be no dispute in the literature that the following sets of circumstances are either a limitation to the effectiveness of the appliance or else a contra-indication for its use.

1. Unreliable patient co-operation.
2. Intermittent wear.
3. Possibility of only uni-lateral response.
4. Inability to eliminate excessive curve of Spee in many cases.
5. Excessive distal tipping of maxillary first molers.
6. Impaction of second molars.
7. Sometimes excessive lingual inclination of maxillary incisors.
8. Class II Division I cases with deep overbite and loss of mandibular arch length.
9. Length of treatment.

Newcombe[57] concluded that he had "too many instances where he could not forecast correction of the malocclusion." As a consequence, he says that he is now more critical of selecting patients, but he does not say what are his criteria. Possibly, he initially was not selecting suitable cases for extra-oral therapy.

As regards patient co-operation Newcombe[57] sets a six month limit to see what progress and co-operation is taking place. Patient co-operation is a most important aspect of extra-oral therapy and the nightly use of the appliance is essential for the success of the treatment.

Another limitation which has a human aspect to it, is the length of treatment. Parker[59] had the objection to extra-oral force in that the treatment took too long. Similarly, Ketterhagen[42] comments, "it doesn't take most intelligent parents or patients long to realize that their neighbour's children had been in and out of appliances in less than half the time. The advantage of the head cap for a given individual lies in its ability to enhance the degree of perfection it is possible to attain, and not necessarily in reducing the lenght of treatment, nor in reducing the financial investment necessary for such treatment." Nelson[52] however, feels that while treatment may take slightly longer, the overall number of hours and degree of force is less. Also it should not be too difficult for Ketterhagens' 'intelligent' parents or patients' to realize that if a possible, shorter, full banding treatment is to be used, then maybe treatment would have to be postponed for several years until further eruption of permanent teeth.

The remaining contra-indications and limitations to the use of the appliance revert once again to the importance of case analysis in selecting patients for extra-oral force treatment. The results as reviewed in a previous section should be applied to the particular case, and if any of the possible results are detrimental to the prognosis of the case, then extra-oral therapy should be given deeper consideration or another treatment plan investigated.

OTHER USES OF EXTRA-ORAL FORCE.

Finally, the extra-oral appliance has been mentioned by some writers in two other roles, one as accessory anchorage to intra-oral anchorage, the other as a means of retention.

As mentioned previously, the big advantage of extra-oral force treatment to the maxillary arch, is that no anchorage is sought from the mandibular arch. However, even in those cases where upper and lower arches are places and intermaxillary elastics are used, extra-oral force can still be used as anchorage at night while the elastic traction is discontinued. This use of extra-oral force as a reinforcement for existing intra-oral anchorage is recommended by Stoner[68] and others.

Kanter[41] (1956) uses occipital anchorage to help preserve "the inegrity of the mandibular dental arch while it is being used to move segments of the maxillary dental arch distally." However, his illustrations in this article, which are done on technique models, all show malocclusions where the maxillary arch is a full tooth in advance of the mandibular arch. Also, all premolar teeth and second molars are shown erupted. Even with upper and lower arches, intermaxillary elastics and extra-oral anchorage it seems that Kanter[41] would be fortunate to correct the malocclusions without extractions. He does not mention that any extractions are indicated or planned in the treatment.

Newcombe,[57] after his disappointments in treating malocclusions in the mixed dentition with extra-oral force and bite plates alone, says that "perhaps the best use of extra-oral force is in conjunction with other appliances." Therefore it seems that, as Nelson[56] says, while a "realistic orthodontist no longer looks for stationary anchorage in the mouth," even in cases of intermaxillary elastic traction involving

reciprocal anchorage, the use of extra-oral anchorage at night as a reinforcement is highly beneficial, particularly to the mandibular arch, where too much elastic force can cause serious mesial tipping of mandibular molars.

The extra-oral appliance has been mentioned by Hopkins,[39] Nelson[55] and Kloehn[48] as being of use as a retentive appliance. Hopkins[39] recommends the "use of cervical gear during the retention period, which is almost indispensable when one observes a tendency for the maxillary teeth to start slipping forward toward their original positions. The Hawley retainer will not prevent this forward slipping, since it is usually en masse.....combining cervical gear and various types of acrylic retainers is often practical." Nelson[55] (1952) feels that extra-oral anchorage can be used to good advantage in retention once the distal movement or correction of the malocclusion has been attained - "When intermittent force has been used to secure a correction of the malocclusion, the intervals between wearing the headcap can be gradually increased in length until the appliance is worn only once a week." Nelson[55] goes on to say that "as a form of retention, extra-oral anchorage permits freely functional movement of teeth with intermittent restraint against tendencies to relapse."

On the contrary, Kloehn[48] considers it desirable "to overtreat to the extent of carrying the mesio-buccal cusp of the maxillary in line with the disto-buccal groove of the mandibular molar, because no retention is used. During this time, the patient is instructed in muscle therapy.....the facial musculature must serve as retention when appliances are removed and the stability of the result is dependent upon this." This aim to overtreat is highly desirable as Kloehn suggests, but having seen in another section of this review the uncertainty of distal

movement of maxillary molars; also the depencence on mandibular growth for correction of molar relationships, it will not always be possible to achieve this stage of overtreatment.

It does seem then, that the extra-oral appliance can be used in a deminishing fashion as a means of retention while the new occlusion is "settling-in" and also while muscle habits are corrected and the facial musculature is put to its proper function.

BIBLIOGRAPHY.

1. ANGLE, E.H. Regulating Appliances. Int. D.J. 323-329 1889.

2. ANGLE, E.H. Malocclusion of the Teeth 7th Edition - Text S.S. White Dental Mfg. Co. 190-195. 1907.

3. BALDRIDGE, J.P. Unilateral Action with Headcap. Angle Ortho.31:63:68 1961.

4. BIEN, SAVL. M. Analysis of the Components of Forces Used to Effect Distal Movement of Teeth. Angle J. Ortho 37:520 1951.

5. BJORK, A. The Face in Profile. Swensk Tandlakare - Tidskrift. Vol. 40. no. 55 1947.

6. BJORK, A. Cephalometric X-Ray Investigations in Dentistry. Inter. D.J. 4:718. 1954.

7. BLOCK, A.J. Analysis of mid-line and off-centre extra-oral force. Angle Ortho 24: 1-7. 1954.

8. BLOCK, A.J. Headgear - Modifications and Admonition. Angle Ortho 32:19-26 1962.

9. BLUEHER, W.A. Cephalometric Analysis of Treatment with Cervical Anchorage. Angle Ortho. 29:45-53. 1959.

10. BRADER. A.C. Variations in Profile Change and their Significance in Timing Treatment - King. E.W. Discussion on Article by King E.W. Angle Ortho 30 141-153. 1960.

11. BROADBENT, B.H. A New X-Ray Technique and its Application to Orthodontia. Angle Ortho 1:45-66. 1931.

12. BRODIE, A.G., DOWNS, W.B., GOLDSTEIN, A., MEYER, E., - A Cephalometric Appraisal of Orthodontic Results. Angle Ortho 8:264-351. 1938.

13. BRODIE, A.G., On Growth Pattern of the Human Head, From the Third Month to Eighth Year of Life. Am. J. Ortho and Oral Surg. 68:209-262. 1941.

14. BOWYER, J. Round Table Discussion. Am J. Ortho 48:277, 1962.

15. BRODIE, A.G. Late Growth Changes in the Human Face. Am.J. Ortho. 23:146-157. 1953.

16. BUCHNER, H.J. Anchorage Considerations in the Treatment of Class II Division I Malocclusions. Angle Ortho 4:217-245 1957.

17. CASE, C.S. Dental Orthopedia. Chicago 1921. C.S. Case Co. Text. Page 132-135.

18. CLOSSON, D.A. Extra-oral Anchorage, Its Indications, Use and Application. Am.J. Ortho 36:265. 1950.

19. DRENKER, E.W. Unilateral Cervical Traction with a Kloehn Extra-oral Mechanism. Angle Ortho 29:201-205. 1959.

20. ELASSER, W.A. & WYLIE, W.L. - The Craniofacial Morphology of Mandibular Retrusion. Am.J. Phys Anthrop. V.S. Vol 6 1948.

21. EPSTEIN, W.N. Analysis of Changes in Molar Relationships by Means of Extra-oral Anchorage (Headcap) in Treatment of Malocclusion. Angle Ortho 18:3-69. 1948.

22. FISCHER, B. Treatment of Class II Division I (Angle) Am. J. Ortho and Oral Surg. 33:705-737. 1947.

23. FISCHER, B. Orthodontics - Diagnosis, Prognosis, Treatment - Text. Page

24. FLETCHER, G.G.F. The Age Factor in Orthodontics. Trans Brit Soc. Orthodont., 9:31-40 1958.

25. GOULD I.E. Mechanical Principles in Extra-oral Anchorage. Am.J. Ortho. 43:319-333. 1957.

26. GRABER, T.M. Orthodontics-Text. Philadephia 1961. W.B. Saunders Co. Page 72.

27. GRABER T.M. A Cephalometric Appraisal of the Result of Cervical Gear Therapy. Am.J. Ortho. 40:60. 1954.

28. GRABER, T.M. Extra-Oral Force - Facts and Fallacies. Am. J. Ortho. 41:490-505. 1955.

29. GRABER, T.M. Appliances at the Crossroads. Am. J. Ortho. 42:683-701. 1956.

30. GREGORAK, W. Eruption Path of Permanent Maxillary Molars in Class II Division I Malocclusion Using Headgear. Am. J. Ortho 48: 367-381. 1962.

31. HAACK, D.C. & WEINSTEIN, J. The Mechanics of Centric and Eccentric Cervical Traction. Am. J. Ortho. 44:346-357 1958.

32. HANES, R.A. Bony Profile Changes Resulting from Cervical Traction Compared with Those Resulting from Intermaxillary Elastics. Am. J. Ortho. 45:353-364. 1959.

33. HEDGES R.B. Change in Molar Relationship in Class II Division I Treatment. Angle Ortho. 18:45-58. 1948.

34. HELLMAN, M. Diagnosis and Treatment of Class II Malocclusion of the Teeth. Int. J. Orthod, Oral Surg, and Radiog. Vol.17 No.2 1931

35. HELLMAN, M. An Introduction to Growth of the Human Face from Infancy to Adulthood. Int.J. Orthod., Oral Surg., and Radiog., 18:777. 1932.

36. HENRY, R.G. Cervical Anchorage and the Upper First Permanent Molar. Austral D.J. Oct. 261-268. 1961.

37. HIGLEY, L.B. Anchorage in Orthodontics Am. J. Ortho. 46:456-465 1960.

38. HOLDAWAY, REED A. Changes in Relationship of Points A and B during Orthodontic Treatment. Am.J.Ortho. 42:176-193. 1956.

39. HOPKINS, S.C. Inadequacy of Mandibular Anchorage. Am. J. Ortho. 46:440-455. 1960.

40. HOWES, A.E. Case Analysis and Treatment Planning Based upon the Relationship of Tooth Material to its Supporting Bone. Am.J.Ortho. and Oral Surg. 33:499-533 1947.

41. KANTER. F. Mandibular and Extra-Oral Anchorage. Am. J. Orth. 42:194-208. 1956.

42. KETTERHAGEN, D. Taking a Second Look at Headcap Treatment. Angle Ortho. 27:93-97. 1957.

43. KING. E.W. Cervical Anchorage in Class II Division I Treatment. A Cephalometric Appraisal. Angle Ortho. 27:98. 1957.

44. KING, E.W. Variations in Profile Change and Their Significance in Timing Treatment. Angle Ortho. 30:141-153. 1960.

45. KLEIN P.L. An Evaluation of Cervical Traction on the Maxilla and the Upper First Permanent Molar. Angle Ortho. 27:61-68. 1957.

46. KLOEHN, S.J. Guiding Alveolar Growth and Eruption of the Teeth to Reduce Treatment Time and Produce a more Balanced Denture and Face. Angle Ortho. 17:10-33. 1947.

47. KLOEHN, S.J. Analysis and Treatment in Mixed Dentitions, a new Approach. Am.J. Ortho. 39:161-186. 1953.

48. KLOEHN, S.J. Orthodontics - Force or Persuasion. Angle Ortho. 23:56-65. 1953.

49. LANDE, M.J. Growth Behaviour of the Human Bony Facial Profile as Revealed by Serial Cephalometric Roentgenology. Angle Ortho. 22 No. 2 April 1952.

50. LUCCHESE, F.P. Indications for the Use of Orthodontic Appliances Exerting Extra-Oral Force. D. Abs. 5:487. 1960.

51. McIVER, L.W. Five Steps to Better Occlusion in Class II Treatment. Am. J. Ortho. 48:175-191. 1962.

52. MOORE. A.W. Observations on Facial Growth and Its Clinical Significance. Am.J. Ortho. 45:399-423 1959.

53. MORRIS, V.B. Retraction of upper Buccal Segments Using Removable Appliance. Dent. Practitioner XI:439-441 1961.

54. MOSMANN, W.H. & HACKENSACK, N.J. Diagnosis and Treatment with Occipital Anchorage. Am.J.Ortho 42:112-115 1956.

55. NELSON B.G. What Does Extra-Oral Anchorage Accomplish. Am. J. Ortho. 38:422-434. 1952.

56. NELSON, B.G. Extra-Oral Anchorage in Class II Division I Malocclusion - its Possibilities and Limitations. Angle Orth. 23:121-133. 1953.

57. NEWCOMBE, M.R. Some Observations on Extra-Oral Treatment. Angle Ortho. 28:131-148 1958.

58. OPPENHEIM, A. Biologic Orthodontic Therapy and Reality. Angle Ortho. 6:157-167. 1936.

59. PARKER. W.J. A Technique of Treatment With Cervical Gear. Angle Ortho. 28:198-209. 1958.

60. POULTON D.R. Changes in Class II Malocclusions with and without Occipital Headgear Therapy. Angle Orth 29: 232-250. 1959.

61. RENFROE, E.W. The Factor of Stabilization in Anchorage. Am. J. Ortho. 42:883-897. 1956.

62. RENFROE, E.W. Technique Training in Orthodontics. Text Page 177. Edwards Bros, inc., Ann Arbor Mich, 1960.

63. RICKETTS, R.M. Facial and Denture Changes During Orthodontic Treatment as Analysed from the Temporomandibular Joint. Am. J. Ortho. 41:163-179. 1955.

64. RICKETTS, R.M. The Influence of Orthodontic Treatment on Facial Growth and Development. Angle Ortho 30:104-130. 1960.

65. SALZMANN, J.A. Principles of Orthodontics - Text Edition 2. Philadelphia 1943. J.B. Lippincott Co. Pages 181,206, 236,559.

66. SILVERSTEIN, A. Changes in the Bony Facial Profile Coincident with Treatment of Class II Division I (Angle) Malocclusion. Angle Ortho. 24 214-237. 1954.

67. STONER, M.et al. A Cephalometric Evaluation of Fifty Seven Consecutive Cases Treated by Dr. Charles H. Tweed. Angle Ortho . 26:68-98. 1956.

68. STONER, M. Past and Present Concepts of Anchorage Preparation. Angle Ortho. 28:176-187. 1958.

69. THOMPSON, W.M.Jr. Occipital Anchorage. Angle Ortho.10:206-211 1940.

70. TOUSTEIN, B.C. Behaviour of the Occlusal Plane and Related Structures in the Treatment of Class II Malocclusion. Angle Ortho. 25:189-198. 1955.

71. URBAN,W.D. A Cephalometric Study of Orthodontic Treatment using Upper Appliance with Occipital Anchorage. Angle Ortho. 25-61-76. 1955.

72. WEINBERGER, B.W. Orthodontics: An Historical Review of Its Origin and Evolution. C.V. Mody Co. 284:1926.

73. WEST E.E. Analysis of Early Class II Division I Treatment. Am. J. Ortho. 43: October 1957.